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A METHODOLOGICAL ANALYSIS OF DEMOLITION WORKS IN MALAYSIA

(ANALISIS METODOLOGIKAL TENTANG KERJA-KERJA PEROBOHAN DI MALAYSIA)

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PUSAT PENGURUSAN PENYELIDIKAN
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TAJUK PROJEK: **A METHODOLOGICAL ANALYSIS OF DEMOLITION WORKS IN MALAYSIA**

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ABSTRACT

As Malaysia continues to progress towards achieving a developed status, shortage of land and space will require existing structures to be demolished, in order to make way for new development. The dilemma of insufficient land in urban areas to sustain growth and cater for increasing modernization demands will augment to a critical level. Therefore, there is dire need to expedite research in the field of demolition works within the country. This research was aimed at developing an overview as well as assessing the potential of demolition operations in Malaysia. Two varying methodologies were adopted comprising a case study and a questionnaire survey. The former looked into the Lumba Kuda Flats demolition operations which formed part of the Gerbang Selatan Bersepadu project. On the other hand, the latter targeted feedback from the local industry's professionals. The case study revealed that local contractors were capable of managing large scaled demolition projects in terms of project planning, demolition techniques, health and safety implementation as well as environmental management. All work aspects met the requirements of international standards and codes and complied with local legislation. The survey reported beneficial data which provided strong indication of the industry's capabilities and identified problems plaguing the various aspects of demolition operations. In order to overcome the limitations and barriers presently faced, local professionals needed to look beyond and consider what the global demolition market had to offer. Apart from that, active government participation was extremely necessary in certain areas to provide long term and effective solutions. The benefits offered by the research are invaluable as it serves as a strong foundation and reference for developing future specifications, standards and legislation to govern demolition operations.

ABSTRAK

Dalam usaha mencapai status negara maju, struktur – struktur sedia ada terpaksa dirobohkan untuk memberi ruang kepada pembangunan baru disebabkan masalah kekurangan tanah. Hal ini dijangka akan menjadi kritikal di bandaraya – bandaraya pesat memandangkan dilema tanah yang terhad untuk terus menampung keperluan modenisasi yang semakin meningkat. Jesteru itu, kajian di dalam bidang kerja – kerja perobohan di negara ini adalah amat diperlukan. Kajian ini bertujuan untuk membentuk suatu gambaran menyeluruh serta menilai potensi operasi perobohan yang dijalankan di Malaysia. Dua kaedah yang berbeza ciri iaitu satu kajian kes dan satu kaji selidik telah digariskan sebagai methodologi kajian. Merujuk kepada kaedah pertama, operasi perobohan Flat Lumba Kuda yang merupakan sebahagian daripada projek Gerbang Selatan Bersepadu telah dipilih untuk kajian kes. Kaedah kedua pula lebih berteraskan maklumbalas yang diterima daripada golongan professional. Kajian kes melaporkan bahawa pihak kontraktor tempatan berkebolehan mengendalikan projek perobohan yang besar dari segi perancangan, teknik perobohan, keselamatan dan kesihatan serta pengurusan alam sekitar. Kesemua aspek kerja yang dilakukan telah memenuhi keperluan kod antarabangsa dan kriteria perundangan. Kajian soal selidik pula telah memberikan indikasi mantap akan keupayaan industri tempatan serta mengenalpasti masalah – masalah yang membelenggu aspek – aspek kerja perobohan. Sebagai langkah menangani kekongan serta halangan yang dihadapi, para professional tempatan disarankan untuk mempertimbangkan manfaat yang dapat diperolehi daripada pasaran perobohan global. Selain itu, penglibatan aktif kerajaan di dalam beberapa isu adalah amat diperlukan bagi mencari penyelesaian jangka panjang yang effektif. Dari segi sumbangannya, kajian ini dapat menjadi asas dan rujukan kukuh dalam membentuk spesifikasi kerja dan perundangan, berkaitan operasi perobohan di negara ini.

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CHAPTER 1

INTRODUCTION

1.1 Research Background and Justification

Most demolition practices that had been carried out within the last 20 years or so had little significance in the sense that they did not require high skill and technology. Demolition mainly focused on minor and simple structures such as wooden squatter houses, one or two storey fire damaged buildings as well as dilapidated structures from the past. New projects catering for residential, commercial and industrial development still had sufficient unused land allocations for their construction.

Turning the attention towards the present time, we can note that the situation now, is of somewhat different. An apparent observation can be made in terms of infrastructure development. Road networks of the past are no longer capable of sustaining the substantial increase of vehicle volume. There has been extensive upgrading and buildings of new highways to ease traffic congestion. These works required land acquisitions from private parties as well as involved a considerable amount of demolition operations. An ideal case to illustrate this was the construction of the New UTM city campus that literally cut through the entire length of the Old UTM city campus in Kuala Lumpur.

Further, there has been a steady increase in development projects both from government and private sectors partly due to economic prosperity as well as political stability. Based on statistics obtained from the Construction Industry Development Board (CIDB), it is clear that from Table 1.1, the total nationwide project volume rose by 15.4 % between years 2000-2001 and a lower 5.1 % between years 2001-2002. States such as

Melaka, Negeri Sembilan, Sabah and Selangor recorded high increases with percentages of 138.2 %, 70.3 %, 76.3 % and 31.6 % respectively, between years 2001-2002. From Table 1.2, the figures indicate that from years 2000-2001, projects categorized under infrastructure, maintenance, mixed development, residential and non-residential experienced a huge boom in volume. But however from years 2001-2002, the industry's pace slowed down with only residential projects being extensively undertaken, i.e. an increase of 71.4 %.

It is important to note that the growth of the construction sector has a very direct link towards demolition operations in the country. This is particularly true in urban areas where the utilization of more space for development will eventually lead to shortage of land. Areas experiencing depleting space will turn to redevelopment to sustain growth as well as cater for increasing market demands. This phenomenon has already begun and is expected to intensify in the near future. A present case to describe this would be the proposed demolition of the Pekeliling Flats comprising 7 blocks of 17 storey buildings and 4 blocks of 4 storey shop houses in the heart of Kuala Lumpur to make way for a mixed commercial and housing project. An article of the proposed demolition project is enclosed in Appendix A-A1.

Based on statistics of land use obtained from the Federal Department of Town and Country Planning for Peninsular Malaysia, it is apparent that from Appendix A-A2, the percentages of 'Built Up' land for Pulau Pinang, Selangor and Kuala Lumpur 3

Table 1.1: Project Volume by State, 2000-2002.

States	2000	2001	2002
Johor	441	516	596
Kedah	165	347	296
Kelantan	94	204	232
W.P Labuan	5	3	6
Melaka	57	76	181
Negeri Sembilan	139	155	264
Pahang	207	280	347
Perak	301	363	326
Perlis	28	32	51
Pulau Pinang	178	199	284
Sabah	218	219	386
Sarawak	212	228	299
Selangor	849	969	1275
Terengganu	103	130	232
Wilayah Persekutuan	1304	1241	442
Total	***4301***	***4962***	***5217***

Source: *2001-2002 Construction Industry Forecast Report, CIDB.*

Table 1.2: Project Volume by Contract Category, 2000-2002.

Category	2000	2001	2002
Infrastructure	1187	1387	1278
Maintenance	139	166	No Data
Mixed Development	60	94	105
Non-residential	1828	2273	1993
Residential	969	1030	1765
Landscape	No Data	No Data	55
Others	118	12	21
Total	***4301***	***4962***	***5217***

Source: *2001-2002 Construction Industry Forecast Report, CIDB.*

*** Note:** Non-residential covers Industrial, Commercial, Administration, Social Facilities, Agriculture and Security.

are at a staggering 28.3 %, 16.5 % and 63.5 % respectively. ‘Built Up’ is defined to cover commercial, residential and industrial development. Therefore, it is of no surprise that recently, Federal Territories Minister Tan Sri Isa Samad stated that Kuala Lumpur is facing serious land shortage and subsequently, 39 hectors of land at the Bukit Gasing Forest Reserve had to be de-gazette for development purposes. In addition, the Sungai Buloh and Bukit Cherakah Forest Reserves in Selangor have not been spared either. Relevant articles are enclosed in Appendix A-A3, A4 & A5.

Visualizing into the next 20 years or more, there will be a major problem. The dilemma of insufficient land in developed states for future or new projects is forecasted to augment to a critical level. Considering this fact, the questions to ask are, “What do we do now?” and “What are our options?” The answer is pretty obvious. Existing structures will have to be demolished to meet the demanding needs of modernization and progress. Demolition will play a significant role in future nation building. Our country will be evolving from the present developing status to the future developed state. This statement is not an imagination of the thought, but rather a fact supported by the aims of the government in realizing its Vision 2020 objectives. In fact, the first product of Vision 2020 will materialize on 31 August 2005 with Selangor being declared a developed state by Prime Minister, Datuk Seri Abdullah Ahmad Badawi. The supporting article is enclosed in Appendix A-A6.

Bearing all these matters in mind, there has been no initiative taken to address the problem. The first clear reason is that there is insufficient or probably no information on the subject of demolition in Malaysia. This was proven by the fact that searches and inquiries on the topic from established organizations such as the Institute of Engineers, Malaysia (IEM), “Jabatan Kerja Raya (JKR)”, “Pusat Khidmat Kontraktor (PKK)” and CIDB yielded disappointing results. The second reason being, that the current state of demolition operations is very much illusive. The subject is not often talked about and lacks publicity. The third is that there are no major government policies and regulations on the matter.

This fact was further confirmed by discussions with an officer from the Research and Development Unit of the Town and Country Planning Department, Kuala Lumpur.

There is a dire need to expedite research in the field of demolition works in the country. We still have time to conduct research and prepare for future demands. From the discussions stated above, it is apparent that there are many areas in which research and studies can be focused on. But however, as a first step towards addressing the problem, knowledge on the subject has to be initially acquired. Therefore, this research is focused on capturing and acquiring information and perspective from the local industry. Only by assessing the current image of the operations, can better understanding be achieved and improvements be made and explored.

The weight of the arguments and opinions presented for the case is hoped to have justified the need for research. The contributions of this research can be seen in terms of benefits gained by both the nation and the individual.

1.2 Research Aim and Objectives

This research is aimed at developing an overview as well as assessing the potential of demolition operations in Malaysia. It intends to generate perspective insight into the current state of demolition works which in turn, will be beneficially applied to serve as a solid platform for future research and development. Essentially, the objectives of this research are classified to the following:

- to study the characteristics, processes, techniques and requirements of crucial aspects in the execution of demolition operations,

- to capture and illustrate the actual practice of demolition works done by a local contractor,

- to establish statistical data through feedback obtained from the local industry.

1.3 Scope of Research

For the purpose of this research, the scope of study shall cover these two main areas:

- ***Case Study***

The case study will be based on a current project in the country with reference to a conventional form of building structure. Attention shall be focused on the aspects and organizations involved in the execution phase of the project. Apart from this, the project shall be selected considering factors such as the degree of cooperation anticipated from the project parties as well as time and convenience. •

- ***Questionnaire Survey***

The targeted survey participants would be randomly chosen from developed states comprising Pulau Pinang, Perak, Kuala Lumpur, Selangor, Negeri Sembilan, Melaka and Johor. The sample shall be of a moderate size with sufficiently varied characteristics to be able to reflect a miniature replica of the industry’s professionals. In addition, the survey shall also be unbiased and consider aspects of monetary implications.

1.4 Research Methodology

This section briefly outlines the research methodologies that were used in fulfilling the objectives set out in this research. However, Chapter 3 will provide detailed descriptions and further discuss the topic.

- ***Literature Review***

  Extensive literature review was executed to obtain information which primarily aided in developing a better understanding of the research subject. In addition, it also provided an overview of the demolition industry and enabled specific areas of concern to be highlighted to form research components.

- ***Case Study***

  A case study was conducted on a selected demolition project in Malaysia to illustrate the characteristics of demolition operations. The aim of the case study was to capture first hand information and data from the source itself.

- ***Questionnaire Survey***

  A questionnaire survey was carried out to tap information from the local construction industry. The survey was intended to aid in establishing statistical data through feedback obtained from Malaysian industry professionals.

Figure 1.1 illustrates the interrelationship between the methodologies chosen and the specific objectives.

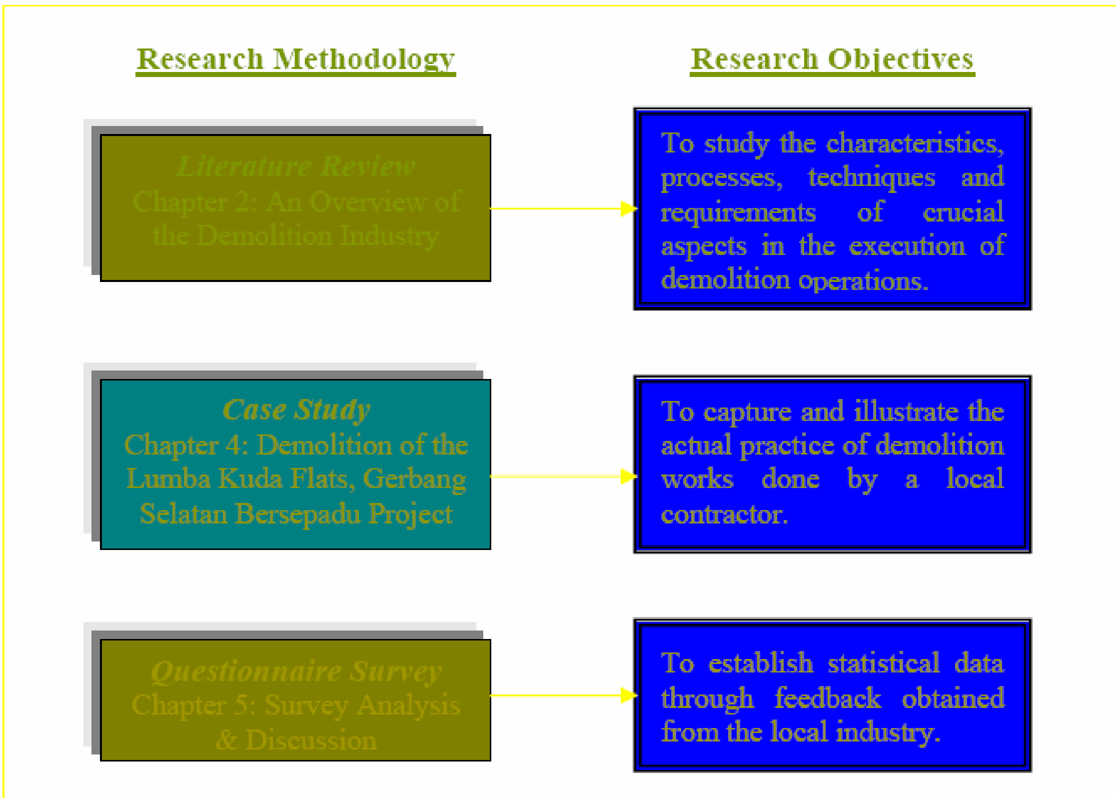


Figure 1.1: Interrelationship between research methodologies and objectives.

1.5 Thesis Layout

This section generally highlights the categorization of the thesis contents in terms of defined and systematic chapters. The thesis is divided into six chapters and a summary of each chapter is presented herein:

- **Chapter 1:** *Introduction*

  This chapter provides an introductory view into the subject of demolition as well as discusses the research background and provides justification to the research. Apart from that, it introduces the research aim, objectives and work scope as well as highlights the methodologies adopted in order to fulfill the objectives outlined.

- **Chapter 2:** *An Overview of the Demolition Industry*

  This chapter elaborates on the overall perception and components that make up the demolition industry. The chapter begins with defining the principles of structural demolition and stressing on the aspects involved in the demolition process. In addition, the various types of demolition techniques and safety requirements are also brought to attention. Further subsequent explanations are then given on the topics of demolition waste management and recycling as well as related environmental issues.

- **Chapter 3:** *Research Methodology*

  The contents of this chapter basically touch on the measures employed to achieve the desired research results. It provides detailed description on the approaches and methods implemented to gather information and data from various sources. The chapter then proceeds to illustrate the overall methodology framework and schedule required for undertaking the research.

- **Chapter 4:** *Case Study: Demolition of the Lumba Kuda Flats, Gerbang Selatan Bersepadu Project.*

  This chapter provides a surface level account of the actual practice of demolition works based on a selected demolition project in Malaysia. It describes thoroughly the concepts, techniques and necessary aspects of the works during the execution of the project.

- **Chapter 5:** *Survey Analysis & Discussion*

  This chapter portrays the analysis performed on the survey questionnaires retrieved from the respondents. It classifies the analyzed information in terms of percentage and ranking computations. The results are presented in various graphical forms with supporting discussions.

- **Chapter 6:** *Conclusions and Recommendations*

  This final chapter presents a summary of the research findings and provides conclusion. It also expresses the extent of which the objectives have been achieved as well as suggests recommendations for future research and development.

CHAPTER 2

AN OVERVIEW OF THE DEMOLITION INDUSTRY

2.1 Introduction

The history of demolition goes back all the way to the war era where the original purpose for its existence was to heed the call of ruling governments to clear and rebuild destroyed and torn cities. Due to the shortage of raw materials and a huge increase in construction demands, early pioneering demolition contractors had to pool their resources, share expertise and work co-operatively on the enormous tasks that faced them. With the passing of time and war momentum behind them, they started to open transfer of experience and problem solving techniques which eventually grew to form technical support, training as well as established worldwide federations such as the National Association of Demolition Contractors (NADC) and the National Federation of Demolition Contractors (NFDC).

Today, the demolition industry has experienced a radical transformation compared to its past. Most demolition projects undertaken are complex in nature, demanding greater skill, experience and precision than ever before. New cutting edge advancements have been made in terms of equipment and machinery that are capable of reaching skies and operating faster, economically and more efficiently.

Demolition techniques are much enhanced with proper planning and design to achieve greater accuracy, results and safety. In addition, stringent legislation and growing commercial as well as environmental concerns have made a major impact on the industry. More organizations are now venturing into and implementing waste management and recycling programs.

Due to the alarmingly decreasing land for construction, nations are calling for the use of developed sites and conversions of existing buildings to meet current demands. Therefore on a broad spectrum, demolition can be predicted to be playing a major role in future nation building. The industry which was previously unknown and termed unsophisticated has finally found itself in the limelight with greater appreciation.

This chapter highlights the fundamentals of structural demolition as well as the aspects involved in the execution of demolition operations. The proceeding sections provide further detailed descriptions as well as discuss the various techniques and equipment commonly found and used in the industry.

2.2 Principles of Structural Demolition

Structural demolition can be defined as:

> "The complete or partial dismantling of a building or structure, by pre-planned and controlled methods or procedures"
>
> (AS 2601, 2001)

> "The dismantling, wrecking, pulling down or knocking down of any building or structure or part thereof; but does not include such work of a minor nature which does not involve structural alterations"
>
> (Department of Labour New Zealand, 1994)

> "Dismantling, razing, destroying or wrecking any building or structure or any part thereof by pre-planned and controlled methods"
>
> (Code of Practice for Demolition Hong Kong, 1998)

There are basically three types or categories of structural demolition and they are:

- **Progressive Demolition –** considered to be the controlled removal of sections in a structure whilst retaining its stability in order to avoid collapse during the works. It is most practical for confined and restricted areas such as town and city centers. Progressive demolition is also more commonly known as top-down demolition whereby deconstruction works are initiated from the top of the structure to progress sequentially to the ground.

- **Deliberate Collapse Mechanisms –** considered to be the removal of key structural members to cause complete collapse of the whole or part of the structure. It is usually employed for detached, isolated and reasonably leveled sites where the whole structure is intended to be demolished. Sufficient space should be available to enable equipment and personnel to be relocated to a safe distance.

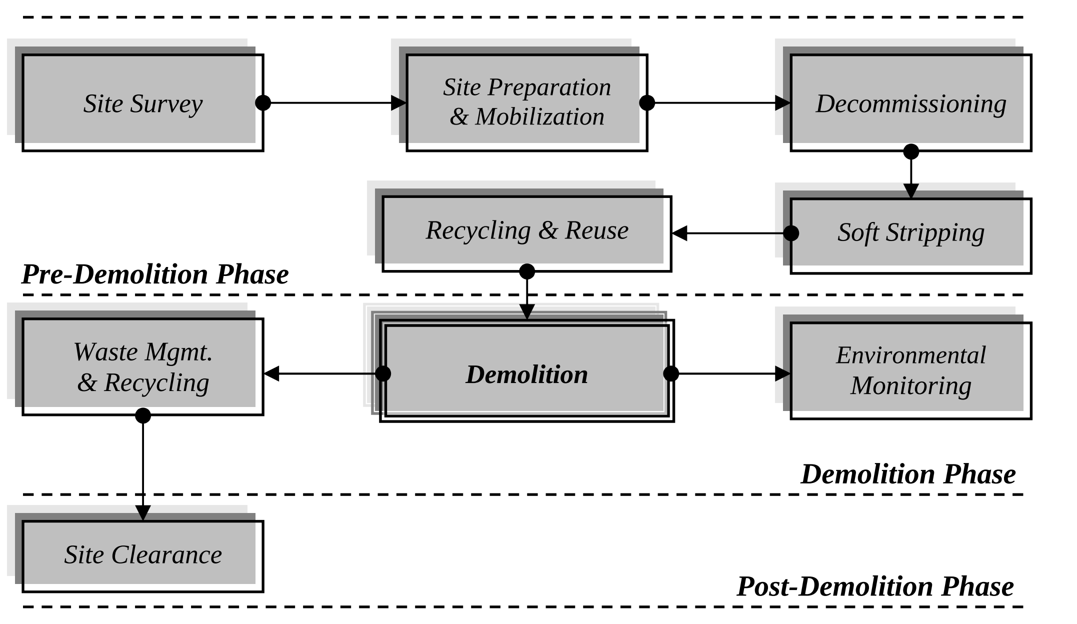
- **Deliberate Removal of Elements –** considered to be the removal of selected parts of the structure by dismantling or deconstruction. It can be used in the lead up to deliberate collapse or as part of renovation or modification works.

2.3 The Demolition Process

The execution stage of the demolition process can be classified as comprising three main work phases which are:

- the pre-demolition phase,
- the demolition phase,
- the post-demolition phase.

These phases are further explained in the following sections. Figure 2.1 below illustrates the sequential flow of activities involved in each phase.



Sources: *BS 6187-2000; AS 2601-2001; Code of Practice for Demolition Hong Kong-1998; Code of Practice for Demolition New Zealand-1994; Lumba Kuda Flats Case Study-2005.*

Figure 2.1: Activities involved in the **execution** of demolition operations.

2.3.1 Pre-Demolition Phase

The pre-demolition phase focuses on works that are conducted prior to the actual demolition and consists of activities such as:

- **Site survey –** normally carried out in the form of desk studies and on-site investigations. The survey is done to obtain information as well as to build familiarization with actual site conditions. Aspects that are surveyed are with respect to access routes, topographical features, ground conditions, location and types of existing services as well as adjacent property. In addition, core samples from structural elements are taken for testing to ascertain the structure's strength and integrity.

- **Site preparation and mobilization –** the site is prepared and conditioned to receive demolition works. This activity includes the erection of safety fencing and hoarding, site offices as well as other site facilities. Mobilization comprises of aspects such as conducting temporary works, erecting scaffolds and safety signages, diversion and protection of existing services and property as well as establishment of plant and machinery.

- **Decommissioning –** is done to bring the structure from its fully operational state to one where all charged systems are terminated or reduced to the lowest hazardous level. This includes the disconnection of electrical, water, gas, plumbing and telecommunication cables as well as removal of bulk processes or chemicals.

- **Soft stripping –** is done to remove all non-structural items such as fixtures, fittings, windows, doors, roof tiles and ceilings.

- **Recycling and reuse –** soft stripping materials are collected and sorted to be reused, sold or recycled.

- **Environmental monitoring –** initial water and air quality as well as noise and vibration levels are monitored by a team of specialists.

2.3.2 Demolition Phase

The demolition phase concentrates on the actual demolition operation and comprises of activities such as:

- **Demolition –** is executed with the use of heavy equipment and machinery depending on the technique selected, to break and demolish the structure into smaller fragments for disposal and recycling.

- **Waste management and recycling –** is carried out to properly manage all wastes and debris generated from the demolition process. The management covers areas such as ordinary debris and hazardous wastes storage, handling, transportation, dumping as well as burning. These aspects are planned and monitored to avoid possible environmental contamination and pollution. Apart from that, debris such as steel and concrete are sorted on site for recycling purposes, or to be reused as secondary construction materials.

- **Environmental monitoring –** water and air quality as well as noise and vibration levels are monitored during the works to ensure that they do not exceed the allowable limits.

2.3.3 Post-Demolition Phase

The post-demolition phase pays attention to the activities implemented after the major demolition works and includes:

- **Site clearance –** upon completion of the overall works, the project site is cleared and reinstated to eliminate any potential hazards. All pits and trenches are covered and filled to prevent water infiltration. Existing temporary drainage systems are inspected and cleaned to ensure proper flow and function.

- **Environmental monitoring –** water and air quality as well as noise and vibration levels are monitored after the works to ensure that they are at acceptable levels.

2.4 Demolition Techniques

This section outlines the various techniques and equipment commonly used in structural demolition works. The industry itself in general, requires very robust and stable equipment capable of producing massive power but at the same time, providing agility in order to demolish and tear down existing structures. The techniques employed can be classified into five main categories which are:

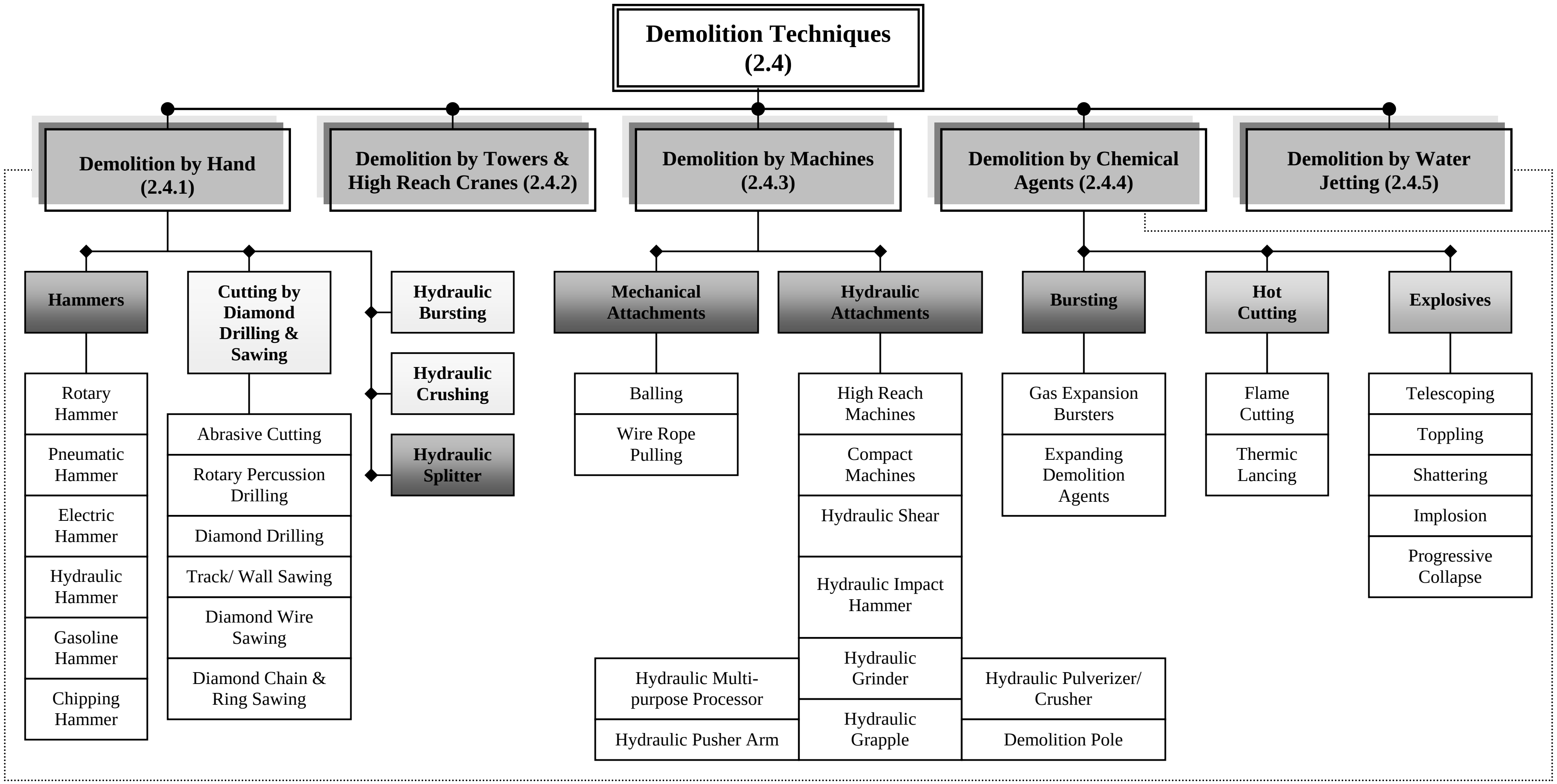
- Demolition by hand,
- Demolition by towers and high reach cranes,

- Demolition by machines (with mechanical or hydraulic attachments),
- Demolition by chemical agents,
- Demolition by water jetting.

These categories can be further expanded to comprise different components as illustrated in Figure 2.2. The techniques adopted can be executed separately, but in most circumstances, combinations of two or more methods are usually used. The contents herein will elaborate to a certain extent the functions, features as well as benefits and disadvantages of the each respective technique.

2.4.1 Demolition by Hand

Hand demolition was often slow whereby only rendering the use of hand-held tools such as hammers, wrecking bars, shovels and cutters. However, this technique has eventually evolved to incorporate more advanced tools for example, hand-powered equipment consisting of breaker hammers, diamond saws and splitters. These tools are operated either by using gasoline, pneumatic, hydraulic or electric power. This technique is most often used in small scaled demolition operations. In larger projects, it is employed to primarily weaken the structure before heavier equipment is brought in. Strict safety precautions in terms of working conditions for example, secure platforms and scaffolding must always be considered and checked. Safety harnesses or belts must be used when working on dangerous and high elevations.



Source: *BS 6187, 2000.*

Figure 2.2: Detailed categorization of the various types of demolition techniques.

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2.4.1.1 Rotary Hammer

The versatility of the rotary hammer allows it to demolish concrete with a hammer only action, or to deliver rotary hammer action for boring holes. This is done in the rotary hammer mode by driving twist drills and core bits, or in the hammer only mode whereby utilizing everything from flat-chisels to ground-rod drivers.

An apparent disadvantage is the fact that rotary hammers have an extra drive train that rotates the drill bits and in doing so, siphons off energy and decreases efficiency in the hammer only mode. It uses a battering ram that floats inside a cylinder and is launched and retrieved by a piston. A shock absorbing airspace between the ram and the piston compresses and drives the ram forward as the piston advances, then sucks it back as the piston retracts.

2.4.1.2 Pneumatic Hammer

The impact energy of this hammer is obtained by allowing compressed air to expand in the cylinder of the hammer, driving the piston rapidly against the anvil, which transmits the released impact energy to the chisel. This tool works on a basic principal of movement induced by the expansion of compressed air.

An air compressor is normally used to supply compressed air to the hammer. The advantages offered are that it can be easily mounted on light carriers, requires lesser accessories as well as maintenance, works better in confined spaces due to its weight-power ratio and is suitable for underwater usage.

2.4.1.3 Electric Hammer

The stroke energy is obtained from an electric motor via an eccentric cam, which produces a reciprocating motion. In comparison to the rotary hammer, the electric hammer is able to deliver more powerful blows since they typically have about 35 % more power. This is due to the reduction in components as well as longer piston stroke. Although the hammer delivers fewer blows per minute, the increased strength of the tool makes it quicker and more efficient in demolishing concrete and masonry.

Figure 2.3: An electric hammer

2.4.1.4 Hydraulic Hammer

The impact energy is obtained from hydraulic oil supplied at a fairly high pressure. Since hydraulic oil is an incompressible fluid, the pressure cannot be converted into motion without an auxiliary medium. In order to make such a motion possible, hydraulic hammers are equipped with a nitrogen bulb or chamber. The compressible nitrogen is separated from the oil by a diaphragm and provides the requisite conversion of pressure into motion. In this way, the piston is able to thrust rapidly against the anvil. The anvil then transmits the released impact energy to the chisel. The hydraulic hammer operates with a completely enclosed hydraulic system. However, unlike the pneumatic hammer, it is not suitable for working underwater unless its supply has been adapted for that purpose.

2.4.1.5 Gasoline Hammer

The stroke energy is obtained from the rotation of a gasoline motor, which is converted to a reciprocating motion by an eccentric cam. These hammers normally weigh from 10 – 40 kg. However, the gasoline hammer produces lower stroke energy in contrast to the pneumatic and hydraulic type hammers.

2.4.1.6 Chipping Hammer

Chipping hammers are lightweight and can be easily positioned to break vertical and overhead surfaces. The smallest chipping hammers whether powered electrically, pneumatically or hydraulically, usually weigh between 5 – 30 pounds. A good indication of the tool's power is its weight whereby the heavier the tool, the more powerful it is.

The chipping action is rapid, ranging from 900 – 3000 blows per minute. The hammer is maneuvered by handling a handle at the back of the tool and by gripping the tool by its shaft with the other hand. Some hammers have a second handle along the side. This additional feature gives operators control of the tool's weight and the ability to direct its chipping action at different angles.

2.4.1.7 Cutting by Diamond Drilling and Sawing

Contractors have gradually developed a preference towards cutting by using diamonds rather than the conventional systems when dealing with the removal of concrete and other construction materials. The advantages offered by cutting techniques incorporating diamonds, well surpass those provided by conventional methods. Table 2.1 summarizes the apparent differences between these 2 techniques.

Table 2.1: Comparison between diamond and conventional cutting techniques.

	Diamond	**Conventional**
Time	o Fast o Reduced labour costs o Reinforcing bar can be cut	o Slow and repetitive o Labour intensive o Separate cutting required
Tolerances	o Accurate cuts	o Limited control of tolerances
Structural	o Limited vibration o Removal of large structural sections will not affect the structure	o Risk of vibration damage to surrounding structure o Potential damage to adjacent sections
Environmental	o Low noise level o Minimum debris o Dust free o Ease of debris removal	o High noise level o Maximum amount of debris o Very dusty o Expensive cleaning up
Access	o Remote machine operation possible o Can be used underwater, in confined spaces o Ease of cutting around existing services	o Inflexibility of machinery o Difficult to be used in underwater and confined operations o Problematic in areas with existing services

Described herein are the various cutting techniques employing the usage of diamonds.

i. Abrasive Cutting

Abrasive cutting is a method of forming a shallow cut into masonry or concrete by using an electric driven angle grinder. There are hydraulic and air driven machines, but the most common is a 110 volt. electric powered type. These machines are fitted with either abrasive wheels or diamond tipped blades, usually running dry. Cutting is restricted to a depth of approximately 85 – 90mm as the blades seldom exceed 225mm in diameter. These tools are efficient in both masonry and un-reinforced concrete but not very successful for cutting steel.

Figure 2.4: A diamond cutting machine (robore.com, 2005).

ii. Rotary Percussion Drilling

It is a method of drilling construction materials using a hand-held drill and is suitable for most un-reinforced materials. It can also be used to create small diameter holes. This technique can be employed to break out concrete for removal as well as form chases for conduits or pipes.

Figure 2.5: A rotary percussion drill (robore.com, 2005).

iii. Diamond Drilling

The power unit of the diamond drill can be electric, hydraulic or pneumatic. Drilling bits are usually in the range of 10mm – 1m whereby the smaller the diameter, the greater the speed of rotation. The driving shaft provides continuous supply of water to keep the diamonds cool, free of dust and grit as well as assist in reducing wear. This technique is used when precise circular cuts are needed.

Figure 2.6: A diamond drilling machine (robore.com, 2005).

iv. Track/ Wall Sawing

This technique enables cutting of door and window openings through walls as well as through floors for stairways and lifts without the need for stitch drilling. The track saw consists of an aluminium rail which has a set of supporting feet that are secured to the concrete by means of rawlbolts. The track has guides and rails built into it together with a toothed rack or track. The traveling bogey is secured to the track by runners and a cog wheel engages the rack to enable it to travel backwards and forwards.

The bogey also houses the hydraulic motor which powers the diamond saw blade. The blade usually ranges between 450mm – 2m. The power unit is always hydraulic; either electric or diesel powered. The saw is usually operated by remote control away from the surface that is being worked upon. The cutting is carried out by making a series of passes along the length of the material being cut. The depth of each pass is dependent upon the type of material and choice of saw blade.

v. Diamond Wire Sawing

The setting up method is almost similar to that of the track saw but in lieu of the saw blade, a grooved pulley wheel of 800mm in diameter is used. The wire is passed over a number of small idler pulleys to the surface being cut. The wire consists of a steel core strand which is approximately 6m in diameter. It has diamond beads along its length at 30mm intervals. The beads are separated by small springs or plastic or rubber. The wire is positioned over the pulleys and fed through pre-drilled holes in the concrete that is being cut. The wire can be of almost any length and is joined by special crimps. Sawing is carried out by turning on the power and maintaining a constant speed, whilst applying pressure by gently providing a steady backward movement along the track.

Figure 2.7: A diamond wire saw (pdworld.com, 2005).

vi. Diamond Chain and Ring Sawing

The diamond chain saw is normally powered hydraulically. It employs a chain fitted with diamond segments. It is useful for cutting window and doorway openings in masonry bricks and blocks because straight lines can be easily cut using right angle comers. The diamond ring saw on the other hand is fairly quiet and vibration free. The depth of cut is usually limited by the blade diameter. This technique is also efficient in creating openings in pre-cast floor systems.

2.4.1.8 Hydraulic Bursting

The burster has a hydraulic power unit which is usually generated by electricity, diesel or petrol. Holes of 110mm or 200mm in diameter either in a straight line or a diamond shaped configuration are initially created using a diamond drill. Once the holes have been completed, the burster head which has a number of pistons is then inserted into these holes. Pressure is subsequently applied from the hydraulic power pack to induce cracks.

Cracking will follow a plane of weakness to the adjacent holes provided that the burster head is correctly positioned. The process is then repeated until the whole area is fractured and ready for removal. Reinforcing steel bars are cut using angle grinders or flame cutters. This technique is quiet and efficient for use in concrete demolition.

2.4.1.9 Hydraulic Crushing

The main difference if compared to hydraulic bursting is that this technique does not require any holes to be pre-drilled and the resulting rubble consists of much smaller dimensions. Provided that a free or open edge is available, the hydraulic crushing jaws which look like a large letter ‘C’ or a crab’s claw, are installed over the concrete that is to be broken. The power unit is then operated to enable the jaws to come together to crush the concrete. Similarly, the process is repeated until the whole area has disintegrated.

Reinforcing steel bars are then cut by angle grinders or cutters. The limitations of this method are that the jaws are quite heavy and the larger units require a balancer to accommodate the weight. This system is not practical for concrete over 350mm in thickness and requires fully boarded scaffolding below the floor area being worked upon. However, this technique provides a few advantages in the sense of being almost vibration and noise free as well as does not need water supply during operation.

2.4.1.10 Hydraulic Splitter

The splitting cylinders are handheld demolition devices which controllably split material with the use of hydraulic pressure. It basically comprises of a handle, control valve, front head, wedge and counter wedges. The splitter functions on a wedge principal, whereby a strong force is applied in an extremely constricted space (from within). Concrete normally puts up considerable resistance to forces applied externally. As a result, conventional demolition methods such as hydraulic chisels or crushers are unable to demolish these materials with any worthwhile degree of control or precision. By comparison, the resistance of concrete to the force applied internally is 90 % less, resulting in the concrete disintegrating relatively easily.

(a) (b)

Figure 2.8: (a) A hydraulic splitter, (b) Mechanism of operation (www.darda.de, 2005).

Referring to Figure 2.6 (b), the mode of operation for this tool consists of 3 phases. The first phase involves a hole of precise diameter and depth to be drilled into the material. The wedge set (1 wedge and 2 counter wedges) is then inserted into the drill hole. In the second phase, the wedge is driven forward under hydraulic pressure, forcing the counter wedges apart with a force of up to 400 tons. The material splits within seconds.

Finally, the third phase requires that the counter wedges be enlarged in order for the split to be expanded to its maximum width. This technique offers several advantages such as being dust free and near silent, vibration free, light weight, controllable and precise, easy handling as well as suitable for close quarters and hard to access places.

2.4.2 Demolition by Towers and High Reach Cranes

Towers and high reach cranes are normally used to carry out demolition works on structures that are very high. In addition, it is also used for high structures that do not provide sufficient working platforms such as cooling towers, elevated water tanks and storage silos. BS 6187 [2] states that the use of such cranes for demolishing high rise structures should be considered for the removal of structural elements and of debris, as an alternative to dropping of materials. Tower cranes are designed for the lifting of freely suspended loads and should not be used for balling operations.

Figure 2.9: A tower crane (www.liebherr.fr, 2005).

2.4.3 Demolition by Machines

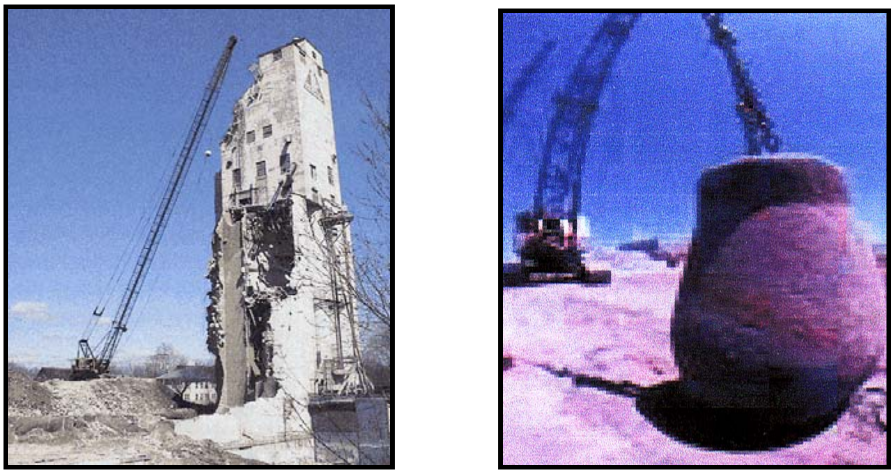
Demolition by the use of machines with mechanical or hydraulic attachments is the most common technique applied in the industry today. Powerful and heavy machinery are often required involving large projects with massive structural forms or dangerous environments. They are not only efficient and time saving, but also capable of operating in extreme conditions. Demolition engaging machines with mechanical attachments are usually executed by balling or wire rope pulling. A typical machine is made up of 3 primary components which are the base machine, equipment and optional attachments. These components can be defined as:

> **Base machine –** "machine without equipment and attachment, that includes the mountings necessary to secure equipment as required"
>
> **Equipment –** "set of components mounted onto the base machine to fulfill the primary design function when an attachment is fitted"
>
> **Attachment –** "assembly of components forming the working tool that can be mounted onto the base machine or (optional) equipment for specific use"
>
> (BS 6187, 2000)

2.4.3.1 Balling

Most structures can be knocked down by balling where destruction is caused by the impact energy of the steel ball suspended from a crane. Balling can be done in two ways which are by hoisting the ball and releasing it to drop vertically or winching the ball towards the machine and releasing it to swing in line with the jib. According to the Code of Practice for Demolition Hong Kong [5], swelling of the jib is not recommended as the ball's motion will be difficult to control. Apart from that, swelling also induces tremendous amount of stress onto the jib. The boom angle when balling should not be more than 60^0 to the horizontal. The top of the boom should not be less than 3m above the wall being knocked down.

The safe working load for the machine must be at least 3 times the weight of the ball. The maximum ball weight should not exceed 50 % of the safe working load (SWL) of the machine, at the working radius. The demolition ball usually weighs up to 6000kg. The ball should be properly fixed in such a manner to prevent it from becoming disconnected by slack in the load line or other causes. A trapped ball can lead to serious overloading of the crane when trying to release it by dragging or lifting. Continuous water spraying is normally executed to minimize the dust production to the surrounding area. This technique is suitable for dilapidated buildings, silos and other industrial facilities. However, the operation requires substantial clear space and while the concrete can be broken into rather small fragments, additional work in the form of cutting reinforcement may be necessary. This form of demolition often creates a great deal of dust, vibration and noise.



(a) (b)

Figure 2.10: (a) Balling machine, (b) Demolition ball (demolitionx.com, 2005).

2.4.3.2 Wire Rope Pulling

This technique of demolition involves attaching ripe ropes to a structure, usually of steel and pulling the pre-weakened structure to the ground by winch or tracked plant such as an excavator. The technique is suitable to detach buildings when clear space is sufficient. Wire ropes of at least 16mm in diameter are normally used with a safety factor of 6, Department of Labour New Zealand [6] and 4, Code of Practice for Demolition Hong Kong [5]. A safety distance of 1.5 times the height of element to be demolished shall be maintained between the machine and the building during the pulling. The rope may be passed through a double or triple pulley block in order to increase the pulling force. The arm of a hydraulic excavator can also provide the required force on the rope. However, the wire rope pulling method is often limited to buildings less than 15m in height. This technique can be used for timber framed buildings, bridges, masonry and steel chimneys as well as for spires and masts. Caution should be employed when pulling pylons and masts because they tend to twist when pulled. If the legs are of different lengths, the pylon could fall at right angles to the pull.

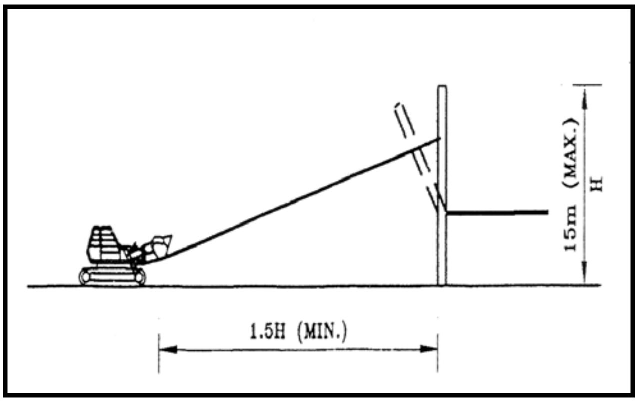


Figure 2.11: Wire rope pulling technique (Code of Practice for Demolition Hong Kong, 1988).

2.4.3.3 High Reach Machines

Correct positioning of the machine relative to the work face is crucial and the angle of the boom should be limited in accordance to the machine's specifications to ensure safe operation and stability. Appropriate machines fitted with suitable booms and arms should be considered to mechanize the deconstruction of high rise structures. Figure 2.10 illustrates the latest high reach wrecker machine from Volvo. This EC 460B model comprises of a 3-piece high reach configuration with a maximum pin height of 26m and forward reach of 14m. This machine can operate safely 30i left and right of the centerline over the front of the undercarriage, allowing attachments with a maximum weight of 2500kg to be used. It also features a full dust suppression system, hose rupture valves and a Prolec total moment indicator.

Figure 2.12: Volvo’s EC 460B high reach wrecker (volvoce.com, 2005).

2.4.3.4 Compact Machines

When compact machines are used for demolition on the upper floors of buildings, an assessment of the strength of the floor should be made, taking into account the possibility that the machine and a quantity of debris could eventually be supported on part of the floor before being removed. These machines are usually used for breaking, cutting, handling, transporting and soft stripping. Precautions such as providing edge protection and restraint systems should be taken to prevent these machines from falling down holes in floors or from the edges of buildings.

(a) (b)

Figure 2.13: (a) A skid steer loader, (b) A telescopic handler (komatsu.com, 2005).

2.4.3.5 Hydraulic Shear

Machines mounted with hydraulic shears can be used for cutting purposes for a variety of materials such as wood, steel and concrete. It is normally used particularly where there might be a risk of fire or where the more precise cutting of a torch is not required. The shear's unique jaw and blade configuration allows it to process all these materials without the need for costly and time consuming jaw or blade change outs. It is made of strong, abrasion-resistant, custom alloy steel, capable of effectively converting tangled steel into dense piles of processed scrap.

(a) (b)

Figure 2.14: (a) A rebar shear, (b) A plate and tank shear (genesis-europe.com, 2005).

2.4.3.6 Hydraulic Impact Hammer

Demolition by impact hammer involves the destruction of masonry, rock and concrete structures by applying heavy blows to a point in contact with the material. It is usually used for primary and secondary breaking. Primary breaking focuses on the demolition of the actual structure where else secondary breaking is tuned more towards breaking elements from the former into smaller fragments for easier handling and transportation. These hammers produce excessive noise, vibration and dust. Impact hammers should not be used to demolish tall vertical structural elements such as walls and columns from the sides, as there might be a possibility of debris falling onto the machine.

(a) (b)

Figure 2.15: (a) Hydraulic impact hammer in primary breaking, (b) Hydraulic impact hammer in secondary breaking (rammer.com, 2005).

2.4.3.7 Hydraulic Grinder

This machine is widely used as another form of convenient demolition technique. This innovative attachment is capable of grinding through hard rock and dense concrete. It features mounting brackets that allow easy installation and removal on a range of 60,000 – 150,000lb excavators. It comes equipped with removable and replaceable carbide processing teeth that offers maximum grinding productivity and wear life. In trenching, concrete removal and other rock based operations; the Cyclone grinder from Genesis dramatically outperforms traditional tools such as hydraulic hammers as well as minimizes noise and vibration.

Figure 2.16: Genesis's Cyclone grinder (genesisequip.com, 2005).

2.4.3.8 Hydraulic Grapple

As defined by BS 6187 [2], the grapple is designed for use in primary demolition and re-handling operations, for example steel and concrete beams, columns, walls and floor sections progressively to ground level. The jaws interlock to enable partial loads to be safely secured. The parallel-jaw closing action ensures that material is drawn into alignment during the dismantling, lifting and loading cycle as appropriate. Figure 2.15 (a) illustrates a fixed hydraulic grapple form Allied Construction while Figure 2.15 (b) shows a rotating hydraulic grapple from Genesis. The continuous 360^0 rotation along with articulation of the bucket cylinder allows the rotary grapple to perform in positions that cannot be achieved with a fixed grapple.

(a) (b)

Figure 2.17: (a) Allied's fixed grapple (alliedcp.com, 2005); (b) Genesis's rotating grapple (genesis-europe.com, 2005).

2.4.3.9 Hydraulic Pulverizer or Crusher

Demolition by a machine mounted pulverizer or crusher is the progressive demolition of reinforced concrete or masonry structures by crushing the material with a powerful jaw action by closing the moving jaw(s) against the material. The RC series pulverizers from Allied Construction are light yet powerful and durable, capable of delivering quiet and vibration free cutting and crushing performance. When used in recycling, it pulverizers concrete to separate it from the reinforcing bars. By reducing product size, it facilitates in easier handling and transportation operations.

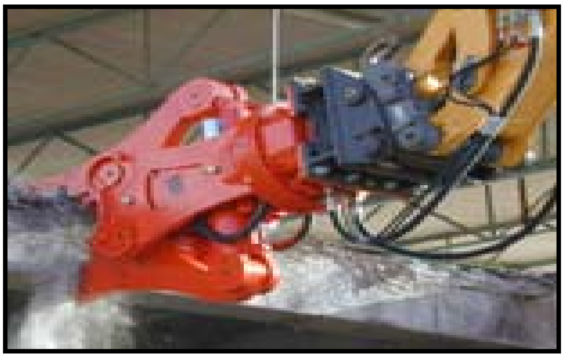


Figure 2.18: Allied's RC series hydraulic pulverizer (alliedcp.com, 2005).

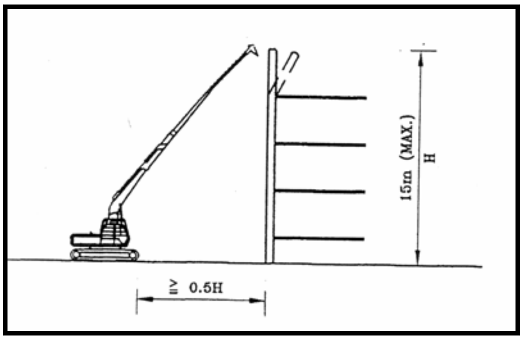
2.4.3.10 Hydraulic Multi-purpose Processor

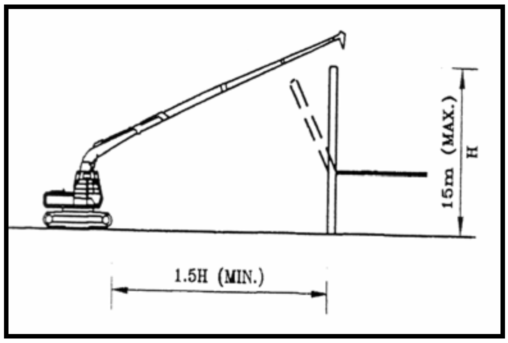
BS 6187 [2] states that multi-purpose attachments can be used to progressively demolish reinforced concrete or steel structures including chemical and oil storage tanks by the use of interchangeable jaws. Multi-purpose attachments can be mounted either directly to the boom or to the dipper arm. The NPK multi-processor is designed to maximize the attachment by using a variety of changeable jaw sets that can be used for concrete cracking and pulverizing, scrap metal shearing, plate and timber shearing as well as reinforced concrete processing. It operates in such a manner that whenever the jaws encounter resistance, the hydraulic booster is automatically activated. The pressure intensifier system has a relatively low oil flow, which produces faster cycle times and more crushing strength.

Figure 2.19: NPK's hydraulic multi-processor (www.npke.nl, 2005).

2.4.3.11 Hydraulic Pusher Arm

Mechanical pusher arm involves the use of machines equipped with a pusher arm attachment for applying horizontal thrust to demolish the structural element. The pusher arm is commonly made of steel. When the arm is properly secured to the excavator, its forward motion generates the pushing force. The Code of Practice for Demolition Hong Kong [5] suggests that a minimum safety distance of 0.5 times the height of the building element being demolished shall be maintained between the machine and the building for pushing into the building. The main advantages of the pusher arm is that it is extremely mobile, produces high output and is able to wok on vertical faces and floors above standing level. The disadvantages however, are that it needs adequate access, a firm and relatively flat base to work from as well as can only operate within the reach of their booms. The pusher arm technique is not suitable for large buildings on confined sites but is rather efficient for masonry infill structures.





(a) (b)

Figure 2.20: (a) Pushing-in by hydraulic pusher arm, (b) Pulling-out by hydraulic pusher arm (Code of Practice for Demolition Hong Kong, 1988).

2.4.3.12 Demolition Pole

A telescopic or rigid demolition pole with attachments such as a claw or ripper hook, can be used to achieve greater working height and distance from the base machine during the progressive dismantling of roofs, walls and lintels of masonry built structures. The working radius of the machine is increased by the fitting of an extended pole which is mounted onto the dipper arm. Positioning and use of the attachment should be achieved by movement of the boom and/ or pole rather than by movement of the base machine.

Figure 2.21: Demolition pole machine with a rotating boom (alliedcp.com, 2005).

2.4.4 Demolition by Chemical Agents

This form of demolition is usually costly but capable of producing quick results. Adequate care and safety precautions have to be taken when dealing with bursting or flammable chemical agents as well as explosives. This technique requires special skill and experience. There is always a bigger risk to be addressed and possibilities of uncontrolled and unplanned events occurring are very much higher. Demolition by chemical agents consists of 3 components which are bursting, hot cutting and explosives.

2.4.4.1 Bursting

The bursting technique can be adopted in situations where relatively quiet, dust free and controlled demolition is preferred. This method generally functions on the basis of expansion whereby lateral force is applied against the inside of holes drilled into the material. However, rather than shattering the concrete into bits as dynamite and impact tools would, the lateral forces build up over time to crack the concrete into smaller portions. There are 2 common bursting demolition techniques and they are:

i. Gas expansion bursters

The effect of the burster is obtained by inserting it into a prepared cavity in the mass to be demolished. Upon being energized, the resultant increase in pressure of the gas ruptures a diaphragm, releasing the gas into crevices in the surrounding structure which is then fractured. A gas expansion burster should be effectively restrained within the prepared cavity in order to prevent it from becoming projected in an uncontrolled manner. The characteristics of gas expansion bursters are:

- Able to split concrete in a controlled manner,
- More costly than hydraulic pressure bursting,
- Quiet, no vibration, little or no dust,
- Temperature sensitive – freezing greatly reduces effectiveness,
- In excess of 4300psi of expansive pressure may be generated to produce concrete cracking within 10 – 20 hours.

ii. Expanding demolition agents

The expansive demolition agent is a cementitious powder. Using a drill with a mixing attachment, the powder is mixed in a bucket and poured or tampered into the drilled holes. As the mix hardens and expands, the concrete cracks between the drilled holes. As the hairline cracks develop over the material, they run outwards into each other and grow wider, until the material literally falls apart under an expansive force that can exceed 12,000psi. When used correctly, this technique produces little dust or debris.

A phenomenon known as blow-out is sometimes associated with expansive demolition agents. This happens if the powder mix gets too hot and reacts with the water too quickly for the material to expand laterally. The result can range from a puff of smoke to a loud gunshot-like sound that can send the hardened mix 30ft into the air. Since blow-outs are unpredictable, safety procedures require personnel to stay well away from the drilled holes once the mix has been poured into them. If a blow-out does occur, the remaining mix in the holes is usually still effective enough to crack the material.

2.4.4.2 Hot Cutting

Hot cutting should be selected only where the work system chosen avoids the risk of fire or explosion. Work methods should prevent localized oxygen enrichment and be executed in areas away from combustible and flammable materials. As defined by BS 6187 [2], hot cutting techniques are methods that can potentially generate sufficient heat in the form of friction, sparks or flames. The technique employs the use of oxy fuel gases and disc grinders. Hot cutting can be classified into flame cutting and thermic lancing.

i. Thermic lancing

During thermic lancing, combustion typically produces molten material and thick smoke. This technique is applied to cut through material including concrete. Cutting of reinforced concrete involves very high temperatures ranging from 2000 ^{0}C to 4000 ^{0}C. The tip of the lance is preheated to start an oxygen-ion reaction which produces an intense heat source that is then applied to cut the material. The extremely high heat requires special precautionary measures and care. Listed below are some considerations that should be taken into account when employing this method.

- excessive heat causes some deterioration of the concrete adjacent to the cutting,
- works particularly well in the presence of reinforcing steel,
- eliminates vibration and dust problems,
- may create smoke and fire hazards.

2.4.4.3 Explosives

Explosives are generally used for removing large volumes of concrete via insertion of explosive devices in a series of drilled holes. The use of explosives are governed by a few factors which can be seen in terms of it being versatile and flexible, damage to surrounding structures as a result of vibration and air-blasts as well as requires heightened safety considerations compared to other demolition techniques. Over the years, extensive development in explosives has rendered its usage to demolition of entire structures. When engaging explosives in structural demolition, there are a few considerations that must be assessed. These considerations are:

- **Suitability for demolition by explosives –** assessments to determine whether the structure is suitable for demolition is extremely crucial. The structural layout as well as the construction mode of the building has to be analyzed and scrutinized before hand. As an example, a diaphragm wall construction of five storeys can require so much drilling and preparation, that the cost of explosives work would be comparable to that of conventional demolition.

- **Local topography –** it is important to understand the site topography as it may to a certain extent, determine where and how the structure falls. Adjoining structures, existing services, historical buildings and railway tracks are some aspects that must be given consideration. In addition, the ingress of dust into air-conditioning systems of nearby buildings as well as buildings housing sensitive equipment is also a critical issue that must be addressed.

- **Actual structural strength –** an assessment of the actual stresses and strength of the structure must be made prior to demolition. Common forms of assessments include scrutinizing as-built drawings and design calculations, conducting core tests on structural elements for example columns and beams as well as checking for signs of modification or extensions made to the structure. Locations of expansion and construction joints should be carefully noted as these joints can divide the structure into several distinct parts during demolition.

- **Height-width ratio and center of gravity –** the ratio between the height and width of a structure is important mainly when toppling is being used, and will determine the size of the wedge to be taken out. For the successful toppling of a structure, its center of gravity must pass beyond the pivot point, otherwise there is always the risk of a structure standing half demolished or collapsing at random.

- **Fragmentation –** one of the desired end results is that the rubble can be easily cleared. Considerations should be given on whether the structure should be simply dropped and then broken by other means when down on the ground, or whether it is more economical to carry out additional preparation and charging so that the direct debris is already well fragmented. Methods available for achieving this extra fragmentation are high drops, shearing and racking as well as by the use of delays.

- **Ground vibration –** care should be practiced in controlling the magnitude of vibration caused so as not to cause damage to surrounding structures, machineries and utilities. A generally acceptable level is a peak particle velocity ranging between 5 and 50mms^{-1}.

- **Air-blasts and fly debris –** special safety measures must be implemented to avoid and minimize air-blasts and fly debris to prevent injuries or accidental damage. Proper demolition design and the amount of explosives used are important factors that must be evaluated.

- **Survey of surrounding property –** the severity of the expected impact will obviously determine the radius to which this survey will need to be carried out, but on fairly large contracts, it is advisable to carry out an external and sometimes internal survey up to 50m-100m from the structure to be demolished.

As discussed in the Technical Paper No. 3 outlined in the Explosives Engineering Handbook [11], before the demolition of any major structures, a comprehensive planning exercise must be carried out; firstly to determine which elements are to be removed by explosives, secondly to determine in which sequence they are to be removed and finally to plan the placing of the charges. In structural demolition, the length of the drill hole is short in relation to the charge, and to achieve adequate confinement and maximum energy output, the holes are lengthened by drilling at 45^0. The 45^0 hole also allows the easy placing of a quick-setting gypsum plaster which acts as a stemming agent.

It is essential that with these relatively thin members, that the charge is centrally located to prevent the gases from venting along the line of least resistance and waste their energy without producing the desired results. A practical limit to this method is the thinness of wall that can be successfully removed by explosives. It is generally more practical to remove thinner walls by conventional demolition. There are a few techniques available and can be selected when dealing with demolition involving the use of explosives. These techniques are telescoping, toppling, shattering, implosion and progressive collapse.

i. Telescoping

This term describes the near-vertical collapse of a structure caused by introducing enough compressive stress at the base to make the disintegration at the bottom a continuous process as the structure descends. This technique requires the explosives to cause sufficient movement to initiate the collapse, after which gravity provides the main source of energy for the fragmentation. The main use of the technique is for the demolition of natural-draught cooling towers.

ii. Toppling

Structures such as water towers tend to have a circular leg pattern. The hinge must be created behind the center of gravity and that the rear leg or legs must be severed. The remainder legs should be checked to ensure that they will be able to support the structure for the period of demolition, otherwise there is a possibility of a vertical collapse occurring. Although it is common to think that they naturally pivot about the base, but actually, the structure tends to rotate about the center of gravity while frictional forces keep the base in place. The maximum forces generated must be checked against the foundation's resistance to overturning as this is important in preventing a kick-back. The pressure under the foundation must also not exceed the soil's or rock's bearing capacity.

(a) (b)

Figure 2.22: (a) A toppling chimney, (b) A toppling water tank (implosionworld.com, 2005).

iii. Shattering

Shattering is the most common use of explosives, ranging from quarry blasting to foundation works. Its 2 major uses are either to shatter in-site for removal by other means or to shatter to bring about collapse. Charges are normally placed near the reinforcement for heavily reinforced structures to provide maximum transmission of energy for aiding in fragmentation.

Figure 2.23: A shattering bridge pier (implosionworld.com, 2005).

iv. Implosion

The Webster's dictionary defines implosion as a violent collapse inwards. The basic principle is to try to pull the structure away from adjacent exposures towards an area large enough to contain the debris. Therefore, the only time a building truly implodes is when exposures such as other structures or areas of concern completely surround it. One of the key factors in this type of operation is the timing of the charges which brings about the sequential collapse of the structure. In certain cases, they can spread over a period of as much as 16 seconds, including the time taken to shear and fail within the structure.

In other cases, it may be necessary to introduce a rapid collapse because of the column configuration. As well as complicated delay sequences, another way of implementing collapse is by the use of cables to pull in uncharged sections of the building. An essential ingredient in the successful application of this technique is experience. The reason for this is that an estimate must be made of the rate at which various elements of the structure will fail, collapse and fall.

Figure 2.24: A residential building imploding (implosionworld.com, 2005).

v. **Progressive collapse**

This technique is closely related to the implosion technique but is linearly rather than centrally activated. Its main application is on relatively long structures in situations where ground vibration levels are critical. Although such structures could normally be toppled sideways, this would entail the total tonnage hitting the ground simultaneously. A progressive collapse is arranged so that relatively small parts of the structure will hit the ground at considerable intervals due to half second delays. This gives a series of minor impacts at sufficient intervals such that the ground waves do not combine or interfere constructively to give high peak particle velocities.

Figure 2.25: A medical center progressively collapsing (implosionworld.com, 2005).

2.4.5 Demolition by Water Jetting

Water jetting involves the use of water jet stream pumped at high pressure to erode the cement matrix and wash out the aggregates. Abrasive compounds may be added for cutting of reinforcing steel. The maximum allowed reaction force created by the water jet is 250N. Water jetting executed by handheld equipment has several disadvantages such as they cannot be preset to a certain depth, difficult to work with and requires frequent pauses or two operators taking turns to avoid risk of accidents due to fatigue. It also generates a lot of waste water. Apart from that, the benefits are it reduces dust production and fire hazards.

Figure 2.26: Hand operated pressurized water jetting (conjet.com, 2005).

2.5 Demolition Safety Requirements

Safety forms an essential part in any demolition operation. Sufficient precautions and considerations must be given to avoid casualties or even fatalities. This section describes the safety measures that must be adhered to when conducting demolition works with respect to some general aspects as well as the various techniques as outlines in Section 2.4. The importance of using personal protective gear and equipment are also stressed. Proper safety during works can only be achieved if all personnel are skilled and trained to competently execute their specific tasks. Summarized herein are the basic recommendations suggested by BS 6187 [2], AS 2601 [4], the Code of Practice for Demolition Hong Kong [5] and the Department of Labour New Zealand [6].

2.5.1 Site Safety

Site safety features is intended to emphasize protection of the public particularly the pedestrian, site personnel, vehicular traffic as well as adjacent property. The measures cover the requirement for hoarding, scaffolding, warning signages as well as protective enclosures. In any demolition project, the basic necessities are a proper safety and emergency plan along with the provision of first aid medical kits.

- **Hoarding –** should be provided around the perimeter of the demolition site including any additional precautionary measures taken to prevent unauthorized entry or trespassing during the period of demolition.

- **Scaffolding –** the erection and dismantling of the scaffold should be carried out by competent workers possessing adequate experience. Double row scaffolding shall be provided for demolition projects using top down methods. Work platforms should be securely installed to serve both working purposes as well as to retain small debris from falling out of the building. Periodic maintenance shall be performed to remove any debris accumulated on these platforms.

- **Warning signages –** signages of warnings should be posted at strategic locations and must be clearly visible. They should be brief, exact and clearly lettered.

- **Protective enclosures –** consideration should be given to the need for protective, environmental and debris enclosures such as reinforced plastic sheeting and screen netting added to the scaffolding or other temporary structures. They should be designed to take account the loads of projected materials as well as wind loads.

2.5.2 Basic Hand Tools – Soft Stripping

The vast majority of hand tool injuries occur when the proper tool is not used for the right job. Generally, injuries can be avoided if the tools are kept in good condition, used in a safe manner, properly stored and regularly inspected, repaired or replaced if found to be defective. Presented herein are fundamental measures that should be employed when working with some common hand tools.

- **Wrecking bars and crowbars –** these tools should have a sharp point or keen edge that enables a firm hold on the object being moved. Using poor substitutes for these tools such as pieces of pipe, angle, iron or other building materials should be avoided, since they are more likely to slip or break, thus resulting in injury.

- **Wire and bolt cutters –** proper eye wear should be used when using these tools. Cutters should be correctly sized depending on the task and any sort of extensions over its handle to gain additional leverage should be avoided. They should not be over stressed as well.

- **Sledges and hammers –** operators are required to wear eye protection to prevent possible blindness from concrete chips and splinters. Tools must also be inspected prior to use for unacceptable conditions such as mushroom heads, cracks, looseness and splinters.

- **Shovels –** proper use requires a firm solid stance and moving the entire body in the direction of the material that is being thrown instead of twisting the back or knees. Improper use will result in serious back injuries.

2.5.3 Hand Powered Tools

Hand powered tools are potentially more hazardous than common hand tools. Power sources such as compressed air, electricity and fuel further magnifies the safety hazards brought about through careless handling or incorrect usage. Generally, injuries can be avoided by locating power lines and hoses in appropriate places so as not to cause obstructions, positioning them away from heat, oil and chemicals as well as providing adequate inspections on a regular basis. Outlined herein are basic measures that should be considered for a few selected hand powered tools.

- **Pneumatic powered tools –** the air hoses pose a great safety threat because they can be punctured, cut or damaged by heat and chemicals; resulting in uncontrolled whipping. Proper fastening of couplings as well as damage induced by debris and traffic are also factors to be considered. Pointing or touching the compressed air hose opening can cause air bubbles to enter the blood stream, resulting in death, ear drum damage or partial body inflation.

- **Electric powered tools –** these tools must be properly grounded (earthed) or doubly insulated to prevent electrocution, burns and shocks. The cords should be inspected for signs of fraying and cracks or other damage before use. In addition, avoid operating on wet surfaces.

- **Fuel powered tools –** apart from the fact that fuel is highly flammable, there are also hazards induced by toxic fumes. Fuel spilled on hot tool surfaces and the accumulation of vapours and fumes can create an explosive environment. Refueling should be executed when the tools' engines have cooled down, in areas with proper ventilation and away from sparks, flames as well as other heat sources.

- **Abrasive blades –** it is important to select the proper blade for the particular material being worked on. Abrasive blades used for cutting concrete, masonry or metal should be examined for cracks or scratches before each use. A blade guard must always be employed and should cover a substantial portion of the blade. Operators are required to wear safety goggles and advised not to push the blade too hard while cutting, to prevent overheating.

2.5.4 Towers and Machines

Falling debris is of particular concern in demolition works both in terms of the workers actually involved as well as bystanders. The demolition area has to be clear of all unnecessary personnel prior to the works. All demolition work must be provided with an exclusion zone. The extent of the exclusion zone should be considered to be viable depending on the demolition activity, rate of progress and can even extend beyond the site boundary. Large attachments such as those mounted onto excavators require a viewing area of at least 75ft and about 30ft for smaller attachments, such as those mounted on skid-steer loaders, backhoe loaders and mini-excavators.

All attachments and machines should be checked and maintained on a regular basis. They must be used appropriately in accordance with the manufacturer's specifications. Any attempt to conduct modifications should be avoided. Excavators should be equipped with cab safety screens or cages installed over the top and front glass when demolishing any type of overhead structure. The cab windows must also be of transparent and shatter proof glass. The ground or surfaces on which these machines operate must be strong enough for support. Where appropriate, consideration should be given to provide adequate support for cranes and towers especially in the presence of basements and other below ground voids. In addition to this, all machinery should operate on relatively flat terrain.

2.5.5 Chemical Agents

The requirements of safety when dealing with chemical agents cover an extremely wide area, governed by individual and specific material characteristics. However, they can be generalized to focus on a few basic and important aspects. These aspects are in terms of:

- provision of adequate ventilation to prevent harm from toxic fumes and gases,
- proper handling methods,
- proper storage,
- careful usage of materials,
- proper disposal and
- careful packing and storing of used or unused materials.

2.5.6 Explosives

Explosives in their own right are extremely dangerous. The Institute of Makers of Explosives have established various strict conditions and regulations to be made and used as guidelines when engaging explosives in demolition or blasting to avoid unwanted events. In Malaysia, explosives transportation licenses are issued by the Police Department. The permit type POL 102 is required when transporting explosives from the manufacturing company to the site, while permit type POL 123 and 124 is necessary when transporting these materials to another location from the site. Only licensed personnel should be allowed to transport explosives.

Explosives should be kept in magazines that are clean, dry, bullet proof, fire resistant, properly ventilated as well as always locked. The container or housing case should be handled with care and opened with tools that do not generate sparks along with minimal friction. Only the precise amount of explosives and detonators needed for the demolition operation should be transported to the site. An adequate exclusion zone must be provided depending on the demolition technique adopted, as outlined in Section 2.4.4.3. The radius of a typical exclusion zone shall not be less than 2.5 times the building's height.

Sufficient notices and warning signages must be posted to inform and alert all personnel as well as the public. Demolition by the use of explosives normally causes some undesirable side-effects such as excessive dust production, ground vibrations, flying debris and/ or air-blasts. However, these aspects will be further discussed in Section 2.7 respectively, as they relate to environmental issues.

2.5.7 Personal Protective Equipment

Ensuring that proper protective gear is used during the demolition works can avoid and reduce the possibilities of severe injury. Safety wear is usually required in the form of:

- Protective clothing,
- Safety footwear,
- Safety helmet,
- Safety gloves,
- Eye and face protection,
- Hearing protection,
- Respiratory protection,

Figure 2.27: Proper protective gear while conducting hot cutting operations (demolitionx.com, 2005).

2.6 Demolition Waste Management and Recycling

Demolition is often considered to be a waste generating activity. Most demolition wastes are classified as solid wastes. They are usually categorized according to their composition, potential to harm the environment and their disposal procedures. These wastes vary in terms of being the actual debris of the demolition works such as concrete and masonry rubble, timber or steel, buried or existing hazardous chemicals as well as hazards generated from deteriorating materials such as asbestos. Proper segregation of materials is important to keep disposal costs at a minimum, partly because of the fact that the most potentially harmful materials attract the highest disposal costs. If materials are mixed, the whole consignment should be dealt with respect to the most harmful material and may be treated as special wastes.

BS 6187 [2] defines controlled waste as wastes generated from households, commercial and industrial sectors. This includes unwanted surplus substances, building and demolition waste, in addition, anything which is disposed as a result of being broken, worn out, contaminated or spoiled in some form of manner. The waste management licensing system implemented under the Waste Management Licensing Regulations 1994 with conditions imposed by the Environmental Protection Act (EPA) 1990, states that it is illegal to treat, keep or dispose of controlled waste without a waste management license. Those who produce, import, carry, keep, treat or dispose of demolition wastes must take all reasonable measures to ensure that it is managed properly and recovered or disposed of safely. This clearly stresses that waste management must take its duties and responsibilities seriously. The point is particularly relevant at the demolition site since the nature of the wastes may be difficult to identify.

In implementing a sound waste management practice, there are seven key areas which can be actively addressed to ensure legislation compliance and to promote good environmental practice. The first five areas are appointment and auditing of waste carriers and disposal contractors, traffic management, storage and sorting of wastes, salvage and recycling as well as dealing with asbestos and other known hazardous materials. Waste management plans drawn up addressing these areas should be based on the following recommendations as suggested by CIRIA 528 [15]:

- ensure the appropriate inspection and verification of waste carriers and disposal contractors' registration and licenses before they are engaged,

- ensure there are in place detailed procedures for the transfer of waste to registered carriers and that all who need to be are fully aware of those procedures,

- ensure particular care over traffic management, especially if contaminated soil and other debris are being transported,

- ensure segregation of inert, active and special wastes and promote awareness among personnel of the potential legal and financial penalties involved for not doing so,

- ensure there is active salvage, recycling and sorting of all appropriate materials such as bricks, concrete, blacktop, timber, window frames and tiles; classify site waste and separate it for reuse, recycling or disposal to tip and, if not already identified, search locally for disposal outlets for recyclable materials,

- ensure alertness to problems arising from waste disposal including residual paints and solvents in containers, dusts from concrete, timber and asbestos as well as broken glass, all of which may cause safety hazards and/ or pollution problems.

Further to this, the sixth key area involves dealing with wastewater, oil and petrol tanks. Demolition sites always produce wastewater in substantial quantities as well as more obvious pollutants. Demolition activities often affect the water environment in many ways as the result of:

- runoff from washing-down of trucks and other equipment as well as from dust-suppression sprays,
- generation of dust and grit,
- the hosing of dirt and waste from various surfaces,
- leakage from oil and fuel tanks,
- oil or fuel spillage through poor protection, vehicle damage or accidental valve opening,
- vandalism,
- dumping of debris into or near to watercourses,
- demolition of tanks without prior investigation and/ or emptying.

The disposal of these wastes need to be carefully planned and controlled because at risk, are local rivers and other fresh water, the groundwater and in more urban areas, workers in drains and other sewerage facilities who can so easily be overcome by the fumes from hosed away chemicals. Steps taken to tackle this area of concern should be based on the following recommendations:

- ensure careful positioning of oil and fuel storage tanks, and provide protection measures such as bunds of appropriate construction and capacity, oil and petrol separators or other secondary containment,

- ensure secure valves are provided on oil and fuel supplies,

- consider providing settling tanks or other separators for silt-laden material,

- ensure that the level of site security is appropriate,

- consider sealing off or removing abandoned drains to minimize the risk of contaminated water spreading,

- actively managing site surface water, for example by providing collection channels leading to oil and/ or silt traps as appropriate,

- consider using appropriate wastewater for certain site activities to reduce consumption of clean main water supply.

Lastly, the seventh key area involves managing and controlling fires as a result of site burning. Burning is often considered to be the only practical way of disposing of at least some debris from demolition works. But this activity creates nuisance to neighbouring parties and more seriously, an infringement of the legislation. Smoke, gases and fumes given off can cause significant pollution. Surface fires can induce combustion of underground materials such as coal fractions and previously deposited wastes. If induced, such fires can smoulder indefinitely and be exacerbated during any future excavation works that increase oxygen ingress. Measures taken to address this aspect should be based on these following recommendations as suggested by CIRIA 528 [15]:

- identification of relevant by-law restrictions on site fires,
- ensure that the wind and other atmospheric conditions are appropriate, that it is kept under close control and that no potentially harmful or unknown substances such as unmarked chemical drums are placed nearby,

- ensure that the specific location overlies inert non-combustible material,
- consider providing a powerful hose which is always connected to a suitable supply for dousing partially or completely any accidental flare-ups or fuelling of the fire caused by unsuitable materials,
- ensure testing of water supply pressure from time to time,
- ensure proper disposal of ashes as they may contain elevated concentrations of chemicals such as arsenic.

After successful demolition operations, considerations must be given to undertake a post-demolition survey to establish the actual levels and areas of any residual contamination, to act as a basis for future action and development, and to ensure there has been no unintentional cross-contamination of otherwise clean ground. Many environmental agencies appreciate the common problems faced by the demolition industry with regards to waste management and effortlessly endeavours to assist demolition organizations by providing information and guidances. But however, persons or companies that are ignorant and show disregard in adequately managing wastes are normally prosecuted. This is partly due to the ever expanding and stringent policies outlined to counter and control waste as well as pollution.

Along with waste management comes recycling, which forms an essential part of the process. Due to its dominant and vital role, the subject of recycling will be further stressed and discussed herein. Recycling from demolition projects can result in considerable savings since it saves the costs of transporting to the landfill and eliminates the cost for disposal. As landfill costs for construction, demolition and land-clearing debris continue to rise and become more heavily regulated, it makes more economic sense to seek alternative means of disposal from these operations. Since the mid 1990s, the word recycling within the industry has been more of a fashion word in the sense that there has been a lot spoken about it, but very little has been done. However, there are a number of countries, particularly in Europe such as the Netherlands, Germany, Austria and Denmark which are great examples that illustrate how the recycling of demolition materials have been both profitable and important to the environment.

The emergence of recycling as a viable environmental and energy saving option has been discussed and debated for many years. The apparent resistance is not a shortage of equipment and machinery, but a lack of interest, commitment as well as legislation from government bodies. European countries understand and take the matter of recycling demolition debris or wastes seriously. Despite the abundance of natural resources, they continue to use recycled bricks, concrete, asphalt and other similar materials in new construction projects. This is because the government, environmental organizations and manufacturers of recycling plant have developed a successful cooperation which benefits both the environment as well as professional recycling contractors. It must be added that a well functioning recycling sector also increases the potential for developing even more efficient recycling technology.

As quoted from Crispin Dobson, business development manager at Metalcorp., the largest handler and processor of scrap metals in Australia; "*the industry on the whole has moved away from its junk-yard image to one of professionalism, taking into account the environment, quality assurance and health and safety in all of its work practices. We have become more professional because globalization and competition have prompted the need for higher quality material at the best price. In order to achieve this, companies have to work hard to operate more efficiently*".

In many demolition projects, concrete makes up the bulk of debris created. Recycling of concrete is a relatively simple process. It involves breaking, removing and crushing debris into material with a specified size and quality. Crushed concrete may be reused as aggregates in new concrete production or any other structural layer. Basically, it is combined with virgin aggregates when used in new concrete. However, recycled concrete is more often used as aggregates in sub-base layer of pavements and roads. Arrangements can be made to haul concrete from a demolition site to the recycling plant or in certain cases, recyclers are able to move portable recycling machinery to the plant site. Several advances have made recycling more economical in recent years. These include:

- development of equipment for concrete breaking,
- development of methods to remove steel that minimizes hand labour,
- use and application of crushing equipment that can accommodate steel reinforcement.

The increased environmental focus and recognition of the cost-efficiency of recycling has seen it become a major consideration and a big business. Recycling can also form parts of a certain company’s long term diversification strategy in the sense that apart from demolition being one of its core activities, its source of income can be supplemented from recycling. Developments for the future of recycling will most probably focus on the machinery used in terms of incorporating new technology to improve efficiency, reduce noise emissions, at the same time increasingly focusing on environmental considerations.

2.7 Demolition and the Environment

Demolition operations are often at the height of environmental concerns. Environmental issues that are usually associated with the industry are such as water and air pollution, production of dust and grit, noise pollution as well as vibration and the phenomenon of air-blasts. The main emphasis in tackling environmental problems is by proper monitoring and controlling procedures. These 2 aspects must compliment each other; otherwise the total effort will be pointless. As stressed by R. E. Munn [25], monitoring alone, like modeling does nothing to reduce pollution. *"Extensive monitoring is undertaken to prove that something is being done, but bear in mind, nothing is being done about the pollution"*. Monitoring must be executed at the source for more precise results. Theoretically, monitoring of pollution is done for and to:

- regulatory control,
- determine present conditions and trends,
- make short term predictions,
- to provide input data on pollution levels,
- study the effects of pollution on the climate and population.

Pollution controlling measures must then be implemented to ensure that the environment and public are not subjected to potential harm. Section 2.6 has already discussed in detail the measures and control steps that must be considered when addressing demolition wastes with respect to water and air quality. This section however will focus on the remaining environmental matters such as noise, dust, vibration and air-blasts. The contents herein have been outlined to provide background to the fundamentals of these issues as well as some basic controlling techniques that are commonly employed.

2.7.1 Noise

Demolition works are usually noisy and can take place in areas which are normally quiet. Although the works may not last long, the disturbances caused by noise may lead to problems for people who live and work near the affected site. The public is becoming less tolerant of the harmful side effects of demolition processes on both the workers as well as the surrounding community. Prolonged high levels of noise can cause deafness and other psychological effects regardless of the disposition of the recipient. As defined by Harold W. Lord et. al. [22], noise or unwanted sound is a wave type phenomenon by which vibrational energy is propagated through elastic media.

It usually propagates in gases, liquids and solids but not in vacuum. The 2 types of waves that are normally generated in an elastic medium are transverse waves and longitudinal waves. The acceptable recommended sound level pressure is normally in the range of 60 – 80 dB(A). Demolition sites conducting drilling works normally reach sound pressures as high as 90 dB(A). Outlined below are recommendations for noise control at demolition sites as given by BS 5228 and BS 6187 [2]:

- working hours should be between 7.30 a.m. to 6.00 p.m. on weekdays and 8.00 a.m. to 1.00 p.m. on Saturdays. Works should not be allowed on Sundays and public holidays,

- plant and equipment should be properly maintained and positioned at appropriate locations,

- for long term and complex projects, detailed liaison with the local community through structured meetings with the residents should be carried out,

- the types of machinery and demolition technique should be substituted if found to be too noisy,

- preformed shielding should be appropriately positioned to reduce boundary noise levels.

2.7.2 Dust and Grit

Demolition operations often create large volumes of dust and grit which in windy, busy or densely populated areas, can be dangerous to vehicular traffic and a nuisance as well as health hazard to the general public. The most common form of dust formation is attributed by the usage of equipment such as hydraulic breakers and processors as well as other demolition techniques, for example balling and wire rope pulling. In addition, the movement of heavy vehicles such as excavators and dump trucks within the site also contribute to a large percentage, the production of dust. Dust from these sources are normally controlled by conducting continuous dust suppression sprays along the vehicles' routes, on affected structural elements and on debris heaps during the demolition works as well as providing dust screens attached to scaffoldings.

Another important consideration is when demolition involves the deconstruction of dangerous structures that house or had previously been exposed to chemical and explosive materials. These materials can be either chemical agents such as pesticides; carbon, sulphur, aluminium; light metals comprising lead, chromium, cadmium, beryllium; radioactive substances and by-products as well as plastics and coal. R. G. Dorman [16] states that fine dusts of combustible material that are dispersed into the air at appropriate concentrations can burn with great rapidity, releasing sufficient heat to produce a self-propagating reaction which may build up to explosive conditions.

The airborne dust particulates of these compounds when in contact with flame, heat, sparks or even static charges can initiate a dust explosion. The dust cloud may not be pre-existent, for the rush of gases at the combustion front of an initially local explosion during the demolition works may rise into the air-dust previously deposited on existing or exposed surfaces. Dust becomes more reactive as the particle size and volume decreases but however, extreme finess is not necessary. This is proven by the fact that excess of dust which can be burnt by the available oxygen in the air absorbs heat, and therefore suppresses the combustion.

Apart from that, demolition by explosives such as implosion generates a tremendous deal of dust and grit. To date, there is no available method capable of containing the dust produced due to its immense volume and massive area of dispersion. But however, demolition by explosives has one significant advantage if compared to demolition by conventional techniques. The former is instantaneous and often for a short period of time where else the latter is progressive, requiring lengthy time spans. The increase in time results in the increase of exposure to the environment as well as the public. When a structure is reduced to rubble by explosives, the public is evacuated and other items or aspects of importance are removed from the vicinity of the site within the designed exclusion zone radius. The dust particles from the demolition are released at one predefined time, in one direction. This provides neighbouring businesses as well as the public a way to avoid or prepare for the dust with minimal health effects and inconvenience.

2.7.3 Vibration

Sushil Bhandari [31], defines vibration as a repeated movement about the position of rest. The parameters involved with vibration are commonly amplitude or displacement and velocity or acceleration of the ground movement. The United

States Bureau of Mines (USBM) recommends that vibration levels in the vicinity of residential and commercial structures should be maintained below a peak particle velocity of $51mms^{-1}$. The peak particle velocity of a vibration is now accepted as the best criterion for assessing the potential of a vibration to cause damage to a given structure whereby particle velocity takes into account both frequency and amplitude to give an indication of the level of hazard and a fairly accurate picture of the nuisance value of the movement.

As explained in the Technical Paper No. 3 outlined in the Explosives Engineering Handbook [11], a common method of reducing vibrations is to provide a blanket of loose fill for the structure or debris to fall on to. This is usually 1 – 3m deep, depending on the amount of energy to be absorbed. However, it should be noted that loose fill is easily penetrated and if services are under the impact area, the penetration can be stopped by steel plates positioned on top of the blanket. In addition to this, trenches may be cut in the ground to cause diffraction and dispersion of the ground waves. The effect of a trench is to cause a horizontally traveling wave to tend towards the surface.

It should be added that special considerations must be given when conducting demolition by explosives for below-ground structures such as foundation systems. Vibrations generated here are more significant in terms of its intensity. The elastic disturbances which propagate away from the explosion source are termed as seismic waves. These waves can be divided into 2 basic groups, namely body waves and surface waves. Body waves are waves that travel through the rock mass while surface waves are waves that travel along the ground's surface to cause ground roll. These waves are quickly transmitted through the solid medium which comes back to its original configuration after their passage.

2.7.4 Flying Debris and Air-blasts

Flying debris and air-blasts are serious environmental hazards that can often cause fatalities, serious injuries, and damage to equipment, buildings and property. These hazards are usually associated with demolition techniques employing the use of explosives. Flying debris can be simply defined as loose particles that become projectile upon explosion. The Nobel's Explosives Company [32] explains that air-blast is actually the propagation of sound waves through the atmosphere whereby a diverging shock-wave front around the area of a blast rapidly degenerates into sound waves. The velocity of sound in air depends upon temperature, wind speed and direction, and to a lesser extent, humidity. Air-blast causes loose doors and windows to rattle as well as shattering of glass and is usually accompanied by noise which tends to increase concern.

In ideal circumstances, the explosive energy should be absorbed in destroying the required elements of the structure. Flying debris and air-blasts are unavoidable effects but however, their magnitude and occurrence can be minimized by generally using appropriate and low amounts of explosives. The Technical Paper No. 3 outlined in the Explosives Engineering Handbook [11], describes various forms of protective measures that are usually engaged in controlling the above mentioned hazards, and they are:

- **Earth bunds –** they can be formed around the base of a structure that is charged at a low level. They absorb flying debris and reflect shock-waves upward but do not greatly affect air displacement effects.
- **Solid screens –** they come in a variety of forms ranging from heavy gauge plywood on scaffold to actual blockwork walls. Their normal use is in close-proximity blasting in areas such as shopping malls where there are a lot of large glass panels. The main purpose of a solid screen is to ensure that fly is stopped at critical points.

- **Tarpaulin screens –** they perform a similar function as the solid screens but are used at a greater distance than the latter. They are capable of stopping only small particles of fly, but if hung about 300mm from the object to be protected, they will de-tune the high frequency shock-wave associated with detonating cords.

- **Protection of structural members –** the basic form of this is wrapping columns and beams with corrugated iron sheets. It is also known as sacrificial protection since the absorbent effect is proportional to the energy necessary to destroy the wrapping.

- **Protection at voids and openings –** this is also done using corrugated iron sheeting but slightly further away from the source. It is basically used to seal up voids in walls and window openings that are uncharged whereby effectively converting the whole wall into a protective screen.

- **Flexible protection –** screens are normally hung down the outside of the wall over the top of the protection at source to give a double screening effect to stop fly. Materials that have been used successfully are multi-layers of heavy carpeting, layers of conveyor belt and corrugated iron sheets hung on a framework which is suspended on ropes.

- **Blast mats –** they are effective for work such as foundation blasting on fairly open sites but are not sufficient protection for close-proximity work.

2.8 Summary

The various sections of this Chapter have been written to give a clear and detailed description on the aspects as well as relevant issues that are normally associated with demolition operations. Knowledge on the principles of structural demolition and the process itself forms the basis for executing works of this nature. Proper understanding about the activities usually implemented during operations is crucial to ensure that works meet and are on par with specifications and standard expectations.

The introductory on the subject of demolition techniques was aimed at describing and illustrating the many methods available and commonly employed in demolition practices. Many advances have been made in the past to improve efficiency, performance and safety, thus resulting in state of the art machinery and equipment as seen today. One can only wonder on whether these enhancements and innovations have reached the height of sophistication, or is there more to come? In demolition works, the aspect of safety is given top priority. Therefore, the explanations provided on the subject, have basically related and stressed on the importance of proper safety requirements. This Chapter has also devoted itself to highlight issues with respect to demolition waste management and recycling. These 2 matters are equally important and should be given adequate consideration to prevent environmental pollution as well as conserve our natural resources.

Apart from that, monitoring and controlling recommendations have been outlined on the aspect of the environment in terms of noise, dust, vibration and air-blast. The respective section was developed to emphasize on the need to check and keep these secondary pollution levels at safe and acceptable limits. The thoroughness of scope and the intensity of information provided in this Chapter is hoped to have achieved its goal in illustrating an in-depth and comprehensive overview of the industry.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This Chapter consists of five sections. The first three sections review and describe the different methodologies used to achieve the research aim and objectives. These methodologies are defined in terms of comprising a combination of qualitative and quantitative characteristics. The fourth section on the other hand presents the overall research framework while the final section describes in detail, the overall schedule for undertaking the research.

3.2 Literature Review & Background Research

The review of literature was done to study the characteristics, processes, techniques and requirements of the aspects crucial in the execution of demolition operations. Information was obtained from a variety of sources which included Codes of Practice from four (4) different countries, specialized publications from demolition organizations, current journals, books, manufacturer's catalogues and relevant internet websites. Information was gathered through extensive reading and understanding, making notes on key subjects as well as keeping a systematic record in terms of a reference list for easy identification, checking and retrieval, when necessary. Besides literature review, an informal background research was also executed to ascertain general insight into the current state of demolition works in the Country. Personalized meetings and interviews were conducted with various organizations throughout Kuala Lumpur, Selangor, Negeri Sembilan, Melaka and Johor. These meetings were designed solely to encourage open-ended discussion on related topics and to capture useful information. The list of organizations is as tabulated below.

Table 3.1: List of organizations approached in the background research.

Item	Organization	State
1	Dewan Bandaraya Kuala Lumpur	Kuala Lumpur
2	Town & Country Planning Department, Peninsular Malaysia	Kuala Lumpur
3	Federal Department of Town & Country Planning, Peninsular Malaysia	Kuala Lumpur
4	Construction Industry Development Board Berhad	Kuala Lumpur
5	Ministry of Defense, Malaysia	Kuala Lumpur
6	Jabatan Kerja Raya, Malaysia	Kuala Lumpur
7	Kementerian Kerja Raya, Malaysia	Kuala Lumpur
8	Majlis Perbandaran Petaling Jaya	Selangor
9	The Institution of Engineers, Malaysia	Selangor
10	Majlis Perbandaran Kajang	Selangor
11	Majlis Perbandaran Klang	Selangor
12	Majlis Perbandaran Ampang Jaya	Selangor
13	Majlis Perbandaran Subang Jaya	Selangor
14	Majlis Bandaraya Shah Alam	Selangor
15	Perbadanan Putrajaya	Wilayah Persekutuan
16	Majlis Perbandaran Seremban	Negeri Sembilan
17	Majlis Bandaraya Melaka Bersejarah	Melaka
18	National Institute of Occupational Safety & Health, Malaysia	Johor
19	Southern Waste Management Sdn. Bhd.	Johor

The data obtained from the literature review and background research were indeed invaluable as it portrayed two very distinct images; the former with global outlook and the latter with local perspective. The findings essentially shaped the blueprint for the case study and questionnaire survey designs.

3.3 Case Study

The case study was aimed at capturing and illustrating the actual practice of a particular demolition project carried out by a local contractor. The study was to provide an abstract level explanation on how the project was executed. The findings of the study were not intended to be generalized but instead, provide particularization. A holistic design was best suited to fulfill the above requirements whereby the case study would only examine the global or overall nature of the works within the defined boundaries. To ensure adequate focus in the coverage, three (3) important areas consisting of the work methodology, health and safety as well as environmental management were outlined to form the backbone in the case study formulation. Based on this along with the requirements as highlighted in the scope of works, the project was then selected. The case study was conducted on the *Lumba Kuda* Flats demolition project comprising four (4) blocks of fifteen (15) storey residential buildings.

The identification of the relevant organizations was done progressively in stages, as the case study proceeded. Table 3.2 highlights the parties that were approached in the study. These organizations were identified based on their significance in the execution phase of the project. Although both specialists declined to participate, the information or data required from them were kindly furnished by the Main Contractor.

Table 3.2: List of organizations approached in the case study.

Item	Organization	Role	Comments
1	Gerbang Perdana Sdn. Bhd. – Construction Department	Main Contractor	Full participation
2	Gerbang Perdana Sdn. Bhd. – Engineering Department	Main Contractor	Full participation
3	Majlis Bandaraya Johor Bahru	Local Authority	Full participation
4	SUK Cawangan Perumahan	Government Body	Full participation
5	Jabatan Alam Sekitar Johor	Government Body	*Insignificant participation*
6	Geolab Sdn. Bhd.	Specialist–Struc. testing	*Declined to participate*
7	Spectrum Lab Sdn. Bhd.	Specialist–Environ.	*Declined to participate*

The collection of data was done by carrying out interviews and documentation reviews. The interviews provided first hand descriptions and interpretations of the project from individuals of the various organizations. These multiple interviews were personalized and open ended. The questions were short, simple and precise with specific characteristics catering for each different party. They were designed to inquire for facts, opinions and insights on relevant issues.

Documentation review was carried out to ascertain further in-depth information on particular subjects as well as to minimize the presence of contradictory information. The latter was extremely necessary to avoid major inaccuracies in information reporting due to the fact that the study was initiated almost sixteen (16) months after the project's time of completion. The documents scrutinized were in the form of reports, programs, schedules and drawings. There was also visual viewing material such as a video compact disc (VCD) which provided detailed account of the works at site. All information were systematically studied; then sorted and filtered based on their importance and relevance, before finally being compiled and analyzed.

The final report was written on a single-case study format, bearing an explanation building mode of analysis. The findings were reported on a formal descriptive basis; incorporating tabular and graphical displays to enhance the written text as well as to improve communication of the information. The report basically comprised of a linear – analytic structure and emphasized on completeness in information coverage and delivery. The entire composing process of the case study report was deeply governed by the fact that it had to meet the anticipated expectations of the targeted audience, which was the examining panel. The framework for the case study methodology is as illustrated in Figure 3.1.

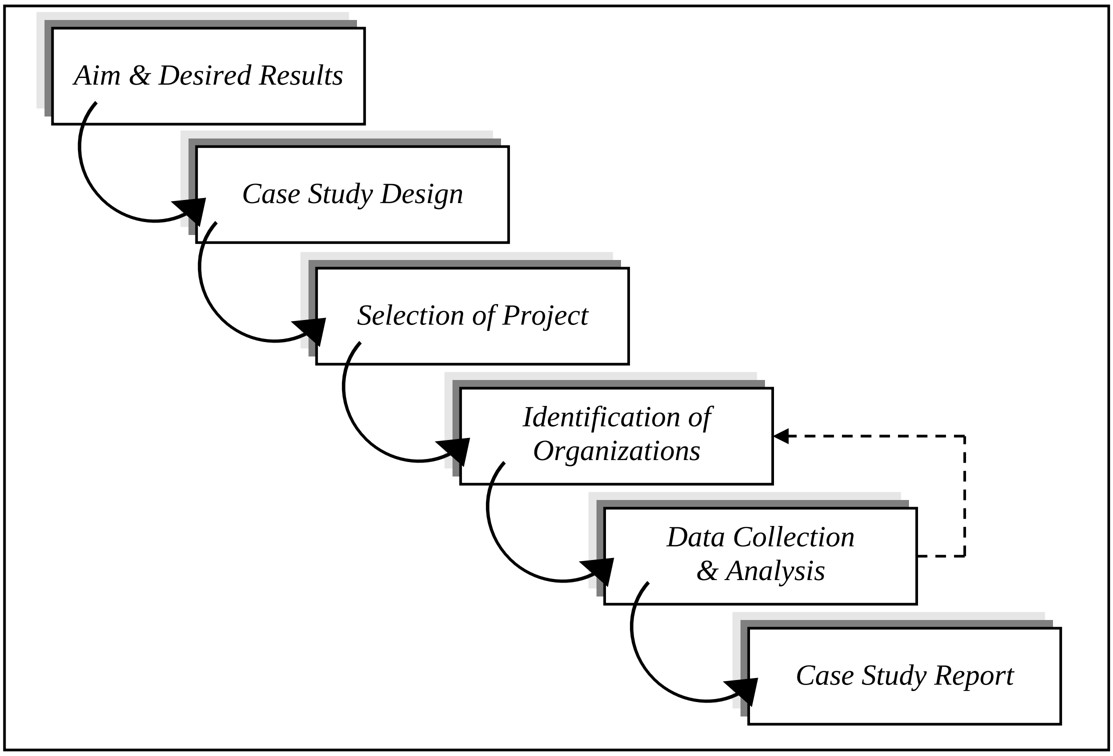


Figure 3.1: Case study methodology framework.

3.4 Questionnaire Survey

The questionnaire survey was carried out in line with the final objective which was to generate and establish statistical data through feedback obtained from professional organizations. The survey was geared towards tapping information from the Construction Industry. In order to accurately describe the characteristics of the industry, a stratified random sampling method was employed. This method proved to be extremely beneficial as it aided in reducing sampling error by providing proper representation of the Industry's various components. Figure 3.2 illustrates the subgroups that were outlined in the sampling process.

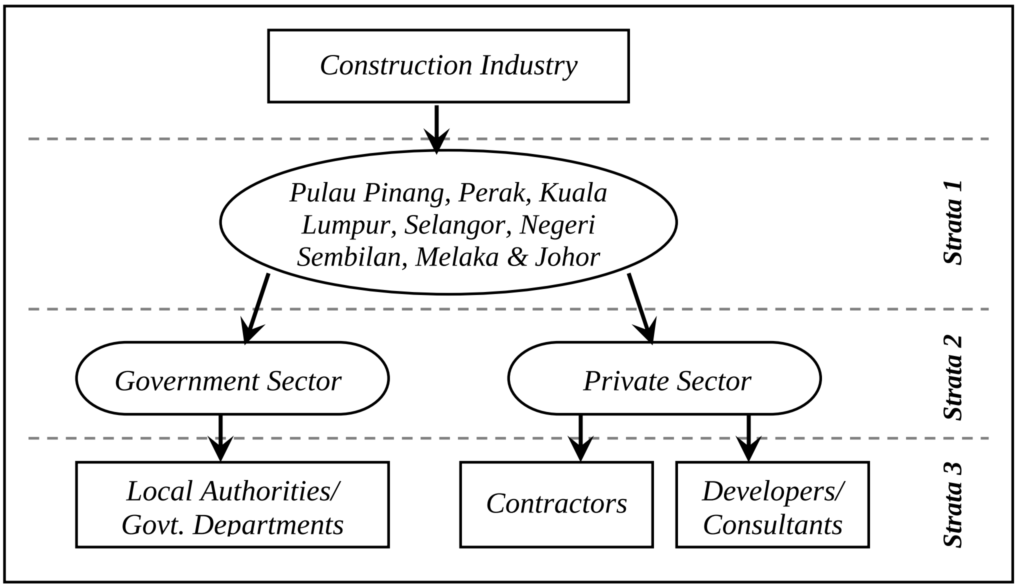


Figure 3.2: Stratified sample.

Seven states were selected for sampling from the West Coast of Malaysia. These states were relatively more developed than the Eastern regions of the Country. The survey participants from these states would have had greater exposure in conducting demolition works and that being the case; a higher return percentage could be expected. The sample was further stratified to comprise the Government and Private sectors. The survey participants basically consisted of Class A building Contractors, property Developers/ Consultants as well as Local Authorities/ Government Departments.

Upon formulation of the sample structure, the sample frame was then constructed. The frame, comprising a list of survey participants, was made up from contacts and addresses obtained from friends, municipal councils as well as a Contractor's directory purchased from the Construction Industry Development Board (CIDB), Kuala Lumpur.

In the survey design, the questions were made to be brief, precise and clear to reduce the possibility of measurement error. A close ended structure was adopted whereby the Likert Scale was used to provide measurement to the various options outlined for each question. Measurement was done in terms of agreement, frequency, significance as well as quality. For convenience and to facilitate statistical analysis, numerical equivalents, i.e. response indexes ranging from 1 – 5, were assigned to each rating scale. Indexes 1 and 5 offered the lowest and highest ratings respectively.

The respondents were required to circle only one response index which best represented their opinion. To ensure a good response rate, adequate focus was also given on aspects such as clarity, style and arrangement. Prior to the actual questionnaire deployment, a pilot study was undertaken, allowing the questionnaire to be pre-tested by an experienced individual. This was done to determine if the questionnaire could be easily understood and interpreted. Upon completion of the pilot study, adjustments and refinements were made and the final version was then developed. A sample of the questionnaire is enclosed in Appendix B.

A total of 100 questionnaires were distributed via mail as per the sample frame. The **percentage proportions of the survey participants** are as follows:

•	Local Authorities/ Govt. Departments	=	16 %
•	Developers/ Consultants	=	42 %
•	Contractors	=	42 %
✓	**Total**	=	**100 %**

From this total, 38 questionnaires were successfully retrieved and the list of respondents is as tabulated in Table 3.3.

Table 3.3: List of survey respondents.

Item	Organization	Strata 3 *- Component -*	Strata 2 *- Sector -*	Strata 1 *- State -*
1	Majlis Bandaraya Ipoh	Local Authority	Government	Perak
2	Majlis Perbandaran Subang Jaya	Local Authority	Government	Selangor
3	Dewan Bandaraya Kuala Lumpur	Local Authority	Government	Kuala Lumpur
4	Majlis Perbandaran Seremban	Local Authority	Government	Negeri Sembilan
5	Majlis Bandaraya Johor Bahru	Local Authority	Government	Johor
6	Federal Department of Town & Country Planning, Peninsular Malaysia	Government Department	Government	Kuala Lumpur
7	UDA Holdings Berhad	Developer	Private	Kuala Lumpur
8	Mutiara Rini Sdn. Bhd.	Developer	Private	Kuala Lumpur
9	Country Heights Property Development	Developer	Private	Selangor
10	S.P Setia Berhad	Developer	Private	Selangor
11	S.P Setia Berhad	Developer	Private	Selangor
12	S.P Setia Berhad	Developer	Private	Selangor
13	Johor Land Berhad ***(Non-usable)***	Developer	Private	Johor
14	Melati Ehsan Development Sdn. Bhd.	Developer	Private	Johor
15	Teguh Runding Sdn. Bhd.	Consultant	Private	Johor
16	STA Consulting Engineers	Consultant	Private	Selangor
17	Perunding ZKR Sdn. Bhd.	Consultant	Private	Negeri Sembilan
18	Maju Integrated Engineers	Consultant	Private	Kuala Lumpur
19	Maju Integrated Engineers	Consultant	Private	Kuala Lumpur
20	HSS Engineering Sdn. Bhd.	Consultant	Private	Kuala Lumpur
21	Hussein & K.H. Chong Perunding (M) Sdn. Bhd.	Consultant	Private	Kuala Lumpur
22	T. Y. Lin Sdn. Bhd.	Consultant	Private	Kuala Lumpur
23	Gue & Partners Sdn. Bhd.	Consultant	Private	Kuala Lumpur
24	UEM Construction Sdn.Bhd.	Contractor	Private	Perak
25	UEM Construction Sdn.Bhd.	Contractor	Private	Perak
26	Gerbang Perdana Sdn. Bhd.	Contractor	Private	Johor
27	Gerbang Perdana Sdn. Bhd.	Contractor	Private	Johor
28	Zainal & Din Construction Sdn. Bhd.	Contractor	Private	Johor
29	Putra Perdana Construction Sdn. Bhd.	Contractor	Private	Putrajaya
30	Putra Perdana Construction Sdn. Bhd.	Contractor	Private	Putrajaya
31	Pembinaan C.W. Yap Sdn. Bhd.	Contractor	Private	Kuala Lumpur
32	Crest Builder Sdn. Bhd.	Contractor	Private	Kuala Lumpur
33	Aneka Jaringan Sdn. Bhd.	Contractor	Private	Kuala Lumpur
34	Econpile (M) Sdn. Bhd.	Contractor	Private	Kuala Lumpur
35	Maju Holdings Sdn. Bhd.	Contractor	Private	Kuala Lumpur
36	Harum Intisari Sdn. Bhd. – Gamuda Land	Contractor	Private	Selangor
37	Harum Intisari Sdn. Bhd.	Contractor	Private	Selangor
38	Gerbang Perdana Sdn. Bhd.	Contractor	Private	Selangor

A summary of the response obtained is as presented below:

•	Total distributed questionnaires	100
•	Total retrieved questionnaires	38
•	Total non-usable questionnaires	1
✓	**Total valid questionnaires**	**37**

The dataset was primarily analyzed in terms of percentage and ranking computations. The analysis was aimed at describing the dataset as a **whole** and not by individual components. This was essential in providing **generalization.** From the indicated proportions earlier, it can be noted that the overall sample was of unequal balance. Therefore, to avoid bias reporting, all three components were weighted accordingly to restore the sample to an equal probability status, as shown below:

Component	**Weighted Response**
• Local Authorities/ Govt. Departments	Increased by 2.083
• Contractors	Decreased by 0.794
• Developers/ Consultants	Decreased by 0.794

The ranking determination was achieved by using the weighted mean formula as highlighted in Figure 3.3.

$$\text{Weighted Mean} = \frac{\sum wx}{\sum w}$$

Figure 3.3: Weighted mean formula.

where,

w = the weight assigned to each component,
(2.083 for Government; 0.794 for Developer & Contractor)

x = the arithmetic mean/ response of each component,

$\sum w$ = the summation of all the weights.

The framework for the questionnaire survey methodology is as illustrated in Figure 3.4.

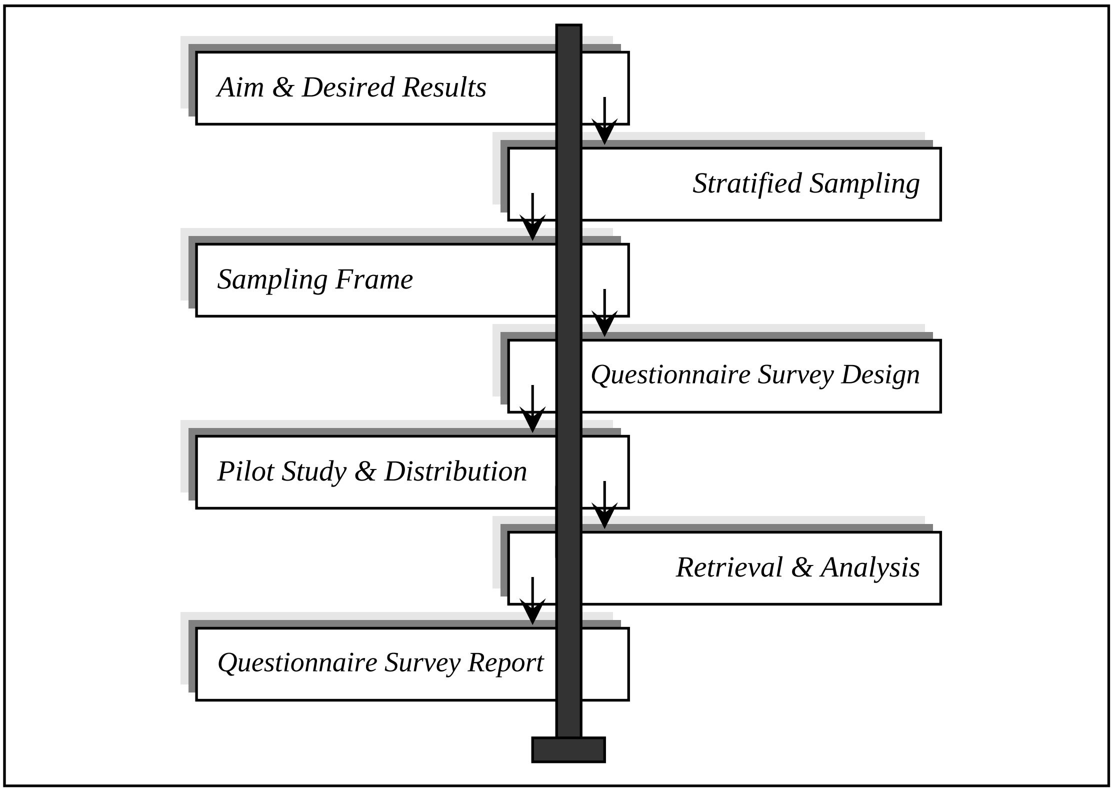


Figure 3.4: Questionnaire survey methodology framework.

3.5 Research Methodology Framework & Schedule

With reference to Sections 3.2, 3.3 and 3.4, an overall research methodology framework was constructed to illustrate the sequential flow of research phases, as shown in Figure 3.5 below.

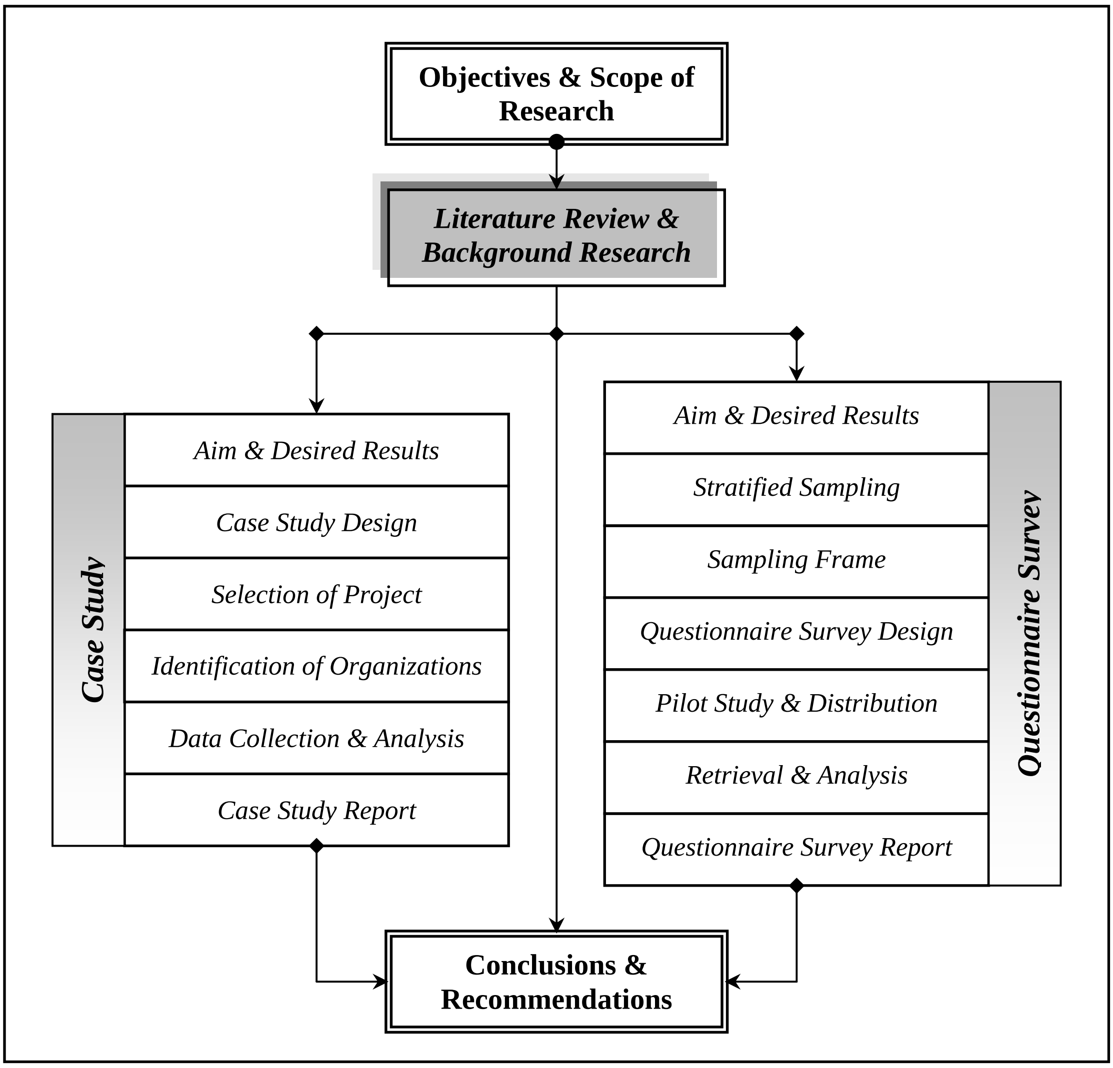
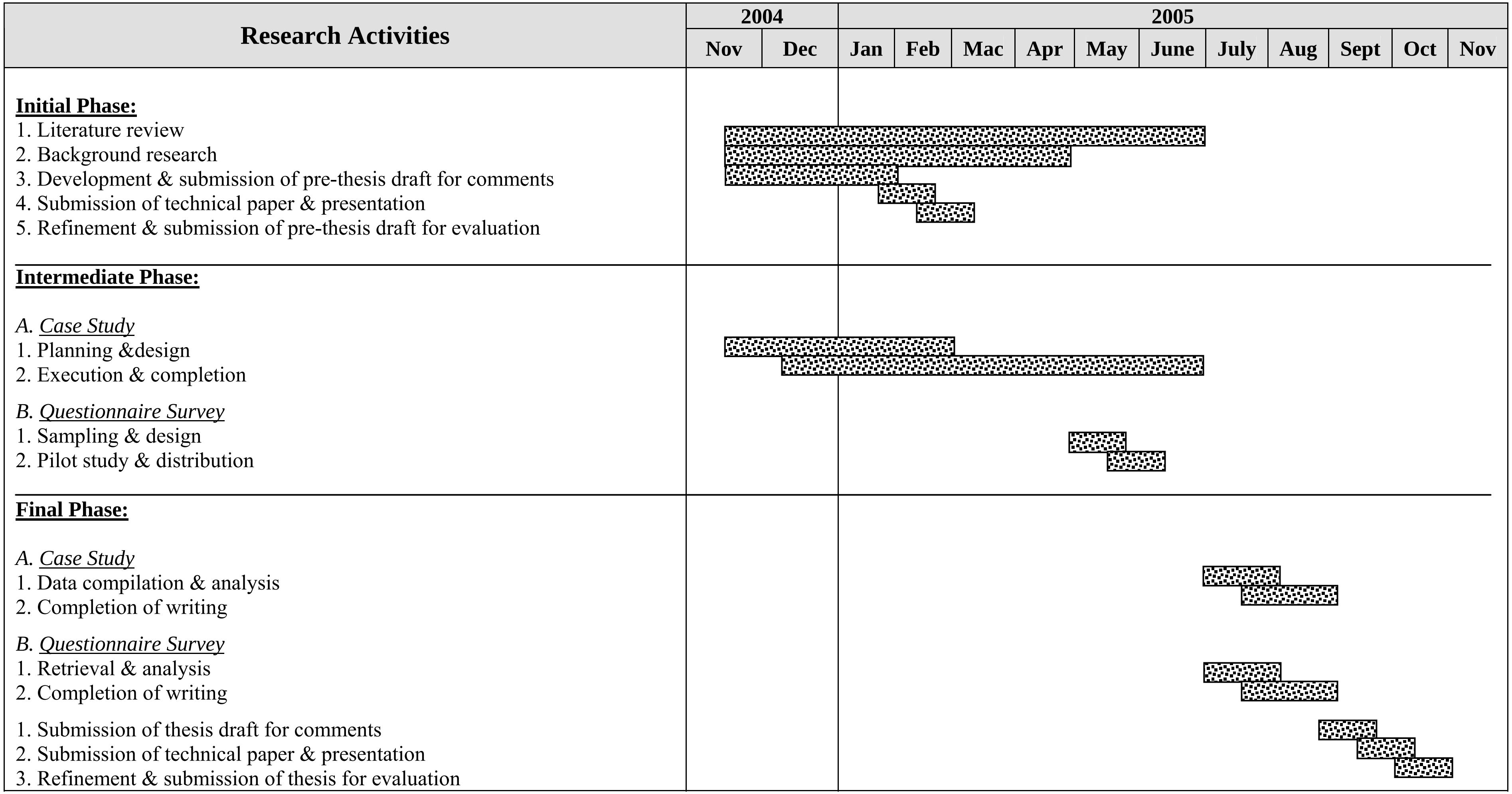


Figure 3.5: Overall research methodology framework.

A research schedule was also established to describe in detail the various research tasks and to provide an indication of their approximate durations, as shown in Table 3.4. The entire research required an estimated one year to complete.

Table 3.4: Research schedule.



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3.6 Summary

This chapter has explained and outlined in detail the research methodologies and approaches engaged in ensuring a smooth and progressive execution. Apart from that, it has also designed an overall framework and schedule aimed at providing a clearer and systematic idea of the various tasks and phases to be expedited in line with the requirements of the research.

The methodologies adopted for the research were governed by the single fact that, the information obtained would be able to provide a background of the demolition scenario in the country. Therefore, the combination of approaches selected to carry out the research had to a high extent, illustrated an image that had both the elements of particularization and generalization. These elements compliment and support each other to portray an exclusive as well as collective overview of demolition operations in Malaysia.

CHAPTER 4

CASE STUDY: LUMBA KUDA FLATS DEMOLITION, GERBANG SELATAN BERSEPADU PROJECT

4.1 Introduction

This Chapter generally reports and discusses the information and data obtained from the case study conducted on the Lumba Kuda Flats demolition operations which formed part of the Gerbang Selatan Bersepadu project. The case study primarily targeted the Main Contractor, Gerbang Perdana Sdn. Bhd. as well as two (2) government departments which were Majlis Bandaraya Johor Bahru (MBJB) and SUK Cawangan Perumahan. It should also be noted that attempts to attract the participation of the sub-contractor and specialists were unsuccessful due to circumstances beyond control. The case study covered the execution phase of the project, emphasizing on project scheduling, work methodology, health and safety as well as environmental management. The study basically required a duration of eight (8) months for completion. The following sections will further present the overall findings.

4.2 Project Background

The on-going Gerbang Selatan Bersepadu project (GSB project) involves the relocation of the existing Customs, Immigration and Quarantine (CIQ) facilities to the present Johor Bahru railway station at Bukit Chagar, as well as to replace part of the Causeway with a road bridge and a rail bridge, including the construction of other related infrastructure and amenities on a fast-track basis. The design and build project is led by Jabatan Kerjaraya Malaysia (JKR) and aims to serve sixteen (16) end users which consist of:

i. Projek Lebuhraya Utara Selatan
ii. Keretapi Tanah Melayu
iii. Jabatan Pertanian
iv. Jabatan Perhilitan
v. Majlis Bandaraya Johor Bahru
vi. Kementerian Dalam Negeri
vii. Jabatan Kastam Diraja Malaysia
viii. Lembaga Pelancongan Malaysia
ix. Jabatan Kesihatan
x. Jabatan Haiwan
xi. Lembaga Kemajuan Ikan Malaysia
xii. Lembaga Perindustrian Kayu Malaysia
xiii. Pejabat Tanah danGalian
xiv. Jabatan Pengangkutan Jalan
xv. Polis Diraja Malaysia
xvi. Jabatan Imigresen

The 2.26 billion project will see tremendous benefits gained in areas such as traffic dispersal, tourism, economy, environmental as well as security. The GSB project layout is as illustrated in Figure 4.1. The major components of this project are:

i. A CIQ Complex
ii. JB Sentral
iii. A road bridge
iv. A rail bridge
v. Interchange No.1
vi. Removal of current structures
vii. Navigational Channel Dredging

Figure 4.1: GSB project layout.

The case study explores component (vi) which concerns the removal of current existing structures to make way for the above project. Removal works were geared towards the demolition of the Causeway and existing CIQ Complex, the Tanjung Puteri Bridge, Malaya Hotel, Bukit Chagar School and Flats, as well as the Lumba Kuda Flats. However, the Causeway and existing CIQ Complex would only be demolished upon the completion of all other project components. Figures 4.2(a-d) and 4.3(a-b) illustrate the demolition operations of the Tanjung Puteri Bridge and Malaya Hotel respectively.

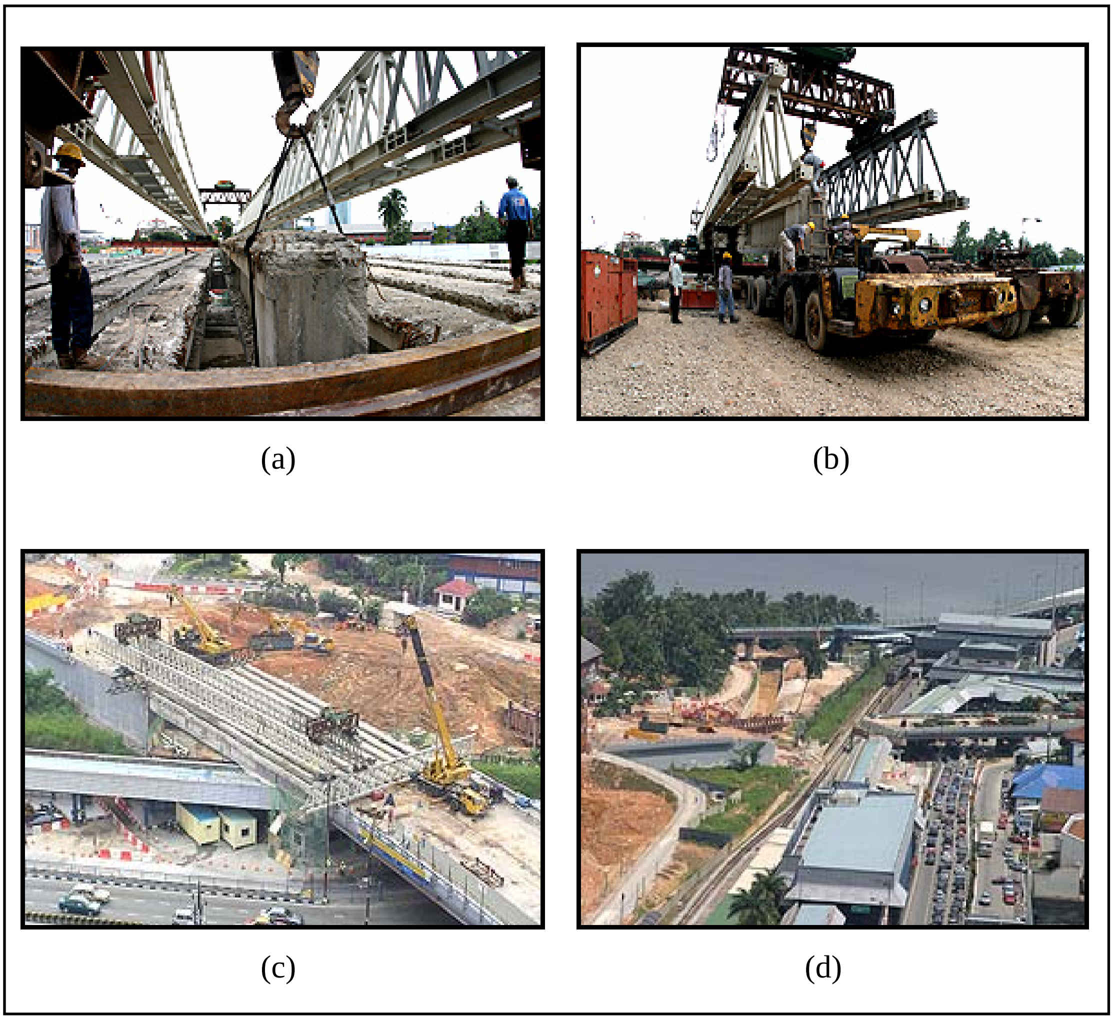


Figure 4.2(a-d): Demolition of the Tanjung Puteri Bridge in progress.

Figure 4.3(a-b): Demolition of Malaya Hotel in progress.

The information herein will focus on the Lumba Kuda Flats demolition works. The Lumba Kuda Flats were demolished under the context of area redevelopment. The community comprised approximately 45 % Malay, 45 % Chinese and 10 % Indian occupants. The total population stood as 1054 persons. The operations involved the design and execution of demolition works for four (4) blocks of fifteen (15) storey residential buildings as well as other single storey buildings and structures at Lots PTB 9007, PTB 9008 and part of Lot 2043. The Flats comprised two phases which were:

- **Phase 1**
  Blocks A & B – *Completed in 1964 and occupied in 1965.*

- **Phase 2**
  Blocks C & D – *Completed and occupied in 1971.*

These blocks were about forty (40) years of age at the time of demolition. The evacuation notice was served in April 2003 and subsequently, the flats were vacated by May, the same year. Demolition works began on the 19th of May 2003 and ended on 19th September 2003. The 4 month project had a total contract sum of RM 2.7 million. The site within the Lumba Kuda Project covered:

i. Lot PTB 9007 (1.329 ha),
ii. Lot PTB 9008 (1.211 ha),
iii. Reserve Lot (0.082 ha) between Lot PTB 9007 and Lot 9008,
iv. Part of Lot 2043 (1.064 ha) encompassing all areas within Lot 2043, East of the existing railway tracks,
v. TNB substation, food stalls and temple located immediately North of Lot PTB 9007 and Lot 9008.

Figure 4.4: Aerial view of the Lumba Kuda project site.

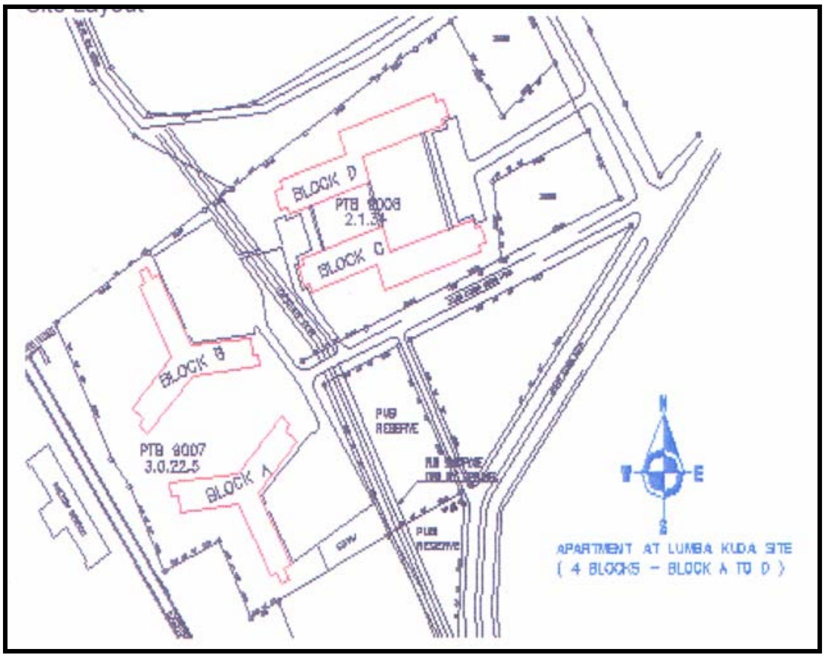


Figure 4.5: Lumba Kuda project site layout.

4.3 Demolition Work Program

This section outlines the actual work schedule for each structural demolition operation within the Lumba Kuda project site as well as lists down the plant and machinery that were used. The respective tables below summarize the work programs in terms of their commencement date, completion date and incurred costs.

Table 4.1: Preliminary works schedule.

PRELIMINARY WORKS			
Activities	**Actual Start**	**Actual Finish**	**Incurred Costs (RM)**
Inspection & Survey & EMP monitoring	19.05.03	05.09.03	108,300.00
Contractor's site office & facilities	19.05.03	02.07.03	22,000.00
Maintenance & other preliminary works	19.05.03	05.09.03	232,000.00

Table 4.2: Physical works schedule.

PHYSICAL WORKS			
Activities	**Actual Start**	**Actual Finish**	**Incurred Costs (RM)**
Mobilization & enabling works	19.05.03	05.09.03	36,000.00
Temporary works	19.05.03	03.06.03	3,000.00
Diversion of services	19.05.03	29.05.03	13,000.00
Protection to Railway and PUB	19.05.03	05.09.03	20,000.00
Main machinery mobilization	17.06.03	01.07.03	0.00
Project site hoarding	19.05.03	05.06.03	80,000.00

Table 4.3: Block A demolition works schedule.

BLOCK A DEMOLITION WORKS			
Activities	**Actual Start**	**Actual Finish**	**Incurred Costs (RM)**
Soft stripping works	19.05.03	03.07.03	110,800.00
Safety scaffolding & netting screen	05.06.03	18.06.03	35,000.00
Demolition of 15 storey superstructure	07.07.03	18.08.03	309,500.00
Demolition of ground beam & pilecap	08.08.03	28.08.03	40,500.00

Table 4.4: Block B demolition works schedule.

BLOCK B DEMOLITION WORKS			
Activities	**Actual Start**	**Actual Finish**	**Incurred Costs (RM)**
Soft stripping works	19.05.03	13.07.03	110,800.00
Safety scaffolding & netting screen	05.06.03	19.06.03	35,000.00
Demolition of 15 storey superstructure	11.07.03	28.08.03	309,500.00
Demolition of ground beam & pilecap	11.08.03	04.09.03	40,500.00

Table 4.5: Block C demolition works schedule.

BLOCK C DEMOLITION WORKS			
Activities	**Actual Start**	**Actual Finish**	**Incurred Costs (RM)**
Soft stripping works	19.05.03	03.07.03	110,800.00
Safety scaffolding & netting screen	05.06.03	19.06.03	35,000.00
Demolition of 15 storey superstructure	20.06.03	15.08.03	309,500.00
Demolition of ground beam & pilecap	23.07.03	20.08.03	40,500.00

Table 4.6: Block D demolition works schedule.

BLOCK D DEMOLITION WORKS			
Activities	**Actual Start**	**Actual Finish**	**Incurred Costs (RM)**
Soft stripping works	19.05.03	01.07.03	110,800.00
Safety scaffolding & netting screen	05.06.03	19.06.03	35,000.00
Demolition of 15 storey superstructure	20.06.03	15.08.03	309,500.00
Demolition of ground beam & pilecap	30.07.03	20.08.03	40,500.00

Table 4.7: Demolition schedule for other buildings.

DEMOLITION WORKS FOR OTHER BUILDINGS			
Activities	**Actual Start**	**Actual Finish**	**Incurred Costs (RM)**
Soft stripping works	19.05.03	30.05.03	10,000.00
TNB substation	15.08.03	24.08.03	8,000.00
Food stalls	22.05.03	22.05.03	5,000.00
Temple	22.05.03	11.08.03	10,000.00
KTMB quarters	19.05.03	22.05.03	500.00
Sewage treatment plant	12.08.03	20.08.03	5,000.00

The major plant and machinery used in the operations were:

i. Excavators
ii. Lorries/ Tippers
iii. Breakers
iv. Water pumps
v. Air compressors
vi. Cranes
vii. Generators
viii. Crushers

4.4 Demolition Methodology

This section describes the demolition methodology employed in the project and covers aspects such as the method statement, structural testing and actual work flow. A top to down demolition sequence was adopted, employing the use of excavators fitted with hydraulic breakers to demolish the necessary structural elements. The concept selected was progressive demolition whereby works involved the controlled removal of structural sections without causing serious disruption to its stability. It should also be noted that in earlier proposals, the flats were planned to be imploded. However, due to certain classified reasons, the proposal was later revised. The method statement used for the works is as follows:

i. The Consulting engineer shall conduct a detailed building survey to determine the structural framing of the building. A typical structural floor plan shall be produced. Concrete strength tests shall be conducted on the concrete to determine its strength. Concrete cores shall be taken at various strategic locations within the building. Calculations shall be made to determine the structural integrity of the reinforced members under live load of the excavator and debris. A demolition plan shall be worked out based on the results obtained. Where necessary, the slabs and beams shall be temporarily supported by props to ensure stability under loading. The excavator shall be hoisted up to the roof upon completion of the temporary strengthening works.

ii. The movement of excavators on the floor slab shall be restricted to within two (2) meters from the edge of the building. Restrictions shall be one (1) meter from floor openings or cantilever structures.

iii. Prior to the main demolition works, the cantilevered beams and slabs, canopies and veranda shall be initially demolished.

iv. Sequence of demolition for the structural elements shall be as follows:

a) Slabs
b) Secondary beams
c) Main beams
d) Columns/ shear walls

v. The debris shall be allowed to fall to the immediate floor below. The excavator shall form a sloping heap out of the debris, allowing it moving passage.

vi. The breaker shall move to the floor below and proceed to clear the debris off the floor. It shall then proceed to break the remaining beams and columns for the immediate floor above.

vii. This process shall be repeated for the subsequent floors until the excavator reaches ground level.

viii. Demolition debris shall be allowed to fall freely to the ground if the horizontal distance from the point of fall to public access/ adjoining property is not less than six (6) meters or half the height from the debris dropped, whichever is greater. Where demolished materials are allowed to fall freely externally, a covered hoarding with catch fans shall be provided. Chutes or skips may also be used. When material is being dropped, a lookout man shall be deployed to ensure general safety. Safety measures shall be enhanced from time to time, if necessary.

ix. Debris shall not be allowed to accumulate above an average height of two (2) meters from ground level. Soil investigation shall be carried out on the site to ascertain the soil profile. Debris shall not be allowed to accumulate to a height that will cause excessive overburden pressure to the soil, causing it to heave. Debris shall be cleared continuously during the demolition process.

x. Vibration monitoring along PUB pipelines shall be performed at the start of demolition works and preventive action shall be proposed to reduce the vibrations, if the peak particle velocity exceeds 15 mm/ sec. Trenches shall be dug along PUB pipelines to reduce vibration.

xi. Screen hoarding shall be placed around the building to reduce dust pollution. Water shall be sprayed on the debris at the demolished floors and on debris heaps.

Prior to commencement of works, structural testing was conducted to determine the building's strength, in accordance with the method statement. Concrete testing works were executed by Geolab (M) Sdn. Bhd., who was the appointed foundation, soil and concrete specialist. The objective of the tests was to ascertain the compressive strengths of various concrete core samples taken from different locations of each residential block. These samples were basically extracted from floor slabs and beams. Testing was done in accordance with BS 1881: Part 120, 1983. The summary of test results for Blocks A and C are as tabulated below.

Table 4.8: Compressive strength results *(Tested date – 29.05.03).*

Sample	**Location**	**Thickness (mm)**	**Measured Core Compressive Strength (N/mm2)**	**Characteristic Strength as per BS 6089: 1981 (N/mm2)**
P1	Block C slab	154	26.9	31.7
P2	Block C slab	140	38.4	51.3
P3	Block A slab	99	32.3	39.2
P4	Block A slab	154	33.3	39.7
P5	Block A beam	-	34.3	44.1
P6	Block C beam	-	31.5	42.6

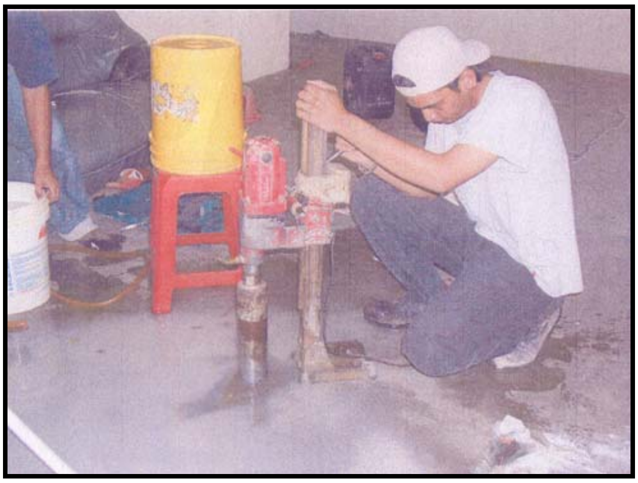
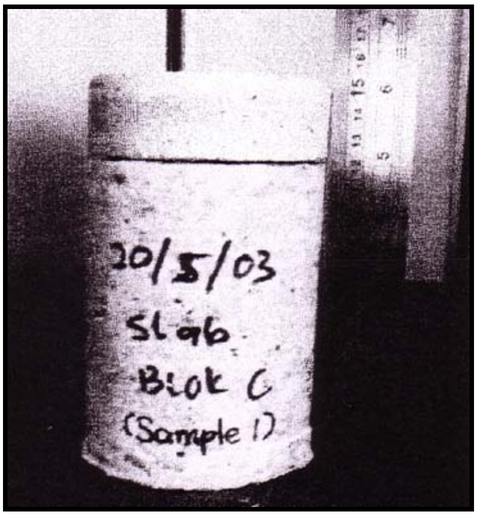
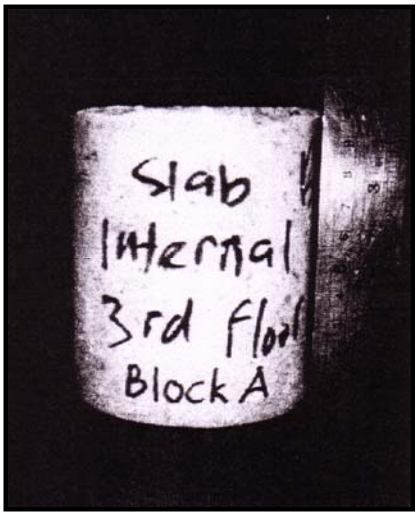


Figure 4.7: Concrete slab coring works in progress.



(a) Block C – concrete slab sample



(b) Block A –concrete slab sample

(c) Block A – concrete beam sample

(d) Block C –concrete beam sample

Figure 4.8(a-d): Concrete core specimens taken at various locations.

To further describe the actual demolition works, the following figures illustrate the sequential flow of operations for Blocks A, B, C and D respectively.

(a) 20 July 2003

(b) 24 July 2003

(c) 28 July 2003

(d) 31 July 2003

(e) 5 August 2003

(f) 9 August 2003

Figure 4.9(a-f): Demolition operations at Block A.

(a) 16 July 2003

(b) 20 July 2003

(c) 24 July 2003

(d) 28 July 2003

(e) 2 August 2003

(f) 9 August 2003

Figure 4.10 (a-f): Demolition operations at Block B.

(a) 16 July 2003

(b) 16 July 2003

(a) 18 July 2003

(b) 18 July 2003

(a) 20 July 2003

(b) 28 July 2003

Figure 4.11 (a-f): Demolition operations at Block C.

(a) 16 July 2003

(b) 18 July 2003

(a) 22 July 2003

(b) 24 July 2003

(a) 26 July 2003

(b) 30 July 2003

Figure 4.12 (a-f): Demolition operations at Block D.

4.5 Demolition Health & Safety

This section stresses on the health and safety measures adopted during the works and presents the risk assessment analysis. As part of the project's requirement, a safety plan was designed specifically for the Lumba Kuda demolition project. The aim of the safety policy was to achieve zero accident rate during operations. Prime considerations were given to the safety of the public and workers. The plan generally comprised aspects such as the functions and responsibilities of each project individual, as well as the identification of protective and preventive measures. The essential conditions as outlined in the safety plan are as follows:

- All workmen shall wear adequate protective clothing and where appropriate, helmet, goggles, safety footwear, safety harness and industrial gloves.

- All workmen shall be properly registered and security guards are to screen any persons entering the site. Gates shall be provided at the main entry. The main entrance shall be locked when site activities have stopped. A side entrance beside the main gate shall be provided for passage of workers and visitors.

- Fans or catch platforms shall be provided to protect persons or property from being struck by falling materials or debris. Entrances, passageways, stairs and ladder runs shall be kept clear of materials and debris and be so protected as to safeguard any persons from falling materials.

- Access to areas where flooring has been removed or where there are dangerous holes or openings such as lift shafts, shall be barred or protected with guardrails and toe boards. Materials used to cover holes shall be securely fixed in position.

- Glass in windows, partitions, roofs, etc. shall be removed prior to structural demolition. Care must be taken to ensure that glass is completely removed and not left where they could cause injury.

- Adequate and suitable lighting shall be provided for all working places, approaches, dangerous openings and places where lifting or lowering is to take place.

- Overloading of any part of the building by debris or materials shall be prohibited.

- All electrical wires or cables shall be disconnected or diverted before proceeding with the demolition.

- "DANGER, KEEP OUT" and "NO TRESPASSING" signs are to be displayed at conspicuous locations on the exterior side of the hoarding.

- Road signages shall be placed along the main entrance to warn the public. The road signages shall comply with JKR specifications.

- The Contractor shall maintain and ensure a safe working environment by keeping the site neat and tidy and free from all hazards and debris. Materials shall be stacked up safely.

- Debris shall be wetted to minimize dust generation. Containers for debris and rubbish are to be provided at designated locations.

- All materials shall be safely piled at such locations as not to interfere with any operations nor present a hazard to anyone on the demolition site. Materials and debris shall not be stored on fans, catch platforms, scaffold platforms, floors or stairways of the building structure being demolished.

In addition to this, a comprehensive emergency response chart was developed, stating the procedures, persons to contact, classification of accidents, listing of relevant authorities and follow up measures which included setting up of an enquiry board and investigation team to review and identify the causes of any accident and suggest corrective actions to be taken.

On a different note, another important area covered was the project's health and safety risk assessment. The assessment involved two (2) major components which were a hazards analysis and a job safety analysis. The former focused on the hazards generated from the usage of machinery and plant where else the latter concentrated on the effects of potential hazards toward human health and well being. Tables 4.9 and 4.10 below indicate the respective analysis.

Table 4.9: Hazards analysis.

Activites	**Machineries/ Plant**	**Potential Hazards**	**Preventive Measures**	**Action**
Erection of hoarding	Excavator and manual works	Toppling of hoarding	Construct as per P.E's design	Project Manager
Erection of scaffolds	Hand held equipment	Workers falling from heights	Workers to observe strict safety rules i.e. wearing of safety belts and helmets	Safety Supervisor
Demolition	SK 100 Excavator with hydraulic hacker	Excavator falling from heights/ flying debris	Only experienced operators allowed to operate the excavator	Project Manager
Lifting of plants and equipment	Mobile crane	Toppling crane	To ensure all outriggers are properly seated on steel the plate	Safety Supervisor
		Snapping crane cables	To ensure cranes have valid certificates	To appoint Lifting Supervisor

Table 4.10: Job safety analysis.

Job Activities	**Potential Hazards**	**Preventive Measures**	**Action**

1) Breaking of concrete using pneumatic breaker and clearing of waste concrete/ hardcore by excavator.	<u>1) Noise pollution & its effects:</u> Annoyance & interference. Temporary and permanent loss of hearing.	1a) Replace pneumatic breaker with electric diamond cutter. 1b) Erect portable sound barrier. 1c) Enclose pump, compressor and generator with sound damping material. 1d) Increase exposure distance or reduce exposure time. 1e) Fix silencer or muffler at the exhaust of the compressor. 1f) Improve machinery maintenance i.e. tighten loose parts, replace worn parts and lubricate moving parts.	S'visor
	<u>2) Vibration & its effects:</u> Tiredness, irritation, giddiness, dizziness, nausea, numbness, swelling and bluish fingers. **Note:** *Low frequency (whole body)* 3-14 cls: i.e. trucks & excavators. *High frequency (hand & arms)* 16-10,000 cls: i.e. pneumatic drills and chisels.	2a) Use vibration isolators and anti-vibration gloves. 2b) Apply optimum hand grip force. 2c) Reduce driving force. 2d) Maintain machinery in good running order, i.e. balancing of rotating parts, sharpening of cutting tools. 2e) 10 minute rest periods every hourly interval.	
	<u>3) Flying & falling objects will cause minor and major injuries which may proof fatal.</u>	3a) Isolate working area with barricade tape and place signboards to warn people. 3b) Safety helmet and safety glasses to be worn during site works. 3c) Cover the building using safety netting. 3d) Watchman to be present during demolition works.	

Table 4.10(cont.): Job safety analysis.

Job Activities	Potential Hazards	Preventive Measures	Action
1) Breaking of concrete using pneumatic breaker and clearing of waste concrete/ hardcore by excavator.	4) Silica dust - Health effects: Scarring and stiffening of lung tissues (silicosis), reduced lung capacity. *Signs & symptoms:* Shortness of breath, easily tired, lost of appetite; constant coughing that may lead to development of TB and heart problems.	4a) Reduce the need for masonry to be cut or drilled. 4b) Apply wet process cutting. 4c) Incorporate dust extraction unit on portable cutting and grinding tools. 4d) Wet dusty haulage roads with water at frequent intervals. 4e) No dry sweeping. 4f) Wear respirators and dust masks where necessary.	S'visor
	5) Health effects of Asbestos: Asbestosis, lung cancer & others.	5a) Wet materials before removal. 5b) Erect signs and barriers to prevent unauthorized entering. 5c) Remove asbestos sheets with minimal breakage. 5d) Wear respirators and disposable coveralls. 5e) Apply local extraction exhaust. 5f) Proper waste disposal.	
2) Soft strip clearing.	1) Effect of sunlight (UV & IR) Sunburn, skin cancer, eye cataract, heat stress and skin pigmentation.	1a) Work in shaded area, erect temporary cover, wear light coloured clothing, wear hats with brims, wear tinted safety glasses.	S'visor
	2) Heat stress: Heat exhaustion. - Excessive sweating from heavy work. Blood volume is reduced and inadequate blood supply to the vital organs, i.e. brain. *Signs & symptoms:* Giddiness, headache, fatigue, weak pulse, nausea, vomiting & fainting.	2a) Reduce physical work. 2b) Drink plenty of water, 1 glass per 20 minutes. 2c) Increase air movement by installing blowers or fans. 2d) Wear loose clothing to increase sweat evaporation.	

4.6 Demolition Environmental Management.

The Environmental Management Plan (EMP) was prepared by Asia Pacific Environmental Consultants Sdn. Bhd. (ASPEC). The EMP basically monitored water and air quality, noise pollution, soil erosion, toxic and hazardous waste as well as waste disposal at various locations throughout the GSB project site, as shown in Figure 4.13 below. The location circled in red refers to **A1/ NM4,** i.e. area of the Lumba Kuda demolition project.

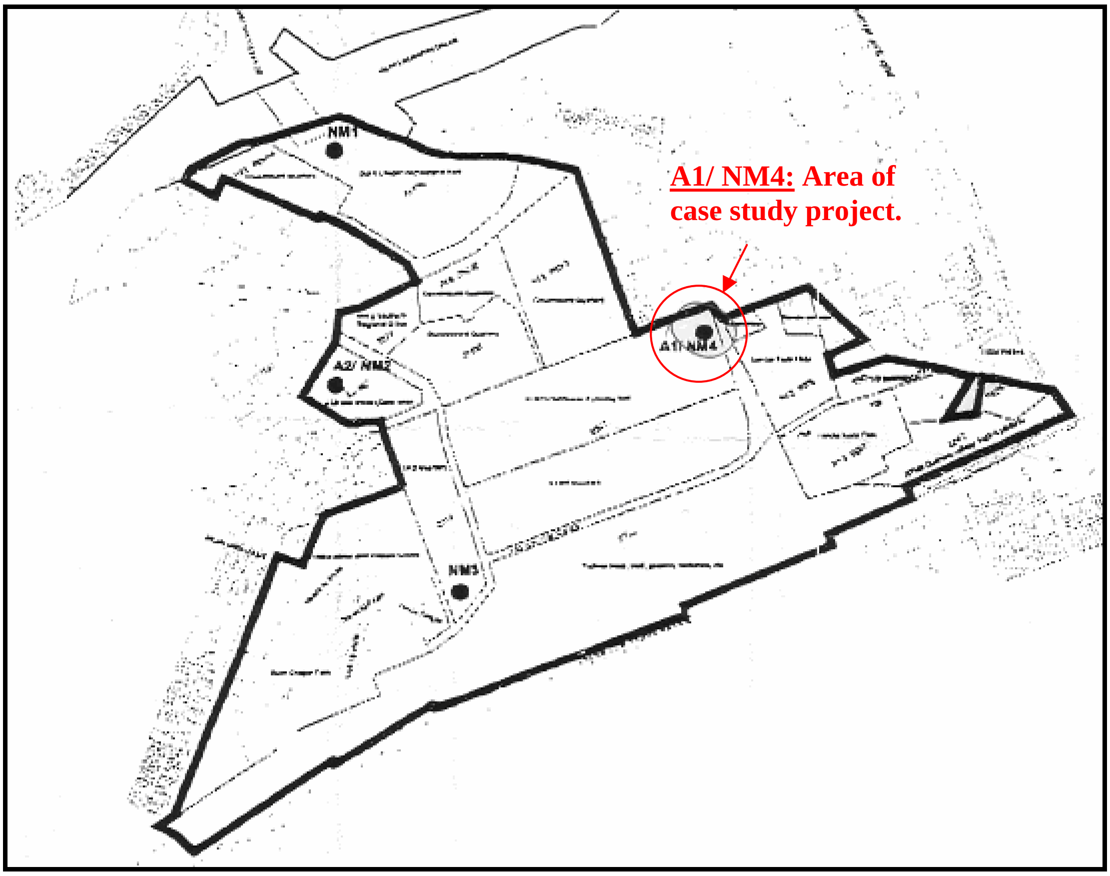


Figure 4.13: Locations of environmental monitoring points within the GSB site.

The contents herein will further report on the air, noise and vibration monitoring works conducted at certain periods during the demolition project.

- **Air Quality**

Monitoring works were carried out on 21st July 2003.

A geographical positioning system GPS 12XL was used to determine the location of the monitoring point, as indicated below.

Table 4.11: Location of air quality monitoring point.

Location	**Description**	**GPS**	
		North	**East**
A1	Near Lumba Kuda Flats	01^0 27' 48.6"	103^0 27' 48.6"

The parameters monitored were relative humidity and temperature, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and PM_{10}. The analytical methods used are as follows:

Relative Humidity and Temperature

Ambient air temperature and humidity measurements were performed using Hanna H18564 Thermohygrometer.

Particulate Matter

PM_{10} was measured using TSI DustTrak Aerosol Monitor Model 8520 (conforms to EC Directive 89/336/EEC and Standard ISO 12103-1).

Gaseous Parameters

The gaseous parameters SO_2, NO_2 and CO were determined using VRAE Multi-gas Exposure Monitor Model PGM-7840 (calibrated using calibration gases and procedures traceable to NIST, USA).
The results of the air quality analysis are as tabulated below:

Table 4.12: Site temperature and relative humidity.

Location	Site Temperature (^{0}C)	Relative Humidity (%)
A1	33.9	66.2

Table 4.13: Air quality monitoring results.

Location	Test Parameter	Concentration	*Specification
A1	SO_2	< 0.1	0.13 ppm
	NO_2	< 0.1	0.17 ppm
	CO	< 0.1	30.0 ppm
	PM_{10}	**319.0**	150.0 (µg/m^3)

The highlighted values indicate that the levels have exceeded the limit of the *Specification.
*(*Malaysian Recommended Air Quality Guidelines)*

The results of air quality monitoring generally complied with the Malaysian Recommended Air Quality Guidelines, except for test parameter PM_{10}. The main reason cited was excessive dust generation from vehicular movement.

Figure 4.14: Air monitoring works in progress.

- **Noise**

Ambient noise measurements were conducted on 28^{th} - 30^{th} June 2003.

A geographical positioning system GPS 12XL was used to determine the location of the monitoring point, as indicated below.

Table 4.14: Location of noise monitoring point.

Location	**Description**	**GPS**	
		North	**East**
NM4	Near Lumba Kuda Flats	01^{0} 27’ 48.6”	103^{0} 46’ 20.5”

Noise levels were monitored for a period of 30 minutes for three sessions, i.e. in the morning, afternoon and evening, per day on an A-weighted frequency. A sound level meter GA 120 (complying with the performance for the IEC 804 – 1985 and ANSI S1.4 – 1983 draft standards for integrating sound level meter type 1 and type 2) was used for the monitoring exercise. The results of the noise level measurements are as tabulated below:

Table 4.15: Noise monitoring results.

Location	**Period**	**Time**	**Noise Level [dB(A)]**					
NM4	Morning	0852	**72.7**	**75.3**	**70.7**	**65.9**	**60.7**	**103.0**
	Afternoon	1359	**71.6**	**74.0**	**71.1**	**66.2**	**60.4**	**90.8**
	Evening	1809	**71.7**	**74.3**	**68.8**	**61.5**	**54.9**	**103.4**

The highlighted values indicate that the levels have exceeded the Recommended Limits.*

The L_{eq} measured had exceeded the recommended level of 65.0 dB(A) during daytime and 55 dB(A) at night. Noise sources were mainly contributed by vehicular movement and human activities as well as demolition works at the Lumba Kuda Flats.

(a) Day time (b) At night

Figure 4.15: Noise monitoring works in progress.

- **<u>Vibration</u>**

  Vibration monitoring was conducted on 21st and 28th July 2003.

  The results of the measurements are as tabulated below:

Table 4.16: Vibration monitoring results.

Location	**Period**	**Duration**	**Vibration Results (max. mm/s p.p.v)**	***Criteria Limit (mm/s p.p.v)**
A1	Morning	12.55 – 1.55 pm	4.48	10.0
	Afternoon	2.15 – 3.15 pm	4.55	
	Evening	6.25 – 7.25 pm	**86.4**	
	Morning	10.45 – 11.45 am	2.54	10.0
	Afternoon	12.30 – 1.30 pm	0.58	
	Evening	4.00 – 5.00 pm	1.63	

The highlighted values indicate that the levels have exceeded the *Criteria Limit.

The results of the vibration monitoring generally complied with BS 5228, except for one period mainly due to heavy night activities at the demolition site.

Figure 4.16: Vibration monitoring works in progress.

4.7 Discussion and Summary

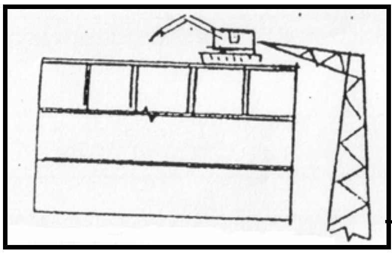
This section basically discusses the case study findings as highlighted earlier throughout the previous sections. The demolition of the Lumba Kuda Flats and surrounding structures were necessary to make way for new development, i.e. the Gerbang Selatan Bersepadu Project. The demolitions were part of an extensive redevelopment plan on government land and were inevitable due to the land's prime and strategic location, a key factor very much essential to the GSB project. Among the many structures demolished, the Lumba Kuda Flats was selected to be studied.

The project's technical consultants were the Architect, planning team, C & S consultant, environmental consultant as well as the health and safety department. The Architect was in control of the overall project as well as the preparation of the site plan. The planning department was given the task of developing a master work plan to identify the sequence of demolition, i.e. which structure had to be demolished first. The C & S consultant was to conduct proper design and prepare the required working drawings. On the other hand, the environmental consultant was basically responsible for executing noise, dust and vibration monitoring exercises. The monitoring works were done on a weekly basis during the demolition operations. Lastly, the health and safety department was in charge of monitoring and implementing health and safety measures.

Prior to the commencement of demolition, a site survey and building inspection were carried out to ascertain valuable data required for ensuring smooth and safe execution of works. In the site survey, as-built drawings obtained from MBJB were scrutinized to locate and identify existing services such as water mains, sewer lines and electrical cables to be disconnected. The termination of live utilities was done concurrently with soft stripping works, using basic hand tools. Most of the materials and debris were salvaged to be recycled or sold. In the building inspection however, detailed checks of structural plans and of the respective blocks were made to determine the structural framing system. This was essential in designing the sequence of structural element removal.

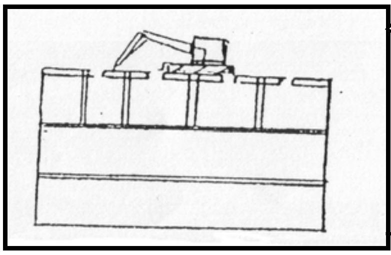
Apart from that, compression tests on concrete core samples taken from the buildings' slabs and beams were carried out in order to ascertain actual structural strength. This was crucial as design had to be done to cater for element simulation under live machinery load. In addition, the age factor was also important as the four (4) blocks were approximately forty (40) years of age at the time of demolition. Upon completion of all preliminary investigation works, the demolition plan was prepared. Based on the information obtained, the four (4) residential blocks were found to be of conventional design and construction. Therefore, to ensure adequate stability during works, the slabs were initially demolished, followed by the secondary beams and main beams. Only after the removal of these elements, the demolition proceeded to target the columns and walls.

The detailed method statement, if simplified, can be illustrated to represent the following:



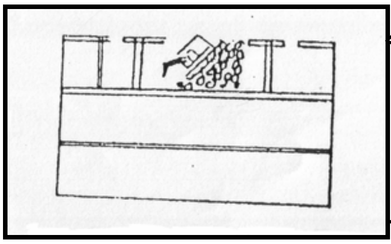
STEP 1:

The excavator is lifted to the top of the building.



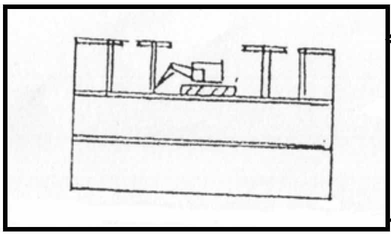
STEP 2:

The roof slab is broken into several sections with each section being supported by beam and column.



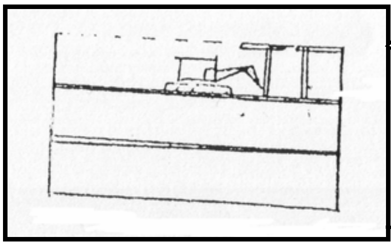
STEP 3:

A slope is formed from the debris. The excavator then descends to the floor below.



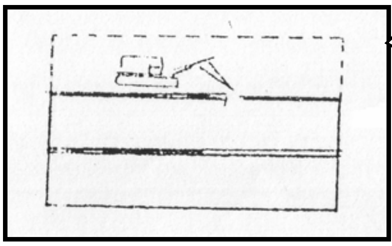
STEP 4:

The debris is removed and the excavator continues to demolish the walls, beams and finally, the columns.



STEP 5:

The excavator proceeds to demolish all other areas before disposing the debris.



STEP 6:

Steps 1 – 5 are repeated for the successive floors below.

A top to bottom demolition method was employed, whereby works started from the 15^{th} floor and preceded downwards. Excavators with different types of attachments such as breakers and crushers were used in the works. Hand held jack hammers were also employed in difficult areas where access with an excavator was denied. In addition, it was also utilized to pre-weaken the structural elements, as carried out on the roof level reinforced concrete water tanks. The selection of demolition techniques were deeply influenced by several factors such as costs, suitability of adaptation to the building, performance requirements, efficiency and speed. Level indicators were used to mark and indicate the respective floor levels due to difficulties faced in recognizing the actual building's height once demolition began.

There were no reported design variations throughout the project. But on certain instances, work methods had to be changed and improvised to suit the necessary conditions. The steel plates used as moving platforms for the excavators were noted to be unsuitable and extremely dangerous on rainy days as the plates become slippery when water comes into contact with the existing dust depositions. To overcome this, an alternate method was used.

In terms of contract, the entire Lumba Kuda demolition project was estimated to be around RM 2.7 million. At the initial stage, two (2) types of contracts were prepared. The first type was where the sub-contractor was allowed to take all debris such as concrete rubble and steel for his own use, thus lowering the contract sum. In contrast, the second type was where the sub-contractor was denied that right, resulting in a higher contract value. In the case of the project, the former type of contract was adopted. Based on the actual project schedule, preliminary works took approximately $3^1/_2$ months to execute with a total cost of RM 362,300.00. Similarly, physical works required a maximum duration of $3^1/_2$ months but with a sum of only RM 152,000.00. Blocks A, B, C and D were all completely demolished within 4 months with an estimated incurred cost of RM 495,800.00 each. In comparison, demolition works for the other minor structures required only a minimal sum of RM 43,000.00 and a maximum time of $2^1/_2$ months.

The Lumba Kuda demolition project required a specific health and safety plan. The designed plan incorporated important aspects such as risk assessment analysis, identification of functions and responsibilities, safety guidelines for all personnel as well as a comprehensive emergency response chart. The risk assessment analysis was done to evaluate the potential hazards resulting from the works itself and recommend appropriate preventive measures. The health and safety plan was to ensure zero accident rate as well as strict adherence to safety requirements and protective personal equipment (PPE). To ensure effectiveness of the plan, tool box meetings were held every morning to brief all personnel on daily activities and job safety awareness.

All workers on site were required to possess high skill and experience with respect to the nature of works to be executed. There were three (3) groups of workers involved. Group 1 handled soft stripping works while Group 2 was assigned to dismantle and remove metal components such as pipes and sewerage systems. Group 3 on the other hand, executed the major demolition woks. All machinery and plant operators were also required to possess the appropriate qualifications and certifications. In terms of site safety, details and photographs of all personnel involved in the demolition operations were properly recorded to ensure that no other persons were able to enter the working area. Adequate exclusion zones or ‘red zones’ were provided around the demolition site as an added safety precaution. The factors that primarily influenced the radius of these zones were the demolition method used, machinery access, machinery location and height of the building.

Hoardings were erected around the project premises and sufficient safety signages were installed to warn all workers and the general public. In addition to this, all site personnel were given advance notice on the works schedule and notices were published in newspapers to inform the public. CCTV facilities were also installed at site for comprehensive monitoring. There were first aid kits on site and all personnel were required to have a safety whistle whereby the whistle is blown as a distress call in the event of an accident or emergency. There were no reported health and safety problems encountered during the demolition operations. Representatives and officers from local authorities were not allowed to enter the demolition site due to safety reasons. However, they were allowed to expedite visual inspections from a distance.

The majority of debris and wastes were in the form of concrete and masonry rubble as well as steel. All these materials were classified as ordinary inert and solid substances. With regards to waste management operations, the entire responsibility was designated to the sub-contractor. Bearing in mind the type of contract adopted, it was agreed that all debris and wastes were to be removed and cleared by the sub-contractor. On-site separation of waste materials largely steel and concrete, was carried out both manually and by machine before being shifted out of the site. The main contractor ensured that the dump trucks were not overloaded and properly covered to avoid debris from falling during transportation to the landfill. The materials were disposed and recycled by the sub-contractor.

As far as environmental management was concerned, monitoring works were frequently conducted by a specialist team to assess the levels of noise, air quality and vibration during the operations. With respect to noise monitoring, measurements were taken around the Lumba Kuda project site during daytime as well as at night using a sound level meter. Measurements at almost all periods recorded levels exceeding the allowable limits, indicating heavy noise pollution. One key reason noted during inspections was that the angle of impact between the breaker head and concrete surface was not at the prescribed alignment. This subsequently contributed towards increased levels of noise production. Several methods were employed to reduce noise emission and some of them included requiring personnel to use ear plugs during the works, only working during the allocated time periods, locating generators and compressors away from public areas as well as ensuring proper maintenance of machinery.

Focusing on air quality, the major concern at the demolition site was the generation of dust. Levels of dust in the atmosphere were measured using a TSI DustTrack Aerosol Monitor. The readings obtained were generally satisfactory but however on certain occasions, levels exceeded the minimum requirements partly due to vehicular movement around the project site. Among the steps taken to keep air pollution within the specified limits were by conducting frequent water suppression sprays on vehicle routes as well as installing sufficient dust screen nettings attached to hoardings around the buildings' perimeters. Water was also sprayed on debris heaps and onto the affected structural elements during demolition.

On vibration monitoring, almost all measurements indicated satisfactory levels. The issue of vibration control was very seriously addressed due to the fact that the demolition site was adjacent to extremely sensitive infrastructure, mainly the Keretapi Tanah Melayu Berhad rail tracks and Singapore Public Utility Board water pipeline. Certain areas of the pipeline were protected with concrete covers. Trenches were also dug at appropriate locations to reduce vibratory effects.

The difficulties or problems encountered during the works were such as fluctuating costs, complaints by the public and of course, noise pollution. There was also a case where the police were called to aid in dealing with drug addicts that had managed to enter the demolition site. Refueling activities were also considered very risky as it had to be done at the top of the structures where the excavators were located. No setbacks were reported in terms of manpower and machinery shortage. The entire demolition project proceeded smoothly without any delays. As a result of paying adequate emphasis and complying with all necessary work requirements, the project was completed with great efficiency and speed.

The case study conducted was successful as it had managed to express satisfactory and essential data on the various important topics. Further to this, the information was able to illustrate sufficient coverage and concrete explanation on relevant work aspects as well as its actual execution. The completeness in reporting backed by reliable information sources has ensured that the findings of the study are both valid and indeed beneficial.

CHAPTER 5

QUESTIONNAIRE SURVEY ANALYSIS

5.1 Introduction

This Chapter presents the statistical analysis performed on the retrieved survey questionnaires and reports its findings. The survey type was a questionnaire survey which was distributed and retrieved via mail. The survey targeted a sample which comprised government departments and local authorities, developers and consultants as well as contractors, from both government and private sectors.

The questionnaire was made up of seven (7) pages consisting five (5) sections which covered areas such as general information, demolition overview, demolition techniques, demolition health and safety as well as demolition waste management. The survey basically took $1^1/_2$ months to design and expedite and a further $1^1/_2$ months for collection; therefore requiring a total duration of three (3) months to complete.

37 valid questionnaires were retrieved from 38 respondents, which formed a composition of:

Table 5.1: Categorization of respondents.

Component		Respondents (Nos.)
1	Local Authorities & Government Departments	6
2	Developers & Consultants	16
3	Contractors	15
	Total	***37***
	Response rate	***37 %***

Due to the unequal proportions of survey participant distribution, the response obtained as highlighted in Table 5.1 had to be weighted accordingly in order to avoid bias or unfair representation. Therefore, to be statistically accurate, the response from Component 1 was increased by a factor of 2.083 and subsequently, the responses from Components 2 & 3 were decreased by 0.794 respectively, to form a weighted composition of:

Table 5.2: Percentage of weighted response.

Component		Respondents (Nos.)	Weighted Response	Percentage
1	Local Authorities & Govt. Departments	6	12.5	33.7 %
2	Developers & Consultants	16	12.7	34.2 %
3	Contractors	15	11.9	32.1 %
	Total	***37***	***37.1***	***100.0 %***

The graphical illustration is presented in Figure 5.1. The analyses performed on the survey questionnaires were of two (2) types; the first being a weighted percentage calculation and the second being a weighted ranking computation. The details are systematically tabulated and enclosed in Appendix C. The following sections will further discuss the survey results.

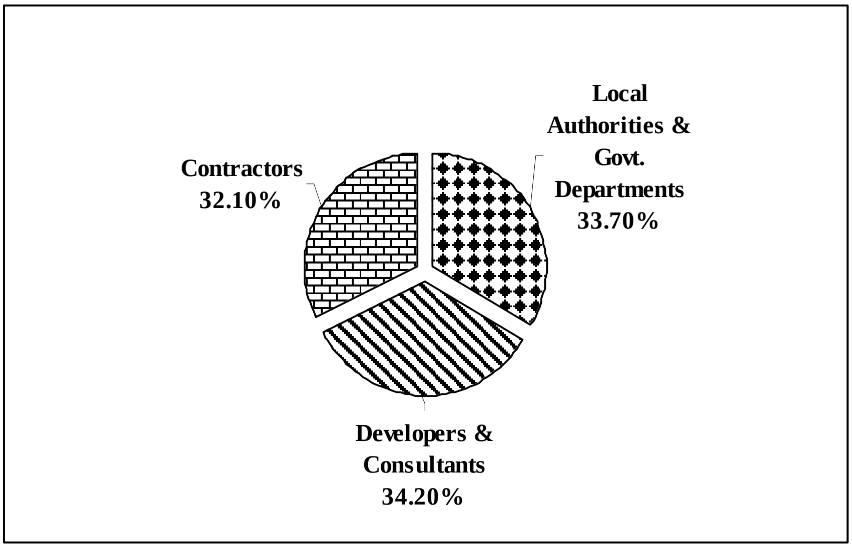


Figure 5.1: Percentage of weighted response.

5.2 General Information

In this section, the respondents were required to answer three (3) questions relating to the department that they belonged to, their working experience and on how demolition projects were usually executed in Malaysia. On the first question, 29.2 % of respondents were from the Project Management department where else 28.1 % and 21.4 % of respondents belonged to the Building and Construction departments.

A further 12.9 % and 6.4 % indicated that they were attached to the Engineering as well as Project Management & Construction departments respectively. The survey also attracted 2 % of responses which comprised respondents from the Upper Management department. The analysis is tabulated in Table C1 – Appendix C and is graphically illustrated in Figure 5.2.

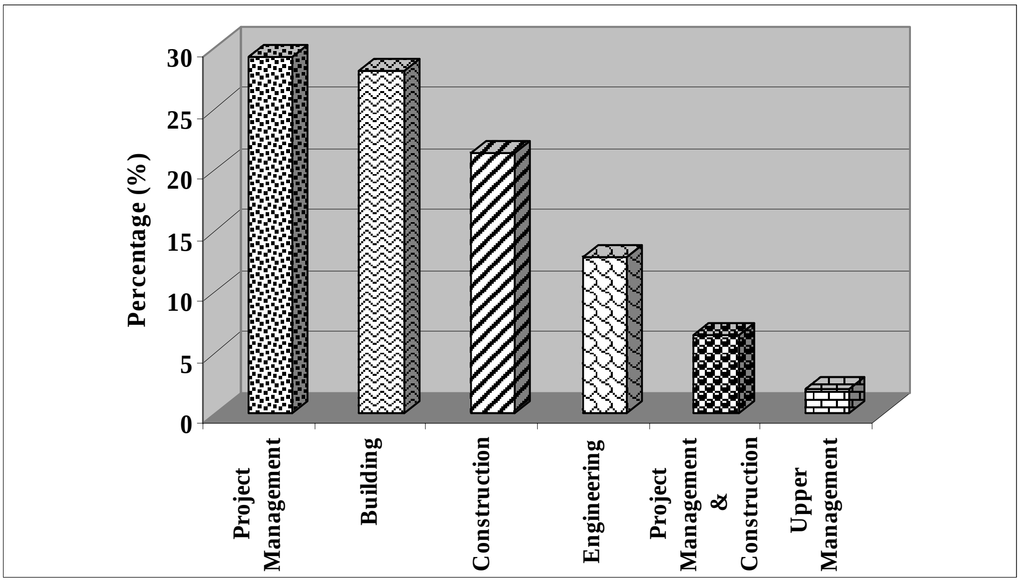


Figure 5.2: Categorization of respondents departments.

With regards to the respondents working experience, a 44.6 % majority possessed more than 15 years experience while 26.2 % reported that they were in the 5 – 10 years category. 15.0 % of respondents had below 5 years of experience in addition to 14.20 % who indicated having worked between 10 – 15 years. The analysis is tabulated in Table C2 – Appendix C and is graphically presented in Figure 5.3 below.

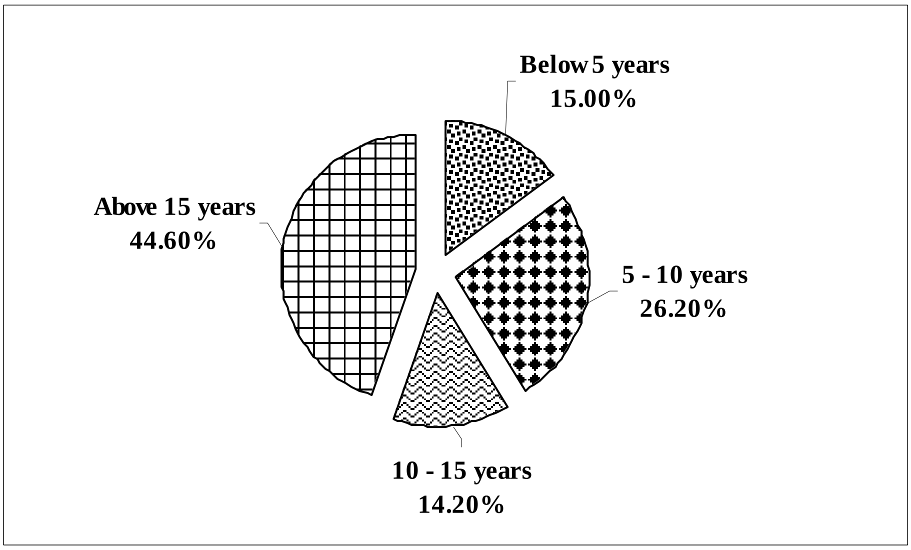


Figure 5.3: Respondents working experience.

With reference to how demolition projects were usually executed in the country, 44.6 % of respondents noted that they were based on both Consultant's advice and Contractor's proposal where else 19.8 % solely indicated Consultant's advice. On the other hand, 12.8 % chose a combination of Consultant's advice, Contractor's proposal and previous experience as the mode of execution while a further 12.1 % identified a grouping of Contractor's proposal and previous experience. Only 6.4 % of the total respondents selected purely Contractor's proposal, followed by 4.3 % suggesting previous experience alone. The analysis is tabulated in Table C3 – Appendix C and is graphically illustrated in Figure 5.4 below.

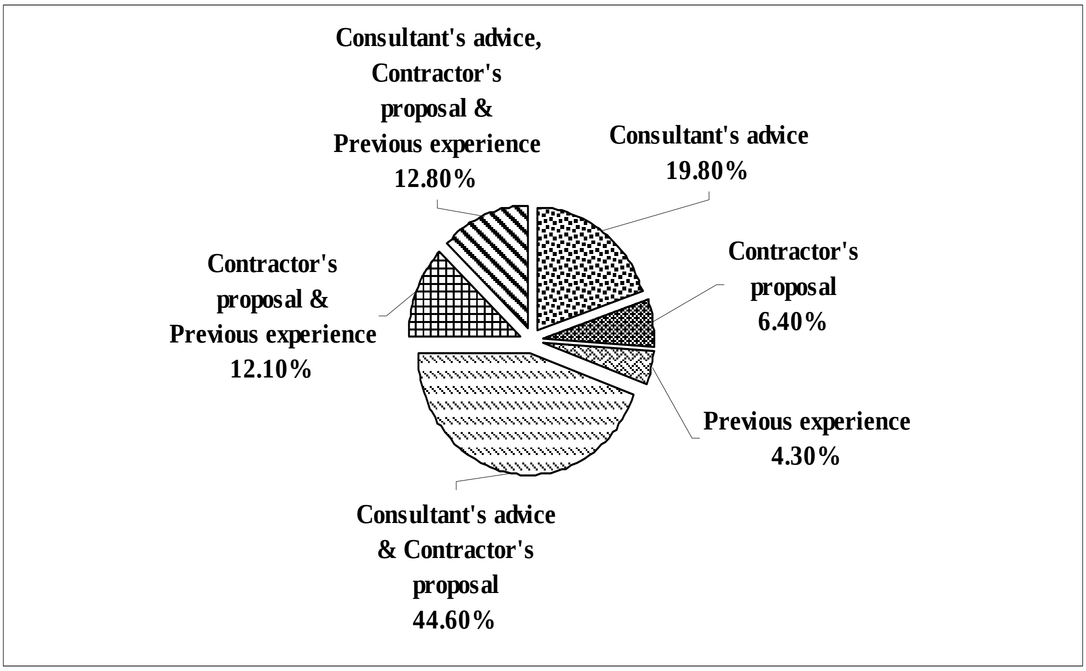


Figure 5.4: Execution mode of demolition projects.

5.3 Demolition Overview

This section was mainly designed to look into the extent and reasons of demolition projects in Malaysia. It also geared towards exploring related work misconceptions, assessing the role of government bodies as well as developing data on past demolition projects in terms of the types of structures demolished, their material compositions and approximate ages. The respondents were first asked to rate on how extensive minor and major demolition works were carried out locally. 41.2 % and 36.1 % of respondents rated minor demolition works as being executed on an average and extensive scale respectively. A balance of 14.2 % indicated it as being not extensively done while in contrast, 8.6 % reported it on a very extensive scale. In comparison, major demolition works gathered a not extensive rating of 61 %, followed by a lower 20.6 % for being carried out on an average scale. A further 14.2 % of respondents noted that the current situation is extensive where else a minority of 4.3 % decided to go with it being totally not extensive. The analysis is tabulated in Table C4 – Appendix C and is graphically presented in Figure 5.5 below.

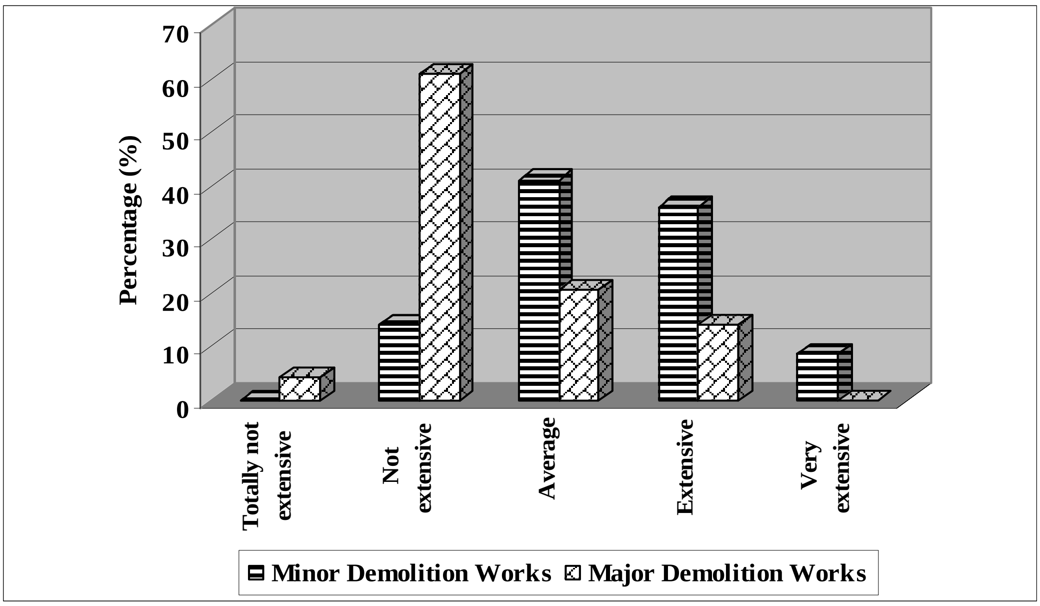


Figure 5.5: Extensiveness rating of demolition works.

Subsequently, the respondents were required to rate on how often demolition works were executed involving two different job scopes which were to: 1) solely demolish and 2) demolish as well as redevelop, whereby demolition formed part of the overall project package. With respect to the former job scope, a high 34.8 % and 30.5 % of respondents were in the opinion of it being very rarely and rarely executed respectively, while 26.2 % settled with the notion of an average frequency. In addition, 6.4 % of respondents stated that the job scope was frequently the case, followed by 2.1 % claiming it to be on a very frequent scale.

On the other hand, focusing on the latter, 36.1 % and 24.9 % of respondents identified the job scope as being carried out frequently and on an average scale each. Further to this, 20.6 % were in the opinion of it being rarely done while another 10.7 % found the job scope to be frequently the case. Only 7.8 % of respondents were selective to a very rarely extent. The analysis is tabulated in Table C5 – Appendix C and is graphically illustrated in Figure 5.6 below.

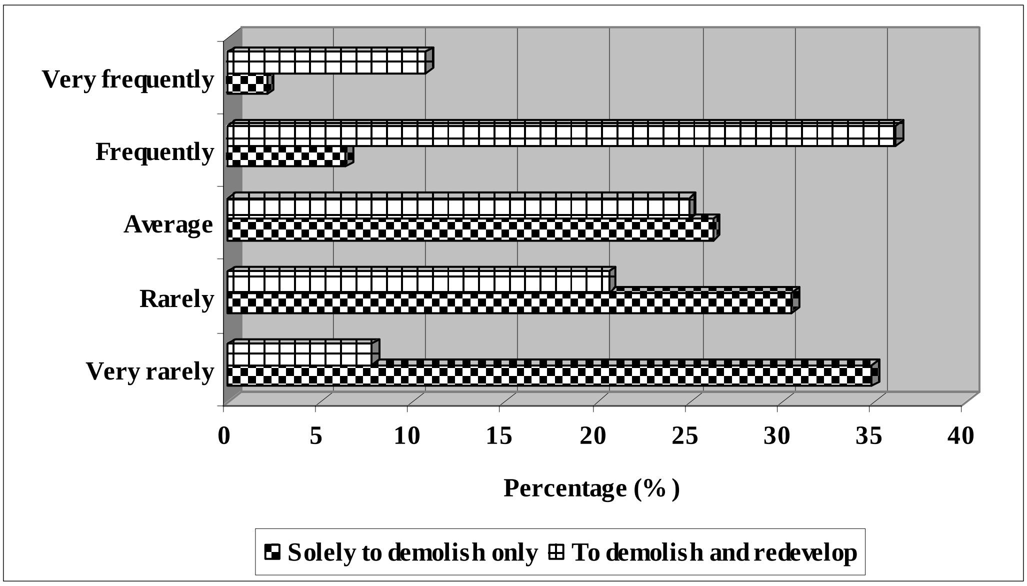


Figure 5.6: Frequency rating of demolition project job scopes.

In order to gain better understanding of the need to conduct demolition works, the respondents were asked to rate in terms of frequency, ten (10) pre-outlined reasons pertaining to demolition projects in Malaysia. The analysis is tabulated in Table C6 – Appendix C. The ranking results are described below in Table 5.3.

Table 5.3: Frequency ranking of reasons for demolition projects.

Reasons for Demolition Projects	**Rank**
Building refurbishment, renovation, conversion	***1***
Infrastructure development, i.e. construction, upgrading & expansion of highways	***2***
Area redevelopment, i.e. increasing land values & economic prospects, land takeover due to the expiration of lease period	***3***
Destroyed or damaged due to fire	***4***
Urban restructuring, i.e. changes in the nation's master plan, due to govt. policies, changes in land use	***5***
Building's physical condition, i.e. dilapidated, deteriorated	***6***
Not suitable for anticipated use, i.e. outdated design & appearance, specific problem with structural materials or systems	***7***
Destroyed or damaged due to natural disasters, i.e. flooding & landslides	***8***
Abandoned or vacant	***9***
Costs of maintenance too expensive	***10***

Moving on, the respondents were required to rate in terms of agreement, five (5) misconceptions often associated with demolition operations. The results are as follows:

Option 1 – *Demolition usually destroys many structures that should be preserved.*

39.1 % of respondents disagreed with the fact while 31.0 % agreed and 25.7 % were of an average opinion. 4.3 % of respondents totally disagreed with the statement.

Option 2 – *Demolition unnecessarily overcrowds landfills with debris.*

42.5 % of respondents were average in their response while 24.1 % agreed and 21.4 % disagreed. As much as 6.4 % totally disagreed with the statement and 5.6 % of respondents went on to strongly agree.

Option 3 – *Major demolition operations are simple and unsophisticated.*

34.8 % of respondents disagreed with the fact, 28.4 % were on an average level while 26.2 % agreed. 8.6 % totally disagreed where else in contrast, 2.1 % expressed strong agreement with the statement.

Option 4 – *Demolition operations are dangerous.*

51.6 % of respondents chose an average opinion while 27.8 % agreed with the statement. A total of 14.2 % strongly agreed where else another 6.4 % showed disagreement.

Option 5 – *Major demolition operations are costly.*

48.1 % of respondents agreed and 33.4 % settled to be average. However, 16.3 % went on to strongly agree on the issue while only 2.1 % of respondents expressed disagreement.

The analysis is tabulated in Table C7 – Appendix C and is graphically illustrated in Figure 5.7 below.

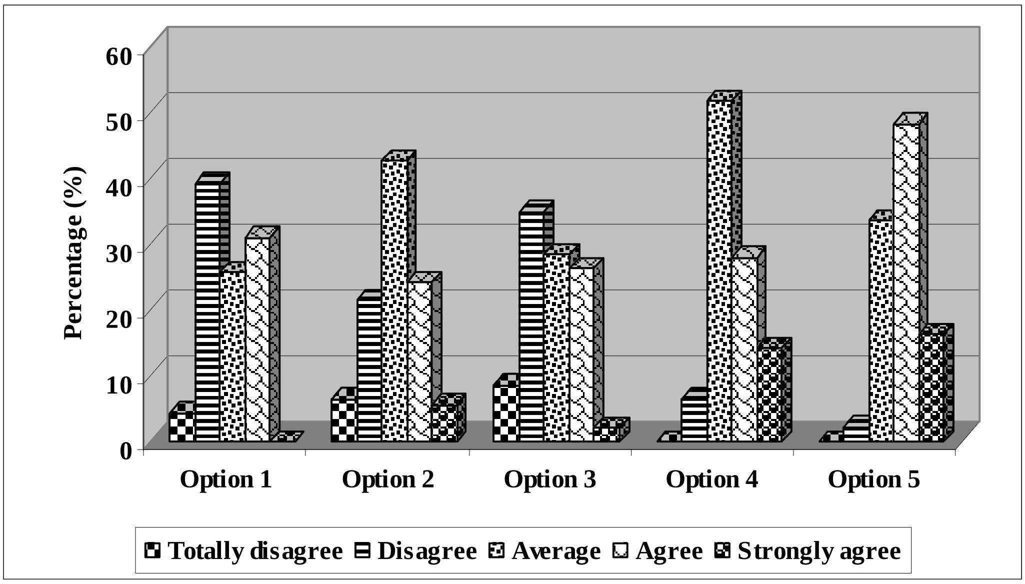


Figure 5.7: Agreement rating of demolition misconceptions.

In an attempt to establish how government bodies and agencies faired with regards to demolition project participation, the respondents were asked to express their ratings in terms of quality. On the issue of involvement and contribution, 58.3 % of respondents were average in their ratings while 36.1 % and 5.6 % indicated below average and above average performances respectively. On the matter of competence and experience, a majority of 63.9 % again expressed their ratings as being average. 34.0 % of respondents stated below average performances where else only 2.1 % ratings were above average. The analysis is tabulated in Table C8 – Appendix C and is graphically shown in Figure 5.8 below.

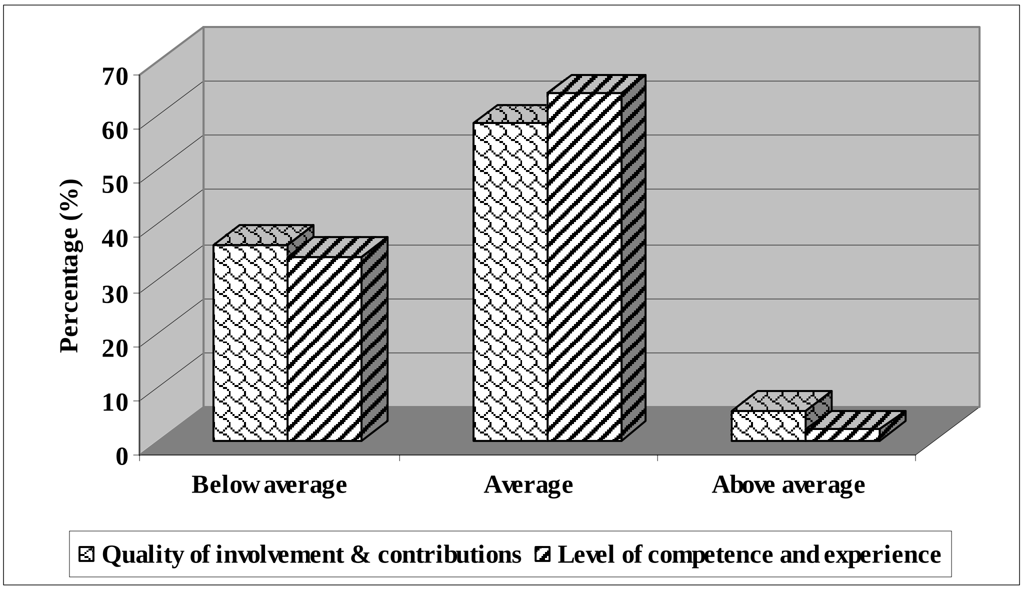


Figure 5.8: Quality rating of government participation in demolition projects.

In order to develop data on previous demolition projects executed in the country, the respondents were required to fill in a simple form recording the ages and types of structures that had been demolished based on their project records, at the same time identifying the materials that made up the debris. From the analysis performed, the six (6) categories of structures involving the highest volume of demolition in descending order are: Civil & Infrastructure with 29.2 %, Public with 18.1 %, Residential with 16.6 %, Commercial with 14.4 %, Industrial with 14.0 % and lastly Specialized with 7.7 %. The analysis is tabulated in Table C9 – Appendix C and is graphically shown in Figure 5.9.

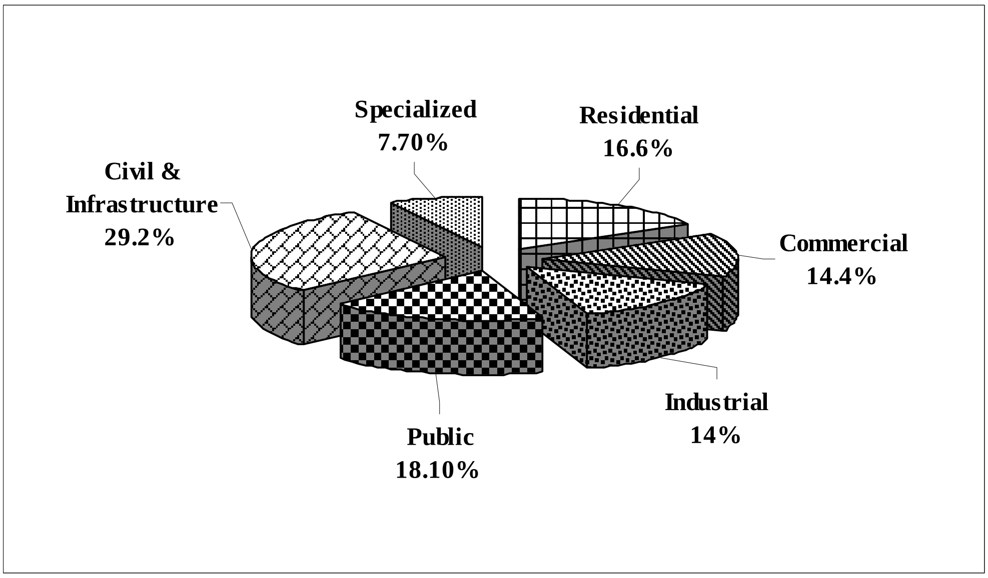


Figure 5.9: Demolition projects by structural categorization.

- **Civil & Infrastructure category**

In this category, 16.8 % of structures demolished were from drainage and irrigation while bridges and retaining walls comprised of 15.7 % and 14.4 % each. In addition, abutments and embankments made up 12.8 %. Railway stations and bus terminals were in fifth place with 10.5 % each, followed by water retaining structures as well as ports and jetties which tied at 9.7 % respectively. The analysis is tabulated in Table C10 – Appendix C and is graphically presented in Figure 5.10.

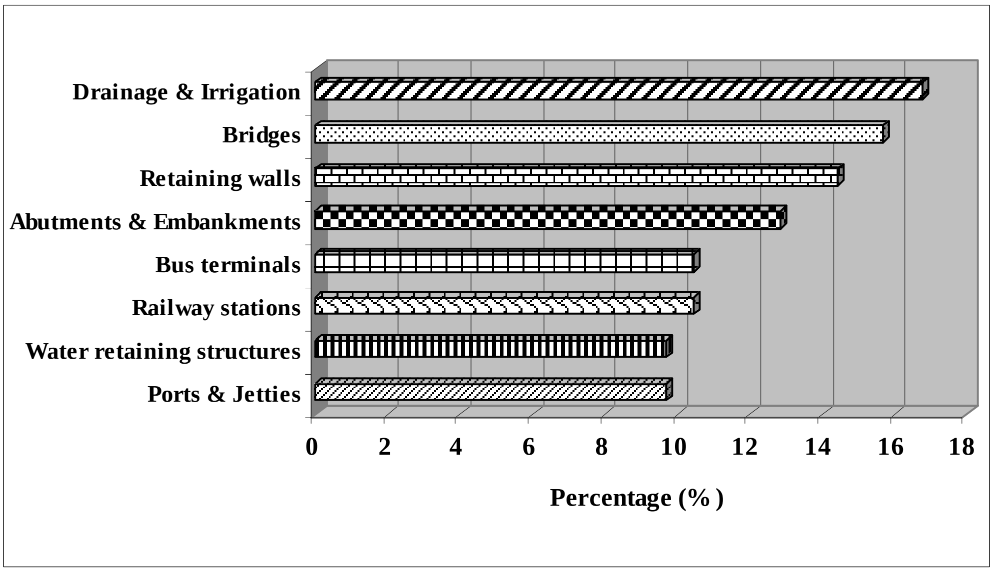


Figure 5.10: Types of structures demolished in the Civil & Infrastructure category.

In terms of materials, 39.3 % of civil and infrastructure demolition debris were made up of reinforced concrete and mass concrete followed by 26.5 % for steel as well as other metals, and 10.2 % for masonry. Timber and wood alongside asphalt comprised 9.4 % and 7.9 % each where else insulation material contributed towards 3.4 %. Plastics and vinyl, hazardous chemicals together with asbestos and lead registered the smallest proportions with 2.2 %, 0.7 % and 0.4 % respectively. The analysis is tabulated in Table C11 – Appendix C and is graphically shown in Figure 5.11.

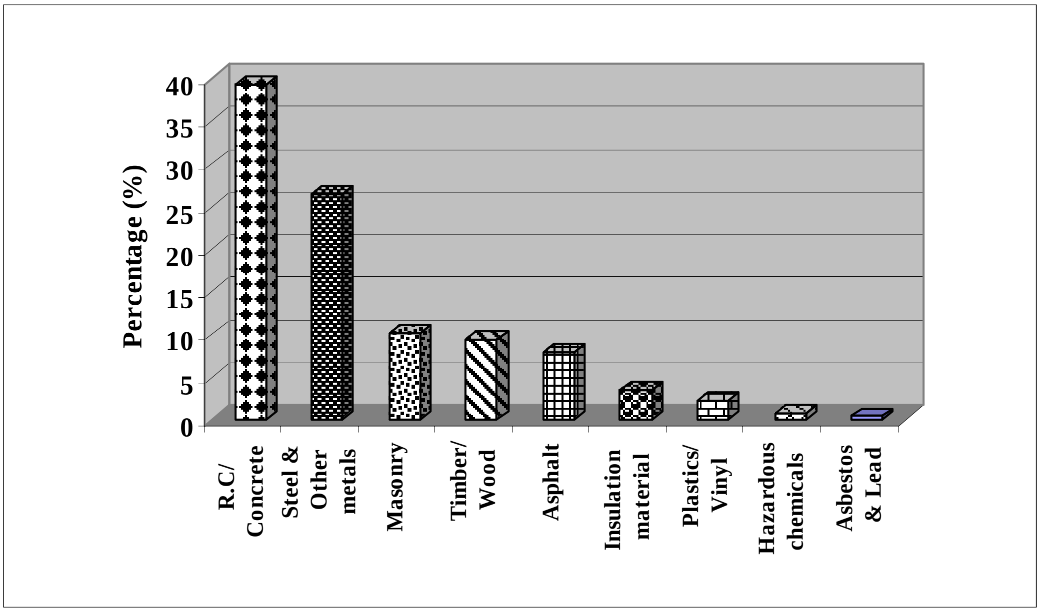


Figure 5.11: Composition of Civil & Infrastructure demolition debris.

With regards to age, a majority 30.0 % of structures demolished were within 50 – 75 years while 22.3 % were between the ages of 25 – 50 years. 18.5 % consisted of structures in the range of 75 – 100 years followed by 16.4 % representing structures below 25 years of age. Only a minimum of 12.8 % formed structures with ages exceeding 100 years. The analysis is tabulated in Table C12 – Appendix C and is graphically illustrated in Figure 5.12.

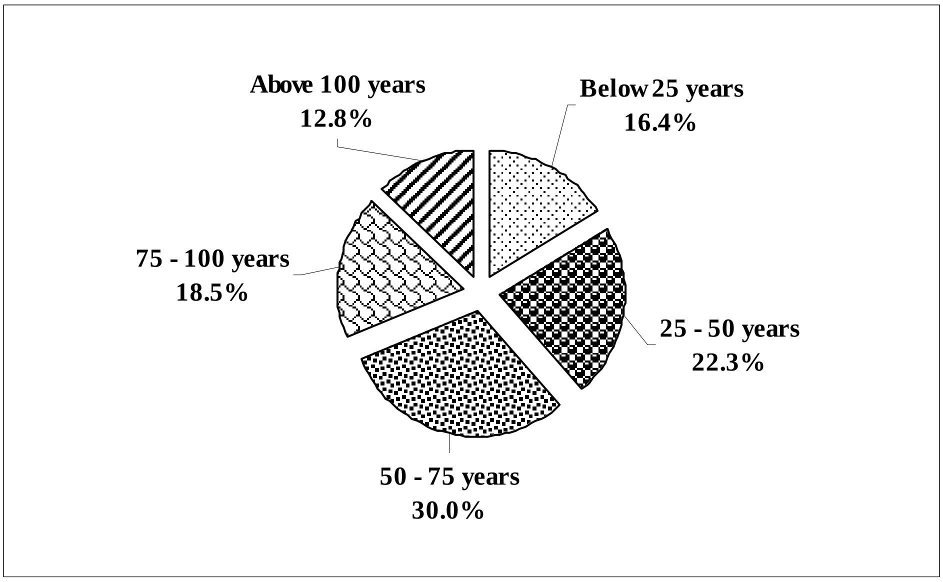


Figure 5.12: Age of structures demolished in the Civil & Infrastructure category.

- **Public category**

In this category, 28.7 % of public structures demolished were places of worship while sports centers and stadiums as well as educational institutions tied in second place with 19.0 % each. 17.7 % were multi-purpose halls followed by hospitals recording 15.6 %. The analysis is tabulated in Table C13 – Appendix C and is graphically presented in Figure 5.13 below.

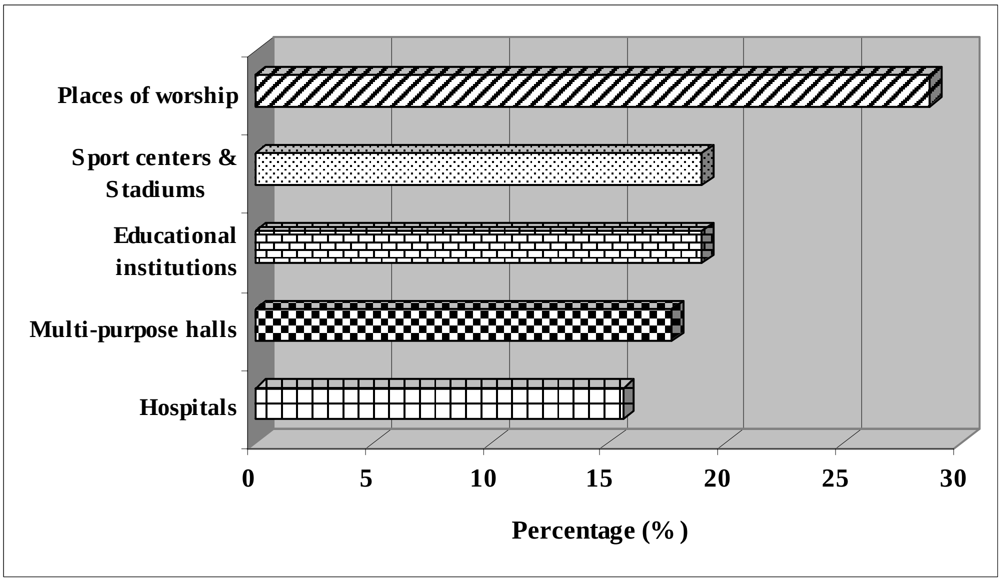


Figure 5.13: Types of structures demolished in the Public category.

In terms of materials, 27.1 % of public demolition debris were made up of reinforced concrete and mass concrete followed by 20.7 % for steel as well as other metals and 18.6 % for timber and wood. Masonry and asphalt comprised 12.0 % and 7.4 % respectively where else plastics and vinyl contributed towards 6.8 %. Insulation material, hazardous chemicals as well as asbestos and lead registered the least debris proportions with only 4.5 %, 1.6 % and 1.4 % each. The analysis is tabulated in Table C14 – Appendix C and is graphically shown in Figure 5.14.

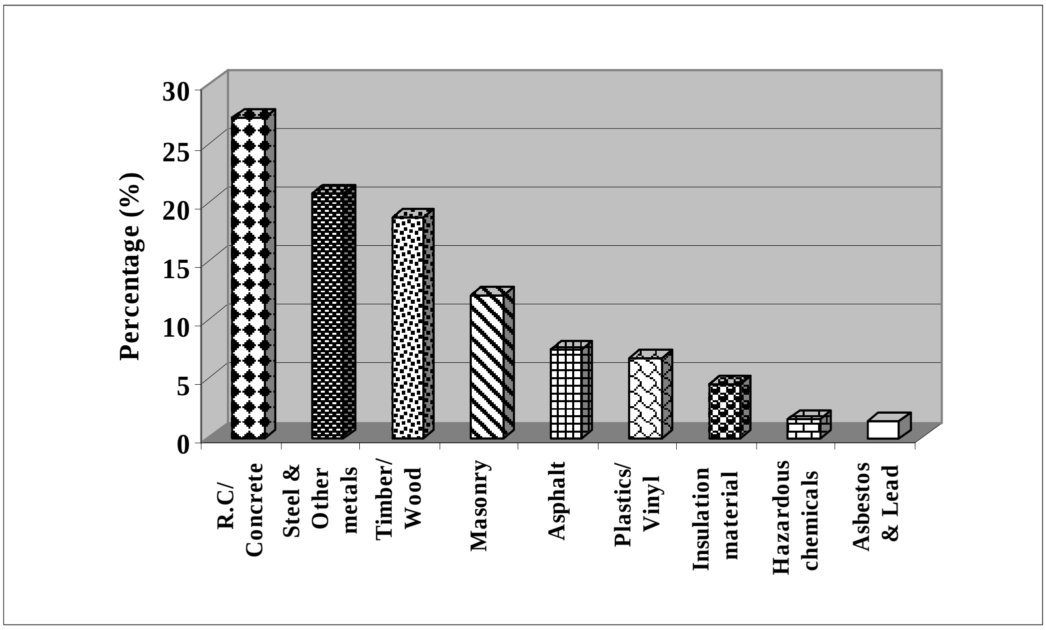


Figure 5.14: Composition of Public demolition debris.

With regards to age, a majority 28.7 % of structures demolished were within 50 – 75 years while 21.0 % were between the ages of 25 – 50 years. 18.2 % comprised structures below 25 years followed by 17.1 % for those in the range of 75 – 100 years of age. A total of 15.0 % represented structures above the age of 100 years. The analysis is tabulated in Table C15 – Appendix C and is graphically illustrated in Figure 5.15.

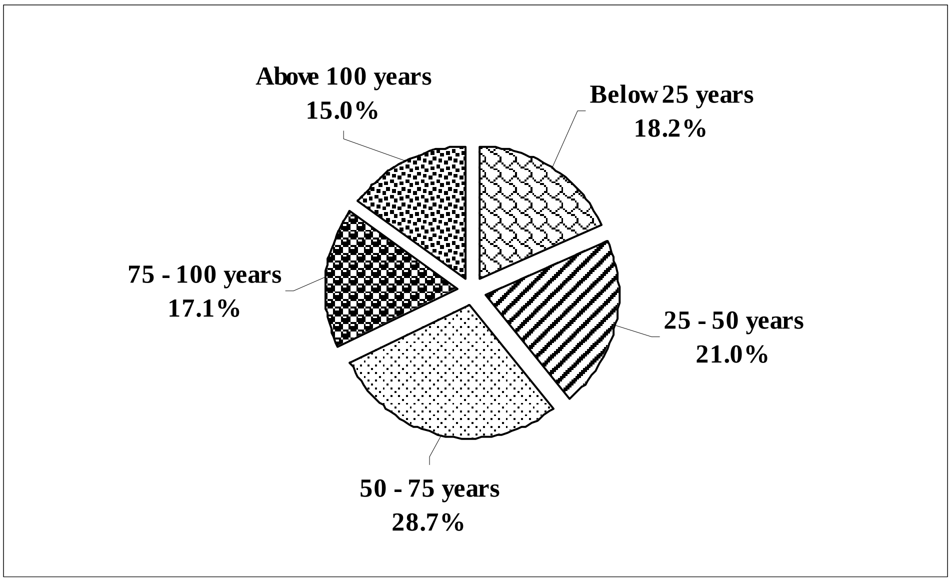


Figure 5.15: Age of structures demolished in the Public category.

- **Residential category**

In this category, 26.1 % of residential structures demolished to date were high rise flats and apartments while 25.3 % consisted of low rise flats and apartments. A further 24.7 % were basically medium rise flats and apartments, followed closely by 23.9 % indicating housing schemes. The analysis is tabulated in Table C16 – Appendix C and is graphically presented in Figure 5.16 below.

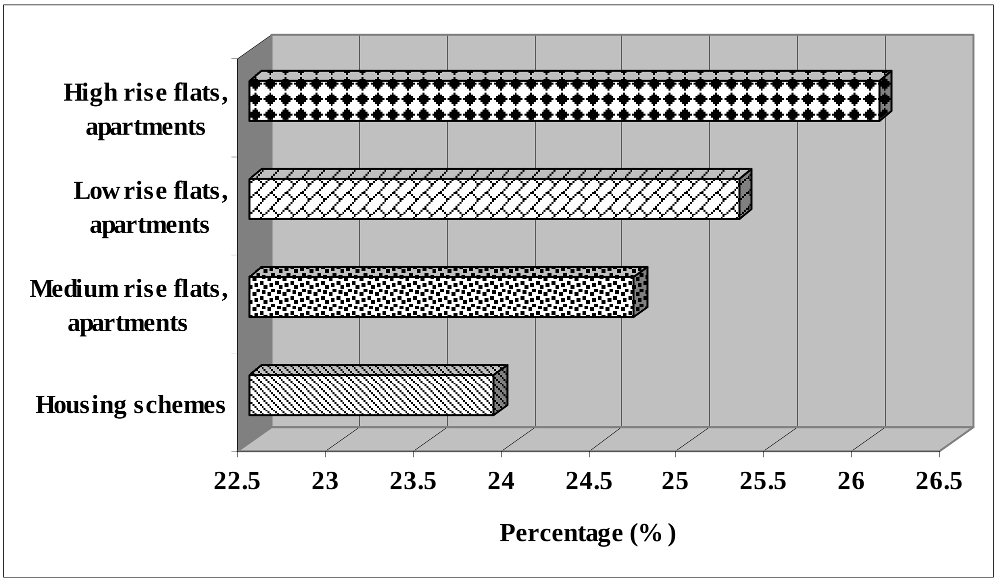


Figure 5.16: Types of structures demolished in the Residential category.

In terms of materials, 40.5 % of residential demolition debris were made up of reinforced concrete and mass concrete followed by 17.7 % for timber and 14.7 % for steel as well as other metals. Masonry and asphalt comprised 14.5 % and 8.7 % respectively where else asbestos and lead contributed towards 2.7 %. Only 1.8 % of insulation material was identified among the overall debris. The analysis is tabulated in Table C17 – Appendix C and is graphically shown in Figure 5.17.

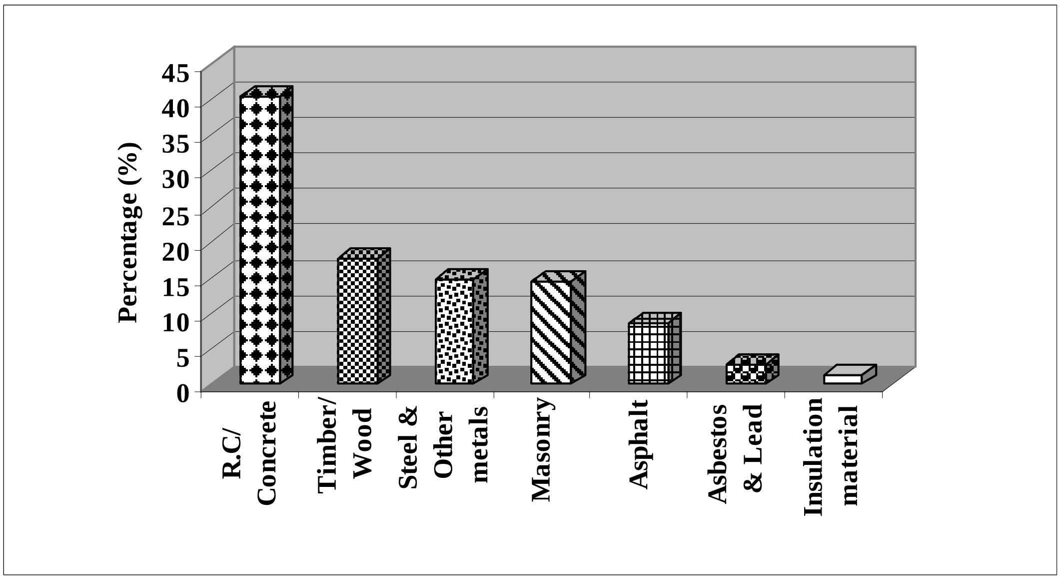


Figure 5.17: Composition of Residential demolition debris.

With regards to age, a majority 34.1 % of structures demolished were within 50 – 75 years while 24.6 % were between the ages of 25 – 50 years. 21.6 % comprised buildings below 25 years followed by 12.0 % for structures above 100 years. A minority of 7.7 % fell within the range of 75 – 100 years. The analysis is tabulated in Table C18 – Appendix C and is graphically illustrated in Figure 5.18.

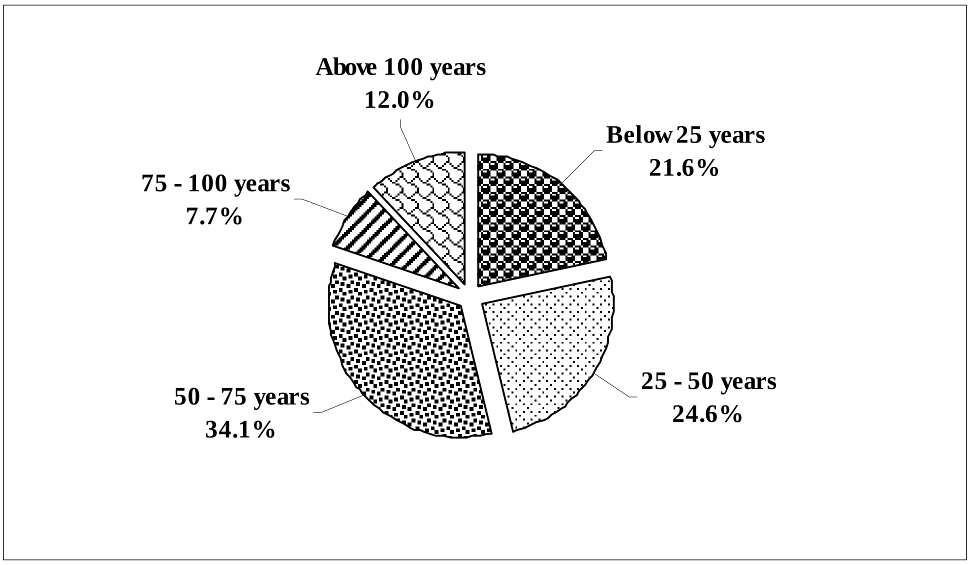


Figure 5.18: Age of structures demolished in the Residential category.

- **Commercial category**

In this category, 38.1 % of commercial structures demolished were offices and shop lots while shopping centers and hotels tied in second place with 21.2 % each. A total of 19.6 % pointed towards convention centers. The analysis is tabulated in Table C19 – Appendix C and is graphically presented in Figure 5.19 below.

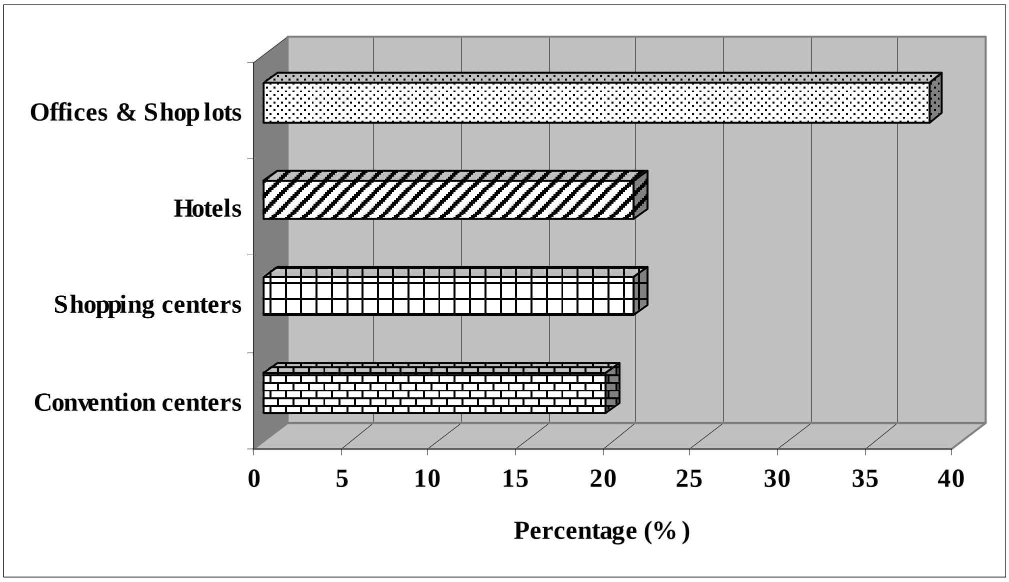


Figure 5.19: Types of structures demolished in the Commercial category.

In terms of materials, 25.6 % of commercial demolition debris were made up of reinforced concrete and mass concrete followed by 19.5 % for steel as well as other metals and 15.8 % for masonry. Timber and wood together with insulation material comprised 13.1 % and 8.8 % respectively where else plastics and vinyl contributed towards 7.9 %. Asphalt, asbestos and lead as well as hazardous chemicals recorded the least amounts with 5.5 %, 2.4 % and 1.4 % each. The analysis is tabulated in Table C20 – Appendix C and is graphically shown in Figure 5.20.

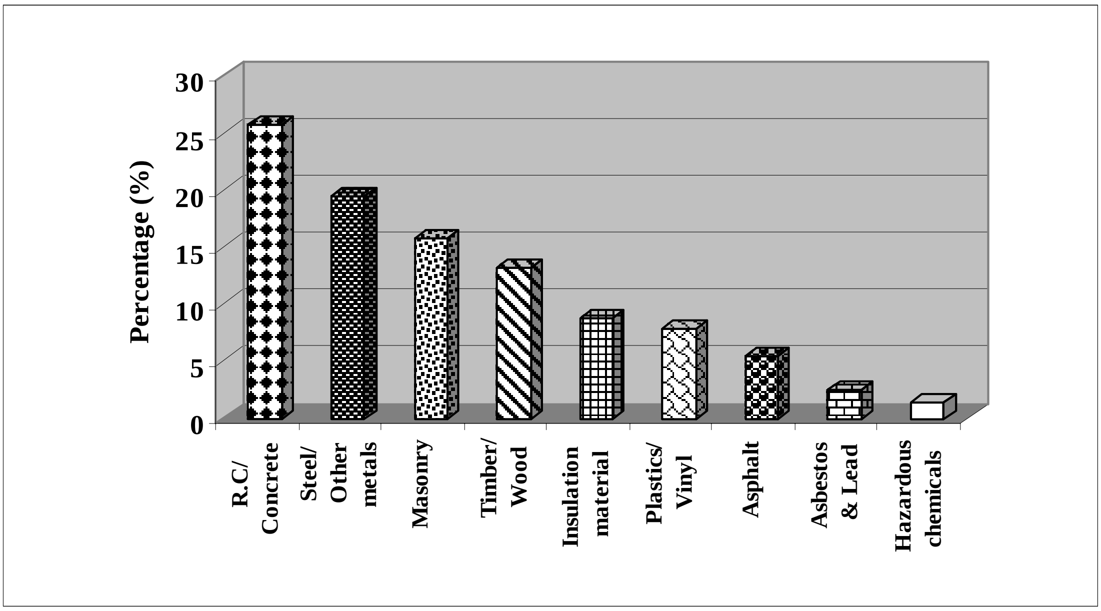


Figure 5.20: Composition of Commercial demolition debris.

With regards to age, a majority 27.5 % of structures demolished were above 100 years while 22.0 % were between the ages of 50 – 75 years. 21.2 % comprised buildings within 25 – 50 years followed by 17.3 % for structures falling in the 75 – 100 years range. Only 12.0 % were below the age of 25 years. The analysis is tabulated in Table C21 – Appendix C and is graphically illustrated in Figure 5.21.

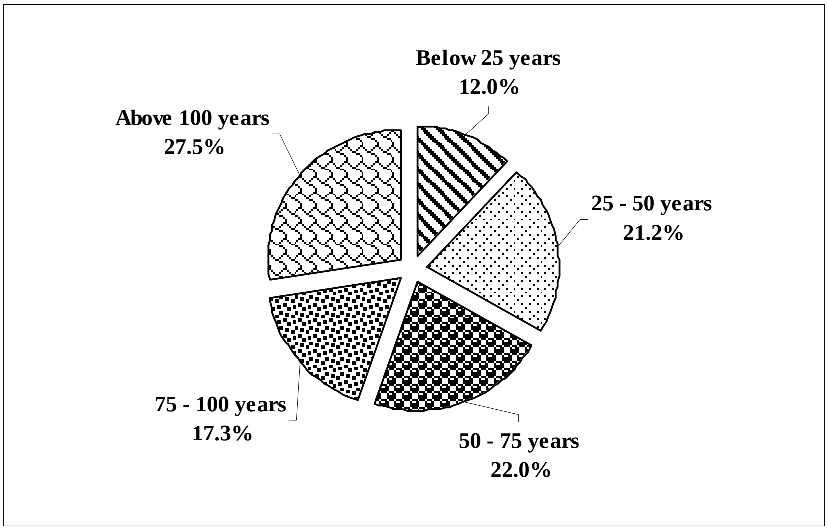


Figure 5.21: Age of structures demolished in the Commercial category.

- **Industrial category**

In this category, 32.8 % of industrial structures demolished were garages and workshops while 25.2 % consisted of small scaled factories. A further 21.9 % were large scaled factories and plants followed by refineries which made up 20.2 %. The analysis is tabulated in Table C22 – Appendix C and is graphically presented in Figure 5.22 below.

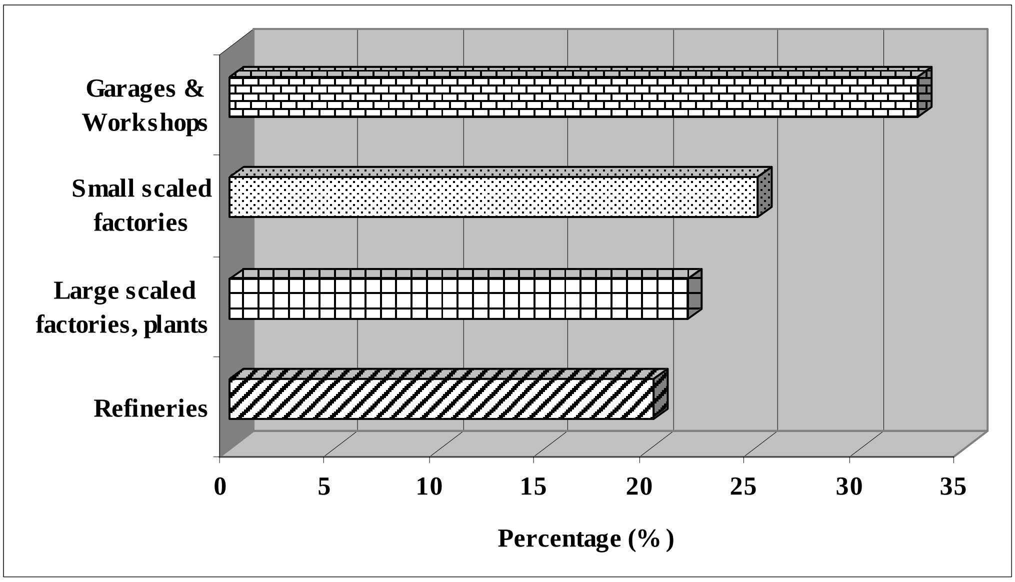


Figure 5.22: Types of structures demolished in the Industrial category.

In terms of materials, 25.6 % of industrial demolition debris were made up of steel and other metals followed by 16.8 % for reinforced concrete and mass concrete. Timber and wood as well as asphalt comprised 10.2 % and 10.0 % respectively where else hazardous chemicals contributed towards 8.8 %. Asbestos and lead stood at 7.9 %. Materials such as masonry and insulation material tied at 7.4 % each while plastics and vinyl formed the least composition with only 6.0 %. The analysis is tabulated in Table C23 – Appendix C and is graphically shown in Figure 5.23.

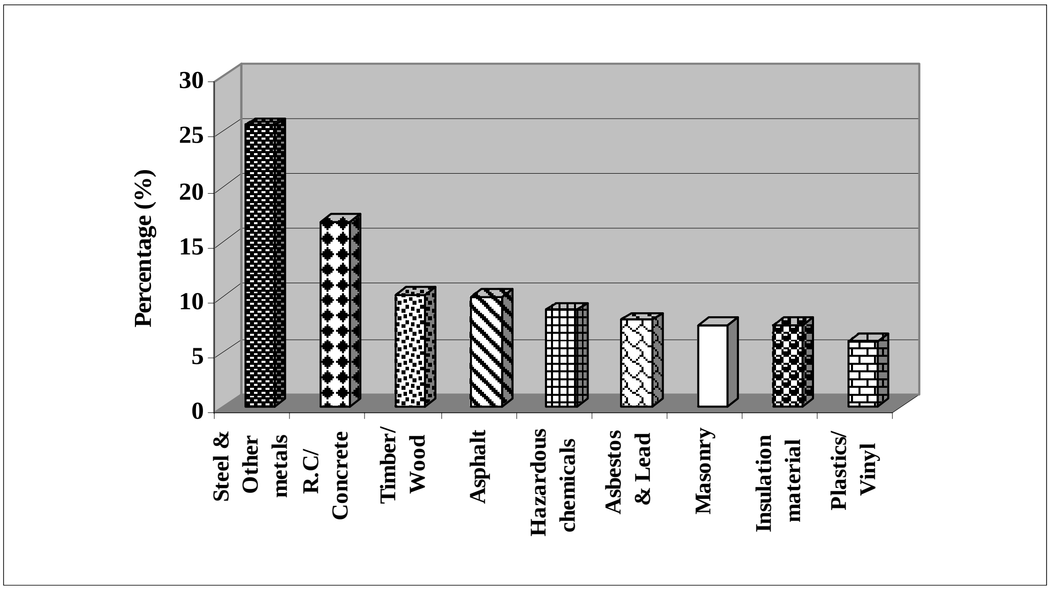


Figure 5.23: Composition of Industrial demolition debris.

With regards to age, a majority 26.0 % of structures demolished were within 25 – 50 years while 24.5 % were between the ages of 50 – 75 years. 21.2 % comprised structures in the range of 75 – 100 years followed by 15.5 % for those above 100 years of age. 12.8 % were below the age of 25 years. The analysis is tabulated in Table C24 – Appendix C and is graphically illustrated in Figure 5.24.

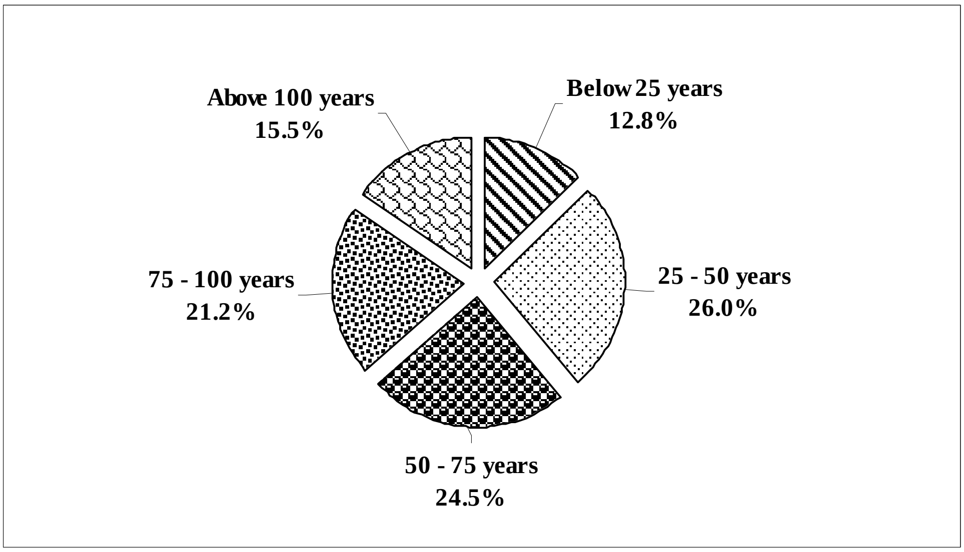


Figure 5.24: Age of structures demolished in the Industrial category.

- **Specialized category**

In this category, 38.6 % of specialized structures demolished were telecommunication, energy and radio transmission towers. Underground structures formed the second largest percentage with 36.7 % while the remaining 24.7 % indicated offshore structures. The analysis is tabulated in Table C25 – Appendix C and is graphically presented in Figure 5.25.

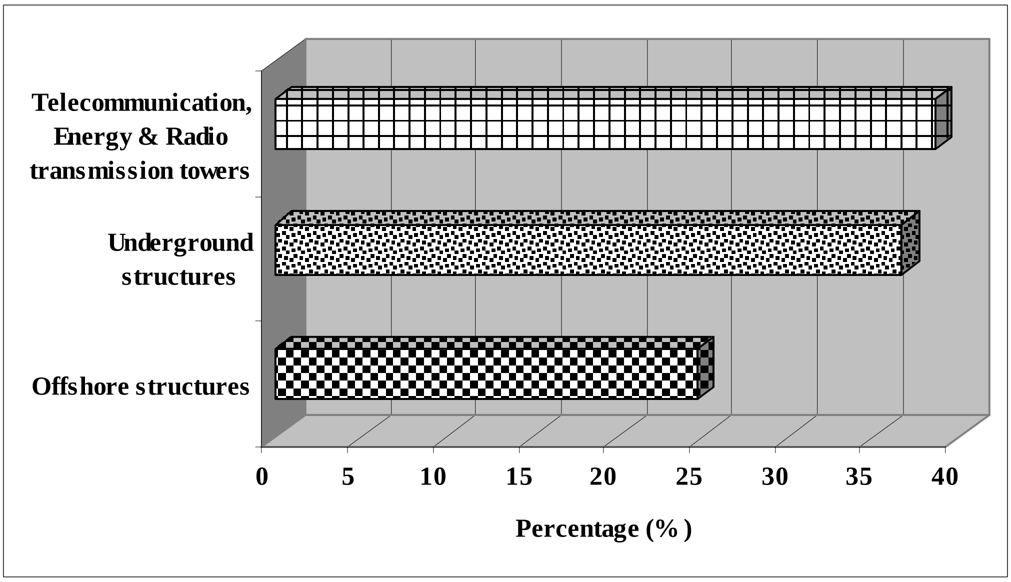


Figure 5.25: Types of structures demolished in the Specialized category.

In terms of materials, 35.7 % of the debris comprised a combination of reinforced concrete, mass concrete and steel as well as other metals. Masonry and insulation material contributed towards 10.6 % and 7.7 % respectively where else timber and wood made up 5.2 %. Only 5.1 % of hazardous chemicals were identified among the overall debris. The analysis is tabulated in Table C26 – Appendix C and is graphically shown in Figure 5.26 below.

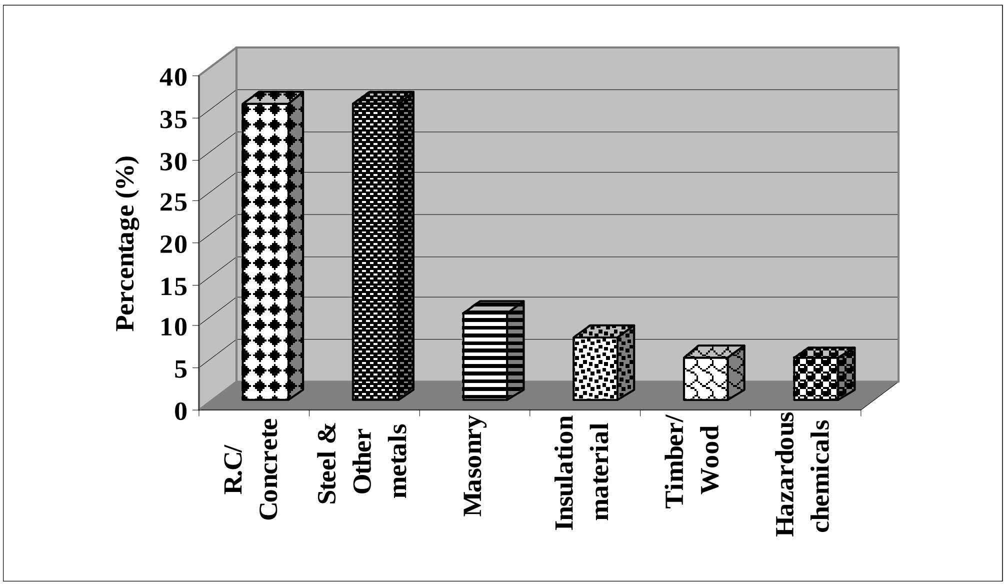


Figure 5.26: Composition of demolition debris in the Specialized category.

With regards to age, a majority 40.1 % of structures demolished were within 75 – 100 years of age while 25.9 % were between the ages of 50 – 75 years. 18.3 % consisted structures in the range of 25 – 50 years where else a total of 15.8 % fell below the age of 25 years. The analysis is tabulated in Table C27 – Appendix C and is graphically illustrated in Figure 5.27.

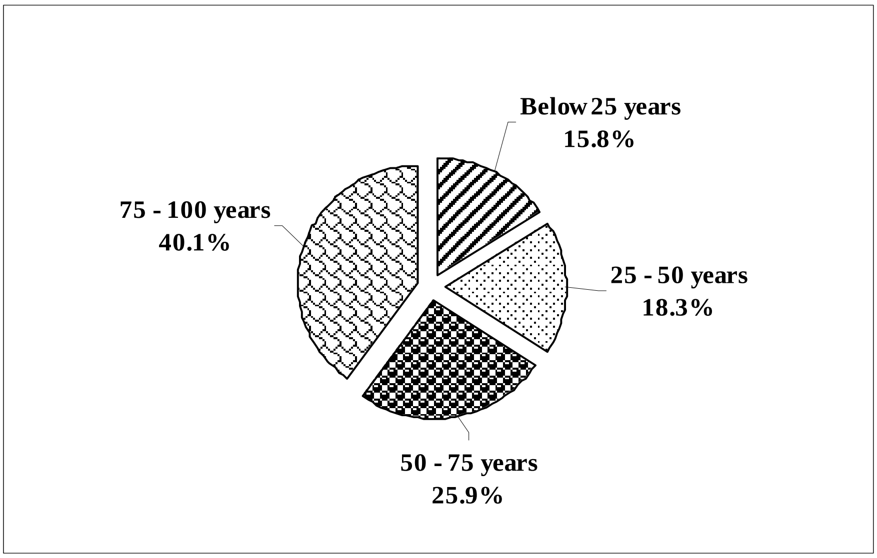


Figure 5.27: Age of structures demolished in the Specialized category.

5.4 Demolition Techniques

This section was created with the aim of assessing the respondents' potential in executing demolition operations. The section covers issues such as demolition concepts and techniques as well as selection criteria. In order to ascertain which demolition concept was most frequently employed in practice, the respondents were asked to rate three (3) various options in terms of frequency. The analysis is tabulated in Table C28 – Appendix C. The ranking results are as indicated below in Table 5.4.

Table 5.4: Frequency ranking of demolition concepts.

Demolition Concepts	Rank
Progressive Demolition - controlled removal of sections in a structure whilst retaining its stability in order to avoid collapse during the works	***1***
Deliberate Removal of Elements - removal of selected parts of the structure by dismantling	***2***
Deliberate Collapse Mechanisms - removal of key structural members to cause complete collapse of the whole or part of the structure	***3***

Similarly, to gain better comprehension on which demolition technique was most frequently employed when conducting demolition works, the respondents were required to rate six (6) various techniques in terms of their frequency. The analysis is tabulated in Table C29 – Appendix C. The ranking results are stated below in Table 5.5.

Table 5.5: Frequency ranking of demolition techniques.

Demolition Techniques	Rank
Demolition by Machines with hydraulic attachments - shear, impact hammer, grinder, grapple, crusher, processor	***1***
Demolition by Hand - various hammers, cutting by diamond drilling and sawing, bursting, crushing and splitting	***2***
Demolition by Towers and High Reach Cranes	***3***
Demolition by Machines with mechanical attachments - balling, wire rope pulling	***4***
Demolition by Chemical Agents - gas expansion bursters, expanding demolition agents, flame cutting, thermic lancing, explosives	***5***
Demolition by Water Jetting	***6***

Subsequently, the respondents were asked to rate their experience and expertise in carrying out demolition projects using the techniques as previously outlined.

Option 1 –*Demolition by Hand*

31.3 % of respondents were average in their response while 28.4 % were capable and 21.9 % noted incapability. As much as 14.2 % reported to be highly capable where else a remainder of 4.3 % expressed total incapability.

Option 2 –*Demolition by Towers and High Reach Cranes*

35.3 % of respondents were found to be capable while a further 30.5 % were incapable. In addition, 25.7 % were average in their response where else only a minimum of 8.6 % expressed high capability.

<u>Option 3</u> –*Demolition by Machines with Mechanical Attachments*

A majority 43.3 % of respondents were capable while 21.9 % reported to be highly capable. A further 21.4 % were found to be average where else 13.6 % claimed to be incapable.

<u>Option 4</u> –*Demolition by Machines with Hydraulic Attachments*

46.8 % of respondents were found to be capable while another 28.4 % noted high capability. 15.0 % were average, followed by 9.9 % reporting incapability.

<u>Option 5</u> –*Demolition by Chemical Agents*

43.9 % of respondents expressed incapability where else 29.1 % were average in their response. 10.7 % were found to be totally incapable. 8.6 % of respondents reported to be capable while only 7.8 % indicated high capability.

<u>Option 6</u> –*Demolition by Water Jetting*

For this technique, a majority 50.3 % of respondents were incapable while 32.7 % were average in their response. 10.7 % were found to be totally incapable. 8.6 % of respondents reported to be capable, followed with just 7.8 % noting high capability.

The analysis is tabulated in Table C30 – Appendix C and is graphically presented in Figure 5.28.

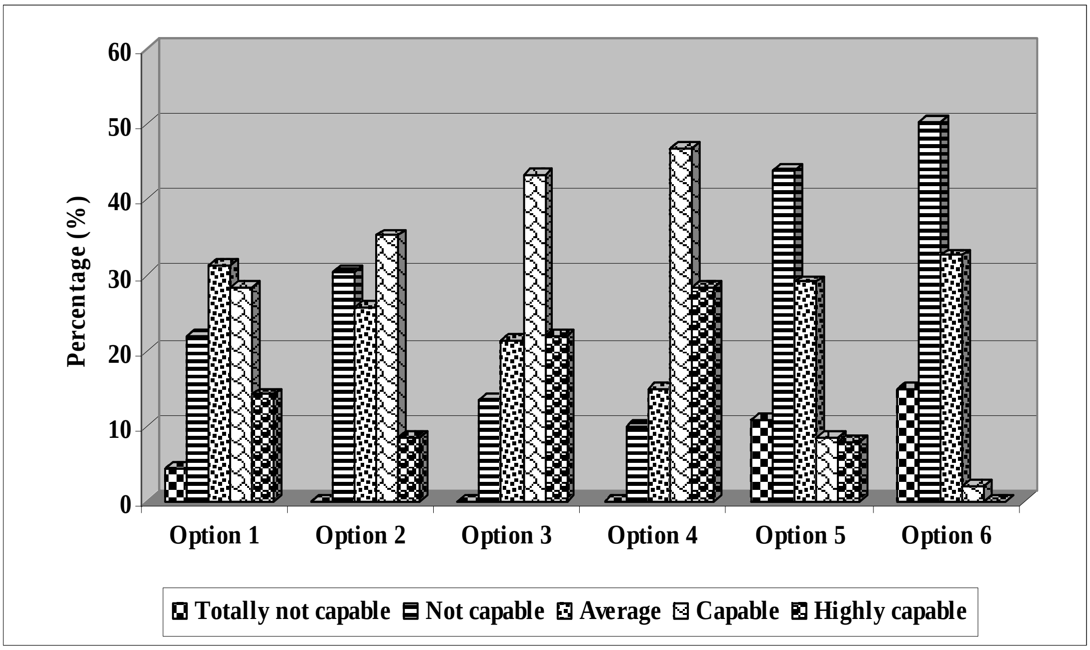


Figure 5.28: Respondents' capability rating of demolition techniques.

To better understand the criteria that influence the selection of techniques in demolition projects, the respondents were required to rate various governing factors in terms of their significance. The analysis is tabulated in Table C31 – Appendix C. The ranking results are shown below in Table 5.6.

Table 5.6: Significance ranking pertaining to demolition techniques selection criteria.

Demolition Techniques Selection Criteria	**Rank**
Location of the structure, degree of confinement and adjacent structures	***1***
Structural form of the structure	***2***
Scale and extent of demolition	***3***
Monetary cost	***4***
Health and safety considerations	***5***
The suitability of the structure to adapt to the technique(s) selected	***6***
Environmental considerations Time constraint Stability of the structure	***7***
Equipment & machinery performance requirements, efficiency and speed	***8***
Permitted levels of nuisance	***9***
Client's specification	***10***
Past experience on a particular project	***11***
The management and transportation of the generated wastes and debris	***12***
Previous use of the structure	***13***
The requirement for reuse & recycling	***14***

5.5 Demolition Health and Safety

This section basically concerns health and safety matters such as the causes of accidents at demolition sites as well as issues relating to health and safety implementation. To determine the primary causes of demolition accidents and injuries at site during operations, the respondents were asked to rate several likely reasons in terms of frequency. The analysis is tabulated in Table C32 – Appendix C. The ranking results are indicated in Table 5.7.

Table 5.7: Frequency ranking of accident and injury causes.

Reasons	**Rank**
Unsafe attitude, i.e. negligence	***1***
Poor site management	***2***
Unsafe procedures at the workplace	***3***
Not wearing proper protective gear	***4***
Lack of knowledge and experience	***5***
Unsafe conditions, i.e. hazardous materials, dangerous elevations	***6***

In order to identify the difficulties often encountered when implementing health and safety procedures, the respondents were required to rate several setbacks in terms of agreement. The analysis is tabulated in Table C33 – Appendix C. The ranking results are stated in Table 5.8 below.

Table 5.8: Agreement ranking of difficulties encountered in H & S implementation.

Reasons	**Rank**
Care free attitude of workers	***1***
Poor H & S monitoring and enforcement	***2***
Lack of cooperation between workers and management	***3***
Unavoidable hazardous conditions at the project site	***4***

5.6 Demolition Waste Management

Due to the growing importance of proper demolition waste management, this section targeted areas such as recycling and reuse as well as problems affecting recycling efforts. Issues on pollution and environmental management were also incorporated. On the question of whether proper deconstruction was carried out to salvage materials prior to demolition, a majority 54.8 % of respondents answered "YES" while 24.1 % reported "NO". 21.1 % were unsure. The analysis is tabulated in Table C34 – Appendix C and is graphically presented in Figure 5.29 below.

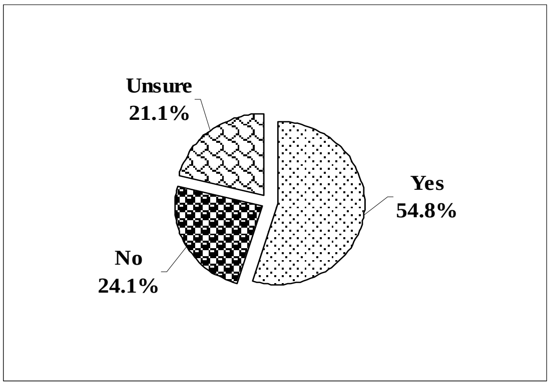


Figure 5.29: Response percentage pertaining to the issue of proper deconstruction.

On the question of whether proper on-site separation of demolition debris and waste materials were conducted, a total of 63.9 % of respondents stated "YES" where else only 28.3 % answered "NO". The remainder of 7.8 % were unsure. The analysis is tabulated in Table C35 – Appendix C and is graphically illustrated in Figure 5.30.

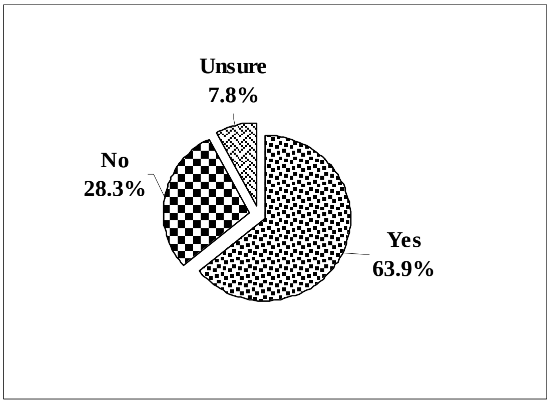


Figure 5.30: Response percentage pertaining to the issue of on-site separation.

The respondents were also required to rate a selection of waste materials with regards to how often they were reused, recycled and disposed. For convenience, the results are systematically tabulated in Table 5.9 and graphically expressed in Figures 5.31 and 5.32 respectively. The analysis is tabulated in Tables C36 and C37 – Appendix C.

Table 5.9: Frequency rating of reused, recycled and disposed waste materials.

Reused/ Recycled (%)					
Materials	**Very Rarely**	**Rarely**	**Average**	**Frequently**	**Very Frequently**
Concrete	46.3	24.1	9.9	15.5	4.3
Steel	6.4	4.3	21.9	36.9	30.5
Other metals	8.6	14.2	34.0	32.7	10.7
Masonry	35.6	34.0	24.1	6.4	0.0
Timber/ Wood	15.0	21.4	46.0	15.5	2.1
Asphalt	49.7	26.3	19.8	2.1	2.1
Plastics/ Vinyl	39.8	48.2	9.9	2.1	0.0
Insulation material	49.7	40.4	7.8	2.1	0.0
Disposed (%)					
Materials	**Very Rarely**	**Rarely**	**Average**	**Frequently**	**Very Frequently**
Concrete	2.1	7.8	21.9	31.3	36.9
Steel	42.5	23.5	21.1	8.6	4.3
Other metals	15.0	27.0	40.9	8.6	8.6
Masonry	2.1	6.4	25.4	41.2	24.9
Timber/ Wood	0.0	9.9	52.4	27.0	10.7
Asphalt	2.1	12.0	19.8	39.1	27.0
Plastics/ Vinyl	2.1	7.8	19.8	48.9	21.4
Insulation material	2.1	4.3	17.6	48.9	27.1

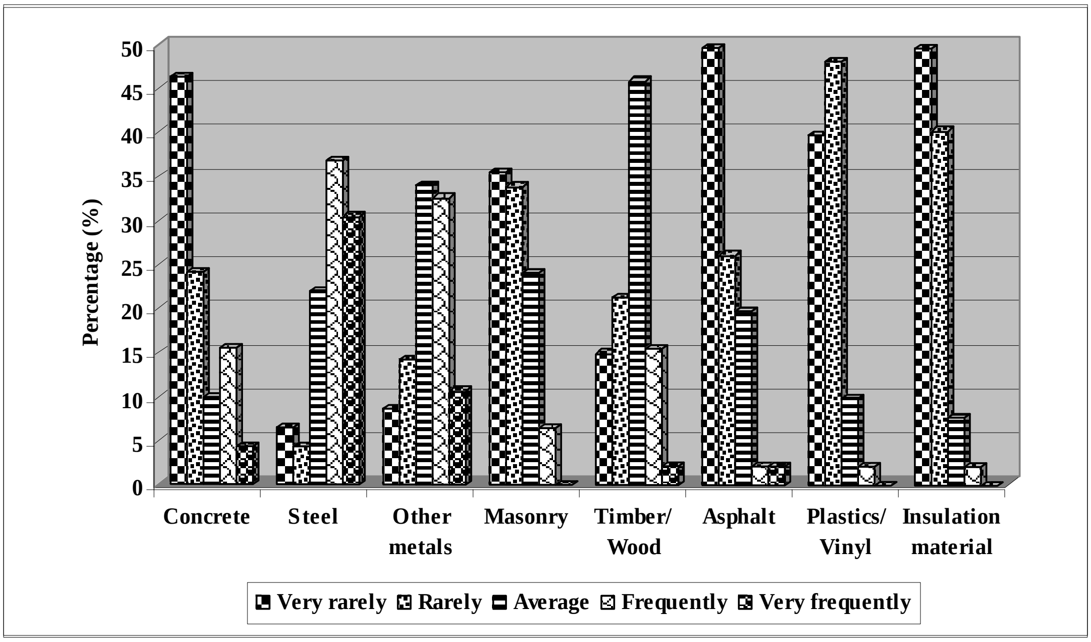


Figure 5.31: Frequency rating of reused/ recycled waste materials.

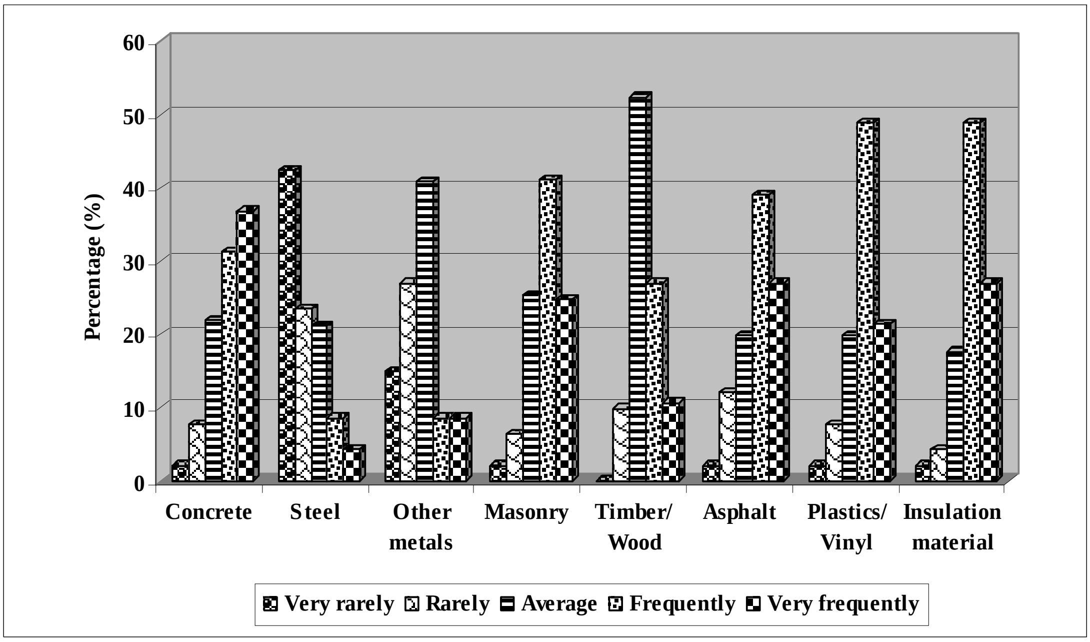


Figure 5.32: Frequency rating of disposed waste materials.

To determine the extent of waste material utilization, the respondents were required to rate in terms of frequency, three (3) major solid waste components, i.e. concrete, masonry and asphalt, on their possible uses. The analysis is tabulated in Table C38 – Appendix C. The ranking results are presented in Table 5.10 below.

Table 5.10: Frequency ranking of solid waste utilization.

Solid Waste Utilization	**Rank**
Disposed off at landfills	***1***
Concrete & masonry used for landfill engineering or restoration	***2***
Concrete & masonry used as backfill material, for embankment construction	***3***
Concrete & masonry used as road base courses and drainage bedding layers	***4***
Masonry used as recycled soil	***5***
Asphalt processed and reused in new pavement construction	***6***
Concrete used as recycled aggregates	***7***

The respondents were further requested to rate in terms of agreement, various perceptions often associated with demolition waste recycling activities. The analysis is tabulated in Table C39 – Appendix C. The ranking results are stated in Table 5.11.

Table 5.11: Agreement ranking pertaining to demolition recycling conceptions.

Demolition Recycling Perceptions	**Rank**
It is difficult to get contractors or sub-cons to cooperate and participate in recycling	***1***
There are insufficient contract provisions and specifications on recycling	***2***
The requirements for separate waste containers and the presence of a variety of waste material makes recycling complicated	***3***
There is usually insufficient space on site to recycle	***4***
Recycling is costly	***5***
Recycling delays the project completion	***6***

In an attempt to identify the barriers that often affect demolition recycling efforts, the respondents were asked to rate several issues in terms of agreement. The analysis is tabulated in Table C40 – Appendix C. The ranking results are indicated in Table 5.12.

Table 5.12: Agreement ranking of barriers affecting demolition recycling efforts.

Demolition Recycling Barriers	**Rank**
No demand for recycled content products or materials	***1***
Lack of recycling education and awareness	***2***
Inadequate cost-benefit data	***3***
Insufficient recycling facilities	***4***
Demolition debris are not statutorily banned from landfill disposal	***5***

With reference to the aspect of environmental management, the respondents were required to rate the types of pollution often encountered during demolition operations. The analysis is tabulated in Table C41 – Appendix C. The ranking results are shown in Table 5.13 below.

Table 5.13: Frequency ranking of pollution types faced during demolition works.

Pollution Types	**Rank**
Noise pollution	***1***
Air pollution	***2***
Vibration	***3***
Water pollution	***4***
Soil contamination	***5***

Finally, to better establish the setbacks often faced when tackling environmental issues, the respondents were requested to rate several issues in terms of agreement. The analysis is tabulated in Table C42 – Appendix C. The ranking results are reported in Table 5.14.

Table 5.14: Agreement ranking of setbacks faced in tackling environmental issues.

Environmental Setbacks	**Rank**
Cost implications	***1***
Lack of environmental education and awareness	***2***
The nature of the demolition works itself	***3***
Lack of initiative and commitment from other project parties	***4***
Inadequate contract provisions and specifications on environmental management	***5***
Weather conditions	***6***

5.7 Discussion and Summary

This section will proceed to discuss the survey findings as outlined in the previous sections. The majority of respondents comprised of developers and consultants, followed by local authorities and government bodies and lastly, contractors. In terms of departmental categorization, the top three (3) departments which registered highest respondent percentages in descending order were Project Management, Building and Construction respectively. The survey also reported that a staggering majority of respondents possessed above 15 years of working experience.

On a different note, the survey highlighted that demolition projects in the country were primarily executed based on consultant's advice as well as contractor's proposal. This comes to show that both parties were equally important whereby the consultant's technical input and contractor's 'know how' were very much essential in ensuring proper work planning and execution.

On the question of how extensive demolition works were carried out in the country, minor demolition works were reported to be on an average level where else major demolition operations were perceived to be not extensive. This fact is particularly true as many projects usually involved only partial demolition such as renovations, structural conversions and refurbishment. Although not as extensively undertaken as compared to the former, major demolition works were often related to the complete removal of the existing structure (s).

On the issue regarding the frequency of demolition job scopes, projects requiring solely demolition works were very rarely executed. In contrast, the survey found that projects requiring demolition to cater for continued development was frequently the case. Most projects of this nature fall into the context of area redevelopment. Examples of some well known projects are such as the Sulaiman Court flats demolition to make way for the SOGO shopping center in Kuala Lumpur, demolition of the Lumba Kuda flats and surrounding structures to cater for the Gerbang Selatan Bersepadu project in Johor Bahru and soon to come, the proposed Pekeliling flats demolition to allow for a mixed development project in the heart of Kuala Lumpur. Similarly, construction and expansion of highways also usually demand a great deal of demolition operations.

In terms of understanding the present need to conduct demolition works, the top five (5) frequent reasons noted in the survey were:

• Building refurbishment, renovation, conversion	*Ranked 1st*
• Infrastructure development, i.e. construction, upgrading & expansion of highways	*Ranked 2nd*
• Area redevelopment, i.e. increasing land values & economic prospects, land takeover due to the expiration of lease period	*Ranked 3rd*
• Destroyed or damaged due to fire	*Ranked 4th*
• Urban restructuring, i.e. changes in the nation's master plan, due to govt. policies, changes in land use	*Ranked 5th*

Based on the findings, a direct link is apparent between the first three (3) reasons suggested above with the extensiveness of minor demolition works in the country as well as the frequency of demolition projects involving job scopes that cater for a bigger picture. These relationships not only illustrate consistent views from the respondents but also strengthen the survey's accuracy. An important hypothesis can be made considering the frequency ranking results. It was quite surprising to note that the leading reasons for demolition projects were of somewhat unrelated to the physical characteristics of existing structures. The lower ranking reasons indicate that only a small percentage of structures were actually demolished due to unsafe, unsuitable or unacceptable conditions. From this, it can be deducted that many structures never really live through their potential life spans. One possible reason to explain this is that currently, changes brought on by the demands for development and modernization are taking shape at a rapid pace so much so that structures were demolished and replaced with new ones even before they could surpass their optimal design lives. Enclosed in Appendix D are photographs and supporting articles that relate to the reasons for demolition operations in Malaysia.

The issue of misconceptions associated with demolition works is hereby discussed. On the statement of whether demolition usually destroys many structures that should be preserved, the majority of respondents disagreed. As to whether demolition unnecessarily overcrowds landfills with debris, the majority were average in their response. Most of the respondents disagreed with the notion that major demolition operations were simple and unsophisticated. On the other hand, a bulk of respondents chose an average opinion on whether demolition operations were dangerous. This would be deeply influenced by the techniques employed and magnitude of project. Lastly, a majority agreed that major demolition works were costly. It should be noted here that demolition costs are heavily dependent upon the job scope and contract specifications. Judging by the overall responses, it could be said that the respondents possessed the right presumption and attitude towards demolition operations.

Apart from the above, on the question of how government bodies and agencies faired with regards to demolition project participation, the survey revealed average quality ratings for both the issues of involvement and contribution as well as competence and experience. Demolition works carried out by government bodies such as local authorities were very much on a smaller scale as compared to those executed by private contractors. Demolition mainly focused on squatter houses, structures constructed without valid permits, structures with illegal extensions and renovations as well as abandoned structures that pose serious hazards to the public and provide grounds for mosquito breeding and drug addicts. The machineries used are also less sophisticated such as backhoes and bulldozers. A majority of local authorities do not have specific guidelines or procedures in dealing with bigger and complex demolition projects. In terms of technical expertise, the job is often awarded to a private contractor. Enclosed in Appendix E are photographs and relevant articles that illustrate demolition works done by local authorities.

An important objective of the survey was to develop data on previous demolition projects executed in the country with respect to the types of structures demolished, their material compositions and approximate ages. From the results obtained, the categories of structures subjected to the highest volume of demolition works in descending order were civil and infrastructure, public, residential, commercial, industrial and lastly specialized. The summary of findings for each category is as follows:

- ***Civil and Infrastructure***

The three (3) main types of structures demolished were drainage and irrigation, bridges as well as retaining walls. The three (3) most common materials found among the debris were reinforced/ mass concrete, steel/ other metals and finally masonry. A majority of the structures demolished were within 50 – 75 years of age.

- ***Public***

The three (3) main types of structures demolished were places of worship, sports centers and stadiums as well as educational institutions. The three (3) most common materials found among the debris were reinforced/ mass concrete, steel/ other metals and finally timber/ wood. A majority of the structures demolished were within 50 – 75 years of age.

- ***Residential***

The three (3) main types of structures demolished were high rise, low rise and medium rise apartments and flats. The three (3) most common materials found among the debris were reinforced/ mass concrete, timber/ wood and lastly steel/ other metals. A majority of the structures demolished were within 50 – 75 years of age.

- ***Commercial***

The three (3) main types of structures demolished were offices and shop lots, shopping centers and hotels, as well as convention centers. The three (3) most common materials found among the debris were reinforced/ mass concrete, steel/

other metals and finally masonry. A majority of the structures demolished were found to be above 100 years of age.

- ***Industrial***

The three (3) main types of structures demolished were garages and workshops, small scaled factories, followed by large scaled factories and plants. The three (3) most common materials found among the debris were steel/ other metals, reinforced/ mass concrete, and finally timber/ wood. A majority of the structures demolished were within the range of 25 – 50 years of age.

- ***Specialized***

The three (3) main types of structures demolished were transmission towers, underground structures and finally offshore structures. The three (3) most common materials found among the debris were reinforced/ mass concrete together with steel/ other metals, masonry and lastly insulation material. A majority of the structures demolished were in the 75 – 100 years age group.

Based on the above findings, good observation can be made with regards to the types, materials and ages of structures demolished in the past. But most interestingly, the findings suggest two (2) very important facts. The first indicates that the debris composition comprised a massive percentage of reinforced and mass concrete elements. This is indeed true as the majority of structures in Malaysia, new or old alike, were basically constructed using concrete. The second fact points out that the majority of structures demolished from all categories were well above 50 years with respect to structural age. The possible reasons for demolition could very well be attributed to their declining states and deterioration due to weakening durability. By comparing this fact with the reasons for demolition at present times as indicated earlier, a distinct contrast can be observed in terms of the shifting and evolving patterns of past and present modernization trends.

Turning the attention towards demolition methodology, the concepts most frequently employed in practice were progressive demolition, followed by deliberate removal of elements and finally, deliberate collapse mechanisms. On the other hand, the techniques most frequently employed were:

• Demolition by Machines with hydraulic attachments	*Ranked 1st*
• Demolition by Hand	*Ranked 2nd*
• Demolition by Towers and High Reach Cranes	*Ranked 3rd*
• Demolition by Machines with mechanical attachments	*Ranked 4th*
• Demolition by Chemical Agents	*Ranked 5th*
• Demolition by Water Jetting	*Ranked 6th*

With regards to the capability ratings of each demolition technique as listed above, a majority of respondents were found to be average in conducting demolition by hand. As far as demolition by towers and high reach cranes were concerned, most of the respondents were indeed capable. Similarly, a high number of respondents reported to be capable using machines with mechanical and hydraulic attachments. Besides that, demolition by chemical agents and water jetting saw a majority expressing incapability. This assessment was crucial to gain better insight pertaining to the respondents' ability in carrying out demolition operations. A clear link can be established in terms of the respondents' potential and frequency of each technique used whereby, techniques which marked highest respondent capabilities were the ones most often employed.

With reference to the factors that influence the selection of demolition techniques, the top five (5) significant criteria noted in the survey were:

• Location of the structure, degree of confinement and adjacent structures	*Ranked 1st*
• Structural form of the structure	*Ranked 2nd*
• Scale and extent of demolition	*Ranked 3rd*
• Monetary cost	*Ranked 4th*
• Health and safety considerations	*Ranked 5th*

It could be stated that conventional methods of demolition were the most preferred choice in practice, given their frequency and capability ratings as well as their selection criteria as ranked earlier.

Touching on the aspect of demolition health and safety, the reasons associated with accidents and injuries at site were:

• Unsafe attitude, i.e. negligence	*Ranked 1st*
• Poor site management	*Ranked 2nd*
• Unsafe procedures at the workplace	*Ranked 3rd*
• Not wearing proper protective gear	*Ranked 4th*
• Lack of knowledge and experience	*Ranked 5th*
• Unsafe conditions, i.e. hazardous materials, dangerous elevations	*Ranked 6th*

Based on the findings, it is not difficult to understand that only by appreciating the importance of having the right health and safety attitude, can accidents and injuries be prevented. It may not be a known fact but, accidents can incur heavy costs which ultimately result in unnecessary expenditure. The most apparent is in terms of insured costs that cover medical and compensation money. But however, the most damaging are the hidden costs such as legal expenses, work delays, fines and even machinery damage. The top five reasons ranked above indicate complete disregard towards basic health and safety requirements. The case is all about a simple matter of site sense and accountability.

On the difficulties often encountered during health and safety implementation, the survey reported strong agreement on the following:

• Care free attitude of workers	*Ranked 1st*
• Poor H & S monitoring and enforcement	*Ranked 2nd*
• Lack of cooperation between workers and management	*Ranked 3rd*
• Unavoidable hazardous conditions at the project site	*Ranked 4th*

Judging by the ranking results, much effort was still needed to further improve and enhance health and safety awareness. Among a few measures that can be considered are:

i. Instill awareness that health and safety is an essential part of good management

ii. All parties and levels of the project must be made aware of the importance of health and safety

iii. Increase cooperation between management and workers to secure freedom from accidents

iv. There must be a definite and known health and safety policy in the workplace

v. Make health and safety an important aspect in the planning process of the project

vi. Conduct continuous monitoring and enforcement in health and safety implementation

The final component of the survey looked into the aspect of demolition waste management. With regards to the question of whether proper deconstruction was carried out to salvage materials prior to demolition, a majority of respondents answered 'Yes'. A large number of respondents also answered 'Yes' to the question of whether proper on-site separation of demolition debris and wastes were practiced. The overwhelming responses to both the questions provide initial indication that waste management awareness is evident, to a certain extent.

Materials salvaged properly during deconstruction activities can be reused in new construction projects. These materials are such as bricks, blocks, doors, windows, plumbing fixtures and pipes as well as electrical fixtures and wiring. Furthermore, they could be effectively incorporated into low cost housing projects. The government and relevant bodies should encourage contractors to participate on the matter. Among the many benefits of proper waste reduction and management include:

i. Reduction in waste disposal volume and costs

ii. Increased revenue from the sale of recovered materials

iii. Improved workplace health and safety

iv. Promotion of sustainable development

v. Preservation of environmental quality

Paying reference to the issue on how frequent demolition waste materials were reused, recycled and disposed, the survey yielded the following results:

- ***Reused/ Recycled***

Concrete	Very rarely
Steel	Frequently
Other metals	Average
Masonry	Very rarely
Timber/ Wood	Average
Asphalt	Very rarely
Plastics/ Vinyl	Rarely
Insulation material	Very rarely

- ***Disposed***

Concrete	Very frequently
Steel	Very rarely
Other metals	Average
Masonry	Frequently
Timber/ Wood	Average
Asphalt	Frequently
Plastics/ Vinyl	Frequently
Insulation material	Frequently

Steel, other metals and timber were the only three waste materials frequently reused and recycled. Apart from that, all other materials were found to be frequently disposed. One genuine explanation is that these three items were in greater demand with higher market value as compared to the others. It must be emphasized that recycling promotes the concept of sustainability. Sustainability essentially implies adopting development policies, strategies and practices that will enable continued growth, at the same time ensuring that the available natural resources are not depleted and that the environment will not be irreparably damaged. Demolition waste materials or debris should be recycled rather than disposed as it helps reduce the depletion of primary natural resources.

On the extent of waste material utilization, the five (5) frequent uses of demolition solid wastes as indicated in the survey were:

• Disposed off at landfills	*Ranked 1st*
• Concrete & masonry used for landfill engineering or restoration	*Ranked 2nd*
• Concrete & masonry used as backfill material, for embankment construction	*Ranked 3rd*
• Concrete & masonry used as road base courses and drainage bedding layers	*Ranked 4th*
• Masonry used as recycled soil	*Ranked 5th*

Solid and inert wastes were most frequently disposed off at landfills. This practice will only see more landfills being created in the future. Landfills consume large expenses of precious land and are associated with both environmental and economic costs. Solid wastes such as concrete and masonry rubble, steel and asphalt are valuable commodities to be just dumped away. Source reduction, reuse and recycling are positive alternatives to land filling. Presently, concrete and masonry rubble were the most reused materials, subjected to a variety of purposes such as landfill engineering and restoration; backfill material for soil replacement works, embankment construction and quarry void filling as well as road base and drainage bedding layers. In addition to this, reclamation projects have also been a key outlet for these inert materials. The prospects of concrete being used as recycled aggregates in Malaysia are still a far cry away. In contrast, the international scene has made remarkable progress on the idea and is currently used as advanced construction materials. The utilization of concrete rubble as recycled aggregates has also indirectly reduced the depletion of existing quarries.

With regards to the general perceptions associated with demolition waste recycling activities, the presumption that sub-contractors were unwilling to cooperate and participate in recycling earned top ranking. Sub-contractors respond to the same cues as everyone else: clear priorities, clear instructions, clear procedures, financial penalties and lastly incentives. The two most important aspects are management – level interaction and training. In the former, supervisors must be made to understand that recycling is important and that deviation from specified procedures will be penalized. In the latter, recycling training should be provided for all personnel with sufficient coverage on the types of materials to be recycled and appropriate recycling procedures.

With respect to insufficient recycling contract provisions, it should be said that demolition recycling starts with good specification that clearly states recycling goals, materials to be recycled as well as planning, reporting and record keeping requirements. Recycling should not be an after thought or in other words, treated as an add-on. On the perception of recycling complexity, what recycling really requires is intelligent up-front planning, most of which is already done as part of the overall project management. The waste management plan tracks the flow of the project, matching the various works being done as the demolition project moves from phase to phase. Therefore, the case of demolition recycling complexity is rarely an issue.

Relating to the presumption of insufficient space on site for recycling, the key to success is to match containers to wastes, both in time and size. Containers are matched with each job phase, and should be frequently checked so that only minimal containers are on location at any time, catering specifically to the wastes being generated. On the other hand in terms of recycling delaying the project completion, the idea is to integrate recycling with other activities, so that the appropriate containers are on site for each phase of the job, and containers flow smoothly in and out of the demolition site as wastes are generated. Far from slowing down the project, recycling saves time and effort. It also contributes to a cleaner and safer job site.

Focusing on the problems plaguing demolition recycling efforts, the five (5) top barriers reported in the survey were:

• No demand for recycled content products or materials	*Ranked 1st*
• Lack of recycling education and awareness	*Ranked 2nd*
• Inadequate cost-benefit data	*Ranked 3rd*
• Insufficient recycling facilities	*Ranked 4th*
• Demolition debris are not statutorily banned from landfill disposal	*Ranked 5th*

The top barriers as noted were inadequate markets for recycled materials, low levels of awareness and interest as well as insufficient information on the advantages of recycling. In addition, facility siting difficulties and the presence of only a small number of debris recyclers were also other problems faced. On the matter of legislation, the current situation is that demolition debris are not banned from landfill disposal. Together with poor local monitoring and enforcement as well as unattractive economic incentives, these issues were among other contributing factors seriously affecting local demolition recycling efforts.

Thus far, nation wide efforts in implementing the country's recycling goals have been weak. It has become increasingly clear that action must be taken to move the country towards a sustainable path. Among the measures that could be taken to further improve and enhance efforts include:

i. Promote reuse of materials to minimize waste generation and the need for recycling,

ii. Increase the efficiency of waste management planning,

iii. Impose higher landfill disposal charges,

iv. Impose regulations that will ban the disposal of wastes and debris at landfills,

v. Improve and strengthen markets for recycled material production,

vi. Promote the usage of recycled or recycled content materials,

vii. Provide budgetary allocations towards increased enforcement against illegal disposal of demolition debris,

viii. Make it obligatory to use recycled demolition debris in new building projects,

ix. Stress on the aspect of on-site recycling,

x. Provide assistance in the establishment of adequate recycling facilities.

Finally, with reference to the subject of environmental management, the most frequent types of pollution encountered during demolition operations were noise pollution, air pollution and vibration disturbances. These were followed by water pollution and soil contamination.

On establishing the problems faced when tackling environmental issues, the top ranking setbacks as reported in the survey were:

• Cost implications	*Ranked 1st*
• Lack of environmental education and awareness	*Ranked 2nd*
• The nature of the demolition works itself	*Ranked 3rd*
• Lack of initiative and commitment from other project parties	*Ranked 4th*
• Inadequate contract provisions and specifications on environmental management	*Ranked 5th*
• Weather conditions	*Ranked 6th*

The survey had to a high extent incorporated all necessary aspects relevant to demolition operations. The thoroughness of its contents had managed to yield in the desired results by projecting significant and sufficient data. The response rate of 37 % was indeed satisfactory. In addition, the survey was able to attract respondents of different work departments from both the private and government sectors. But most essentially, the majority of respondents possessed above 15 years of working experience. This adds tremendous weight to the survey findings as well as strengthens its credibility.

The participation of various organizations, individuals as well as the make up of a varied respondent composition had successfully portrayed a miniature replica of the industry's professionals. This fact also lends a hand in delivering the required diversification needed to ensure complete, sound and reliable data.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This Chapter seeks to summarize and provide conclusion to the research as well as suggest recommendations for future improvement and development. It relates to how effective the research had been in achieving its targeted aim and objectives.

6.2 Realization of Research Objectives

The discussions herein reflect the accomplishments of each specific objective:

Objective 1 – *To study the characteristics, processes, techniques and requirements of crucial aspects in the execution of demolition operations.*

This objective was achieved based on the execution of extensive literature review and background research. In-depth study of various literature provided thorough information on the subject of demolition. It indicated that:

i. Structural demolition can be categorized into three groups which comprise progressive demolition, deliberate collapse mechanisms and deliberate removal of elements.

ii. The execution stage of the demolition process can be classified as consisting three main work phases which cover the pre-demolition phase, the demolition phase and the post-demolition phase. Each phase involves different job activities.

iii. Demolition techniques can be broken down into six components which consist of demolition by hand, demolition by towers and high reach cranes, demolition by machines with mechanical attachments, demolition by machines with hydraulic attachments, demolition by chemical agents and lastly, demolition by water jetting. Each technique has its own unique benefits and disadvantages as well as general considerations.

iv. Health and safety formed an essential part of demolition operations. It mainly stressed on the importance of site safety, proper usage of tools, machinery and plant, considerations when dealing with chemical agents and explosives as well as the requirements for personal protective equipment (PPE).

v. Demolition is considered to be a waste generating activity. In view of this, the aspects of waste management and debris recycling were heavily emphasized. The former touched on various key areas that should be addressed to ensure legislation compliance and promote good environmental practice. The latter on the other hand, related to recycling and reuse of solid and inert waste materials.

vi. Demolition works are often at the height of environmental concerns. Effective tackling of environmental problems are achieved by proper monitoring and controlling procedures. The types of pollution and disturbances encountered include noise production, dust and grit generation, vibration as well as flying debris and air blast. Specific controlling measures are designed to cater for each case.

The background research provided local perspective into the research topic. Interviews and discussions with various individuals from different organizations, mainly government bodies provided insight and at the same time, captured views as well as opinions on several relevant issues.

Objective 2 – *To capture and illustrate the actual practice of demolition works done by a local contractor.*

To realize this objective, a case study was carried out on the Lumba Kuda Flats demolition operations which formed part of the Gerbang Selatan Bersepadu project. The case study was not intended to pass judgment on the overall project execution but instead, provide surface level explanation on how the works were done. The case study essentially revealed that:

i. The demolition operations were part of redevelopment plans on government land.

ii. The concept adopted was progressive demolition whereby a top to bottom demolition method was employed.

iii. The selection of demolition techniques were influenced by costs, suitability of adaptation to the building, performance requirements as well as efficiency and speed.

iv. In the site survey, as-built drawings were obtained from MBJB to identify existing services to be disconnected.

v. During the building inspection, detailed checks of structural plans were made to determine the framing system as it was crucial in designing the sequence of structural element removal.

vi. Compression tests on concrete core samples were carried out to ascertain the buildings' actual strength. This was important considering the building's age and furthermore, design had to be done to cater for element simulation under live machinery load.

vii. To ensure adequate stability during the works, the buildings' slabs were initially demolished, followed by the secondary and main beams and finally, the columns and walls. Prior to the above, soft stripping works were executed to salvage recyclable and reusable materials.

viii. A specific health and safety plan was designed, incorporating aspects such as risk assessment analysis, identification of functions and responsibilities, safety guidelines as well as a comprehensive emergency response chart.

ix. All workers on site were required to possess high skill and experience with respect to the nature of works to be executed.

x. Adequate exclusion zones were provided at designated locations at site and were influenced by the demolition method used, machinery access, machinery location and height of the building.

xi. The demolition debris were mainly made up of concrete and masonry rubble as well as steel. They were all classified as ordinary inert and solid wastes. On-site separation of materials was carried out before being transported to the landfill.

xii. Environmental management concerned monitoring exercises conducted to assess levels of noise pollution, air quality and vibration during demolition operations. Based on the respective measurements, controlling methods were suggested.

xiii. Methods to reduce noise emission included requiring personnel to use ear plugs, working during the prescribed time periods, locating generators and compressors away from public areas and ensuring proper machinery maintenance.

xiv. Among the steps taken to keep dust generation within allowable limits were by conducting frequent water suppression sprays on vehicle routes, installing dust screen nettings as well as wetting of debris heaps and the affected structural elements during demolition.

xv. With regards to vibration, concrete covers were used and trenches were dug to reduce vibratory effects.

Objective 3 – *To establish statistical data through feedback obtained from the local industry.*

A questionnaire survey was executed to achieve this final objective. The survey was necessary as there was very little evidence in the nature of statistical data to represent demolition operations in Malaysia. With reference to the survey findings, it was reported that:

i. Demolition projects in the country were mainly carried out based on consultant’s advice and contractor’s proposal.

ii. With regards to demolition job scopes, projects requiring only demolition works were very rarely executed. On the other hand, demolition works forming part of a development project was frequently the case.

iii. In terms of understanding the present need for demolition operations, the leading reasons cited were unrelated to the physical characteristics of existing structures. The lower ranking reasons indicate that only a small percentage of structures were actually demolished due to unsafe, unsuitable or unacceptable conditions.

iv. On the issue of misconceptions often associated with the works, the respondents possessed the right presumptions and attitude towards demolition operations.

v. Government bodies and agencies received average quality ratings for both the issues of involvement and contribution as well as competence and experience in demolition project participation.

vi. The categories of structures subjected to the highest volume of demolition works in the past were civil and infrastructure, public, residential, commercial, industrial and finally specialized. The make up of the debris compositions indicate a massive percentage of reinforced and mass concrete elements. The majority of structures demolished were well above 50 years of age.

vii. The concepts most frequently employed in practice were progressive demolition, followed by deliberate removal of elements and lastly, deliberate collapse mechanisms.

viii. In terms of frequency and capability ratings of demolition techniques, a clear link was established whereby, techniques which saw highest respondent capabilities were the ones most used.

ix. Based on items (vii) and (viii), and in addition with the significant ratings of demolition techniques selection criteria, it was deducted that conventional methods were the most preferred choice of demolition in practice.

x. The reasons strongly associated with accidents and injuries at site suggested complete disregard towards basic health and safety appreciation. Based on the difficulties often encountered during health and safety implementation, it was clear that much effort was still required to raise the level of health and safety awareness.

xi. Of the various waste materials frequently disposed, steel, other metals and timber were the only ones frequently reused and recycled. Recycling is heavily emphasized as it promotes sustainability.

xii. With regards to waste material utilization, most ended up being disposed in landfills. Concrete and masonry rubble were usually reused for landfill engineering, as backfill material as well as road base and drainage bedding layers. They were seldom recycled as compared to other countries.

xiii. On an overall basis, the respondents had negative perceptions on the aspect of demolition waste recycling.

xiv. The problems identified to be plaguing demolition recycling efforts suggested that nation wide initiative had been weak and increased action must be taken to drive the country towards a sustainable path.

xv. The most frequent types of pollution encountered during demolition operations were noise pollution, air pollution, vibration disturbances, water pollution and finally, soil contamination.

Thus far, the various methodologies employed have been successful in achieving the goals of the set objectives. As observed, the outlined objectives have managed to deliver the desired results in terms of intensity and quality.

6.3 Recommendations for Improvement

From the research findings, it is recommended that the following suggestions be adopted to further improve and enhance demolition operations in the country:

i. Increase publicity and awareness to make it a known and appreciated field of works,

ii. Develop more flexible, cost effective and environmentally friendly demolition techniques,

iii. Adopt and import foreign technologies from advanced countries,

iv. Conduct case studies to aid in transfer of information, experience and skills,

v. Establish an organization specifically to oversee demolition operations and provide technical support, research and development as well as consultation.

6.4 Recommendations for Future Research

The research had identified a number of areas which could be further studied. Listed below are several possible suggestions:

i. Further case studies could be conducted on other types of structural demolition projects to capture information in terms of job characteristics, technologies and complexities involved.

ii. Research could be conducted to assess the impact and barriers associated with using explosives for demolition works.

iii. Research could also be carried out to explore the possibilities and potential of implementing and employing robotic technology in the local demolition scene.

iv. From the observations of the research, it is apparent that currently, structures were being demolished very much ahead of their designed life spans. Therefore, research could be executed to re-evaluate the current standings of Codes that require for the construction of very durable and long lasting structures. Although far fetched, the results could see potential economic benefits on selected projects.

v. Research could be conducted to develop building systems that are flexible and can be readily deconstructed for reuse and recycling.

vi. Considering the poor state of demolition waste management in the country, research could be done to address the problems faced by the industry with regards to debris recycling. Further, research could also explore more positive and useful ways to ensure optimal and better utilization of waste materials.

vii. Research could be undertaken to provide development mapping of cities and urban areas to project the rate of demolition and study its implications on national planning and restructuring.

6.5 Closure

In light of the research findings, it can be said that demolition operations in Malaysia are still at an embryonic stage. This research was needed considering the rationale that demolition will play a significant role in future nation building. The research justification has provided substantial evidence to support this. The research was undertaken with the aim of developing an overview as well as assessing the potential of demolition operations in the country.

A case study and questionnaire survey were chosen as ideal methodologies as their combination would provide the required elements of particularization and generalization, crucial in portraying in-depth and complete overview of the works. This was evident, as observed throughout the findings. Presently, it could be concluded that the potential in conducting demolition operations was generally at a comfortable level. The research shows that the industry was capable in terms of project planning, demolition techniques, health and safety implementation as well as environmental management. All work aspects met the requirements of international standards and Codes and complied with local legislation.

The demolition techniques which were currently used in practice, although satisfactory, could do with a much needed push in the arm. Machinery and plant technology could be expanded and varied to cater for specific functions or all round performance. Local professionals should look beyond and consider what the global demolition market has to offer in order to bring about advancement in the home scene.

Much effort was still needed with respect to waste management. It was sad to note that the industry had little regard towards sustainable growth. The research findings prove the matter without reasonable doubt. The problems plaguing waste management were indeed broad and intense. Solutions were only likely to materialize if efforts received full and active government participation. A totally new approach would need to be endorsed to ensure that waste management becomes a major factor influencing demolition operations. Supported with steady demand, Malaysia could grow and learn from the achievements and failures of other countries.

The realizations of the aim and objectives have thus rendered the research a success. This research provides a first step towards addressing the problems and limitations presently faced by the industry. This research has also highlighted many areas and issues that need attention and further exploration to ensure continued improvement. The benefits offered are invaluable as it serves as strong reference for developing future specifications, standards and legislation to govern demolition operations. Furthermore, it provides solid foundation for further research and development.

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APPENDIX A

Many parting with regret

BY JOANNE A.C. GOH, IRIS LIM AND SOONG PHUI JEE

KUALA LUMPUR: Like most residents of the Pekeliling Flats in Jalan Tun Razak, Abu Bakar Mohd Eusoff, 83, will feel a pang of regret when he moves out from the housing project, which will be demolished next year.

"I have been living here since the flats were opened and I will miss my neighbours," said the retired Universiti Malaya hostel supervisor, who is married to Putih Mohd Tahir, 69, and has four sons with her. He has another son and a daughter from two previous marriages.

Abu Bakar and Putih, who had lived at the flats for the past 36 years, expressed concern about relocating, as the flats are strategically located near the Kuala Lumpur Hospital and the Chow Kit shopping area.

It is also within reach of the monorail and the LRT stations as well as a bus terminal.

Abu Bakar, who stayed in Kampung Baru before shifting to Pekeliling said they were worried about how to get to the hospital to collect their medication as they do not have their own transport.

Federal Territories Minister Tan Sri Mohd Isa Samad had announced that the 36-year-old flats in Jalan Tun Razak would be demolished next year to make way for a commercial and housing project.

The proposed Taman Sari project would begin once alternative housing for the flat residents was sorted out.

The Pekeliling flats, officially known as the Tuanku Abdul Rahman Public Housing, comprise seven high-rise buildings and four commercial blocks. These were built at a cost of RM20.5mil in 1967 under the First Malaysia Plan.

City Hall will be building low-cost flats in Taman Sri Rampai to accommodate the 2,864 families.

"When we first moved here, very few people were happy to live here as City Hall was very strict about residents not having pets or plants," said Abu Bakar, adding that the many families who had relocated to the flats had lost their homes in fires.

A 40-year-old resident, who identified himself as Leong, said the flats had been home to three generations of his family.

"The neighbourhood is very congenial and parents need not worry when their children are out playing, " said Leong, who owns a Chinese medicine shop at a commercial block there.

"We also have a kindergarten, so it is convenient for parents to send their children or observe them while they are in class," he said, adding that he took over his father's shop when his sibling moved out. He now lives there with his wife and three children.

Kindergarten teacher Vaanni Palibalasingam, 20, is glad to move out, as her current one-room flat is too small for her seven family members.

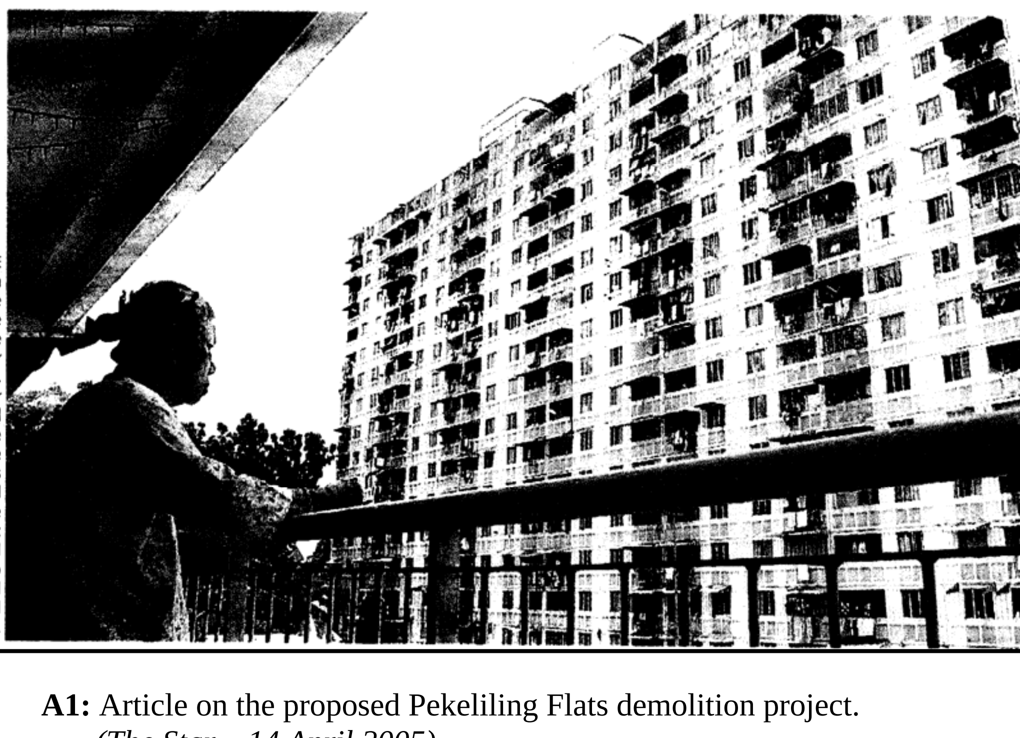
"The advantage of this area is its easy accessibility to public transportation and I am also sad to leave the cordial environment," said Vaanni, a teacher at Tadika Persatuan Bulan Sabit Merah Malaysia that serves the children at the flats.

Jamaatunaliah Matludin, 35, a teacher at the same kindergarten, is a former resident who moved out after finding the cramped conditions at the flats too much of a hassle.

"My husband and I first moved to the flats in 1994, after my first child was born. After our seventh child, we moved to Selayang last year."

A 70-year-old resident, who wants to be known just as Tan, said she has been at the flats since the beginning.

"When the time comes, it will be hard to part with this neighbourhood as I enjoy chatting with my neighbours and we are very comfortable with each other's company," said Tan, who lives alone.



COMFORTABLE AREA: Putih standing in the corridor outside her home as she savours her surroundings. She and her husband will have to move out of the Pekeliling flats soon as they will be demolished next year and redeveloped into a mixed commercial and housing area.

A1: Article on the proposed Pekeliling Flats demolition project.
(The Star – 14 April 2005)

A2: Land Use for Peninsular Malaysia, 2001.

State/ Region	Land Area (ha.)								
	Built Up	**%**	**Agriculture**	**%**	**Forest**	**%**	**Water Bodies**	**%**	**Total**
Perlis	8,980	11.0	61,359	75.4	10,169	12.5	921	1.1	***81,429***
Kedah	34,008	3.6	565,929	59.8	340,655	36.0	6,160	0.7	***946,752***
Pulau Pinang	29,565	28.3	45,289	43.4	24,383	23.4	5,118	4.9	***104,355***
Perak	42,954	2.0	939,797	44.8	1,004,716	47.9	109,121	5.2	***2,096,588***
Northern Region	***115,507***	***3.6***	***1,612,374***	***49.9***	***1,379,923***	***42.7***	***121,320***	***3.8***	***3,229,124***
Selangor	131,106	16.5	390,179	49.0	257,588	32.4	16,908	2.1	***795,781***
Kuala Lumpur	18,158	63.5	9,848	34.4	219	0.8	366	1.3	***28,591***
N. Sembilan	29,724	4.5	448,757	67.5	183,461	27.6	3,372	0.5	***665,314***
Melaka	17,261	10.4	139,194	84.1	8,596	5.2	364	0.2	***165,415***
Central Region	***196,249***	***11.9***	***987,978***	***59.7***	***449,864***	***27.2***	***21,010***	***1.3***	***1,655,101***
Johor	65,379	3.4	1,378,695	72.3	438,686	23.0	24,933	1.3	***1,907,693***
Southern Region	***65,379***	***3.4***	***1,378,695***	***72.3***	***438,686***	***23.0***	***24,933***	***1.3***	***1,907,693***
Pahang	27,382	0.8	1,471,212	41.0	2,075,952	57.8	17,758	0.5	***3,592,304***
Terengganu	23,669	1.8	564,121	43.6	665,895	51.4	41,132	3.2	***1,294,817***
Kelantan	8,906	0.6	654,346	43.5	834,567	55.5	4,782	0.3	***1,502,601***
Eastern Region	***59,957***	***0.9***	***2,689,679***	***42.1***	***3,576,414***	***56.0***	***63,672***	***1.0***	***6,389,722***
PeninsularMalaysia	***437,092***	***3.3***	***6,668,726***	***50.6***	***5,844,887***	***44.3***	***230,935***	***1.8***	***1,318,164***

Source: *NPP Physical Planning, Urban Centres and Hierarchy Technical Report.*

DEVELOPMENT PLANS FOR BUKIT GASING

Uphold spirit, provisions of KL Structure Plan

I WAS the past president of the Malaysian Institute of Planners and advisory committee member to the Kuala Lumpur Structure Plan 2004.

I was shocked by the statement of Federal Territories Minister Tan Sri Isa Samad (NST, June 17) on the proposed development of 39ha at the Bukit Gasing Forest Reserve.

As minister, he should be the caretaker of the Kuala Lumpur Structure Plan.

He should be the first to uphold the spirit and provisions of the plan.

The plan had been formulated with much public funds and with public participation.

It had gone through massive publicity and public dialogue. It represents the collective views and intentions of the people of Kuala Lumpur and its adjoining neighbours.

For someone to simply dismiss the plan goes against the promise of the Government for public participation in planning and development and indeed, good governance.

It is imperative that the minister not take such a high-handed attitude but accept the decisions of the people.

The minister said the reason for developing the forest and hill land is that there is insufficient land within the Federal Territory to meet the needs of the growing population.

However, there are other alternatives to developing the small area of forests we have in the city.

One logical option that has been practised in many major cities in the world is the redevelopment and revitalisation of inner cities.

Old and dilapidated areas within the city can be reclaimed for new development.

Allowing for higher densities and plot ratios will mean that land use is maximised and existing infrastructure fully utilised.

The Government has formulated the National Physical Spatial Plan.

It should be a plan followed by all local authorities in which policies on hill land and environmentally-sensitive areas have been outlined and accepted by the National Physical Planning Council chaired by the Prime Minister.

For one minister to act and allow development on hill slopes and forested areas is contrary to the collective decisions of the council.

Hill lands with gazetted forests should not be sacrificed for the very few, but should belong to everyone in the community.

KHAIRIAH MOHD TALHA
Secretary-general
Eastern Regional Organisation for Planning and Housing

Broken promise

WE were horrified to read that 39ha out of a total of 97.3ha of forest land in Bukit Gasing is going to be developed.

The development would serve the interest of only a few — those who can afford the bungalows on this fine hill — and not serve the interest of the general public, let alone our environment.

This is completely contrary to the promise of former Datuk Bandar Datuk Mohamad Shaid Mohd Taufek on May 7, 2002 when he promised that the Kuala Lumpur forest side of Bukit Gasing would be gazetted in full. This does not seem to be the case now.

The Development Strategy Plan (2) of the KL Structure Plan 2020 states that Bukit Gasing should be protected and developed as parks for recreational purposes.

It says hillsides with a gradient of more than 25 degrees cannot be developed.

Further, a 1994 report by the Geological Survey Malaysia showed that Bukit Gasing was among several hillsides prone to landslides and unsuitable for development.

This relaxation of hillslope development may open the floodgates to a surge of such projects around Bukit Kiara, Ayer Hitam Forest Reserve, Sungei Buloh Forest Reserve, Ulu Kelang and other hillslopes.

This wanton act of destruction against our beautiful hill must be stopped and we call upon other non-governmental organisations to support us in voicing their objections.

DATUK NICK PETERSON
Vice-chairman
Friends of Bukit Gasing

A3: Article of protest over the proposed Bukit Gasing Forest Reserve de-gazettement.
(The New Straits Times – 23 June 2005)

Sungai Buloh forest reserve was established in 1898

THE country's oldest forest reserve, the Sungai Buloh forest reserve, came into being on Jan 14, 1898 when 6,590ha of forested land in the area was gazetted as a reserve.

Selangor Forestry Department records show that there have been numerous de-gazettements for housing development over the years. The reserve has lost 2,928ha since 1990.

One in February 1994 saw 402.6ha being excised and made a State land reserve for public purposes.

The 402ha was meant to be used to create the Taman Botani Sungai Buloh and the land was placed under the purview of the Selangor State Secretary at the time.

However, in May last year, the size of that area was reduced when a 58.8ha plot was removed from its boundaries for development.

Recently, reports of plans to earmark the remaining 343.8ha for mixed development surfaced. Twelve residents associations are fighting the move.

Today, all that remains of the Sungai Buloh reserve is a 26.9ha plot of forested land which serves as the Selangor forestry training complex.

The Sungai Buloh reserve was once known to house several species of protected and totally protected wildlife and a wealth of rare plant species.

Among them were totally protected wild birds like the Bay-headed Beeeater and the Javan Fire-breasted Flowerpecker.

It was also home to totally protected wild animals like the pangolin, flat-headed cat, leopard cat, Derby's banded civet and the large black flying squirrel.

Bukit Cherākah forest reserve was gazetted in two portions. In January 1908, the first 2,248ha was gazetted, followed by 9,642ha in May 1909.

In 1974, 81ha of the forest reserve was reclassified a virgin jungle reserve.

All that remains is a 26.9ha plot which serves as the Selangor forestry training complex

Over the years several parcels of the reserve were de-gazetted including one in 1993 to establish the 869ha Taman Pertanian Malaysia Bukit Cahaya Seri Alam under State control.

As pressures for housing grew, several more sections of the forest reserve were de-gazetted, leaving Bukit Cherakah with 598ha in the northern compartment and 893.26ha in the southern compartment.

Records show that these figures remained until June this year when a 118ha plot was de-gazetted from the southern compartment of the forest reserve.

More de-gazettement can be expected as the area is further opened for mixed development.

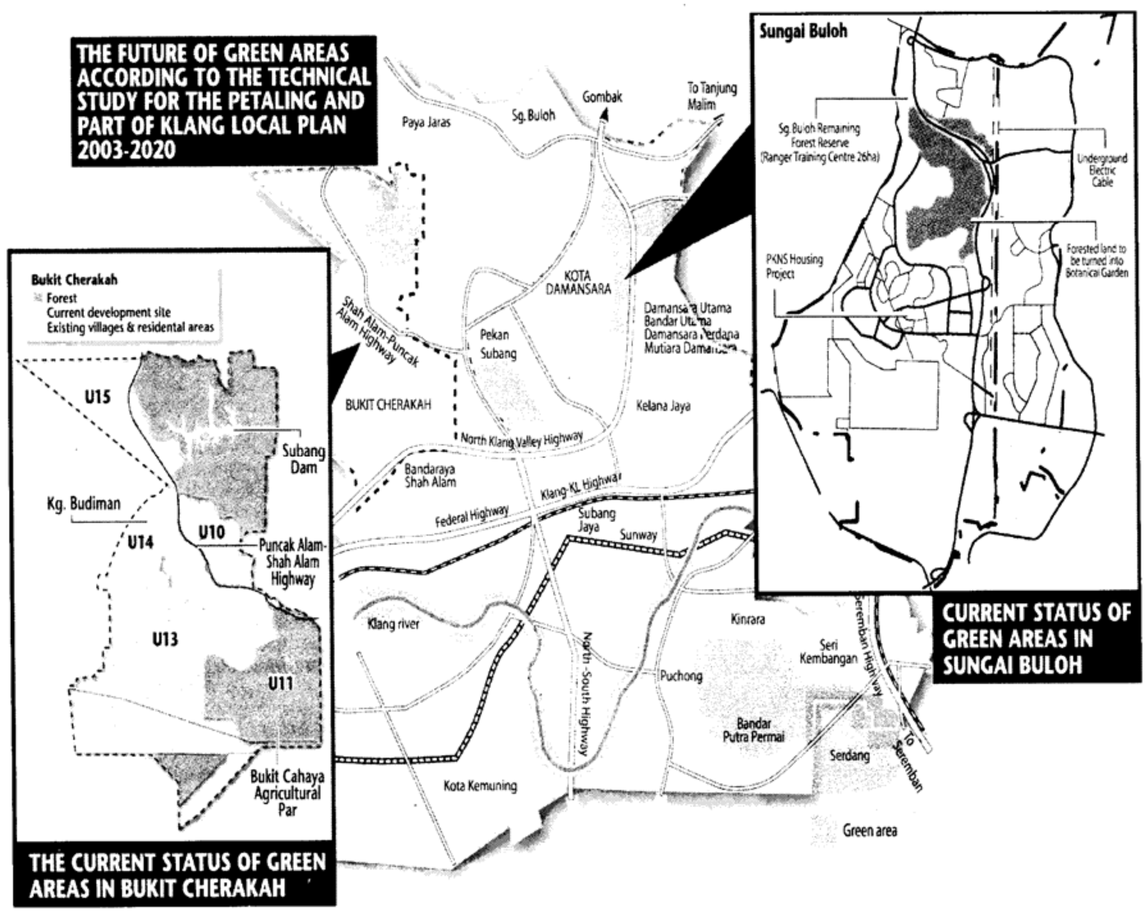
This forest reserve's most important function is as a water catchment area.

While acknowledging pressures for land, a technical report prepared as a basis for the Petaling district's upcoming local plan, identified the continued de-gazettement of the reserve as a problem.

It recommends that what remains of Bukit Cherakah forest reserve be preserved.

It says development plans should take into account the reserve's functions as catchment area and in erosion control.

A4: Article on the Sungai Buloh and Bukit Cherakah Forest Reserve de-gazettements.
(The New Sunday Times – 14 August 2005)



Fight for land can only escalate

Another puzzling transaction is a recent de-gazettement of 118ha from the Bukit Cherakah forest reserve.

The de-gazettement notice was published in June this year but the land seems to have been alienated to an organisation almost a year before revocation of the reserved status.

This means the land was given out while it was still a forest reserve over which the State does not have control.

Laws aside, the fight for land to fulfil housing and other needs in the coming years, will only intensify as the population of Petaling hits 1.9 million in 2015.

Policy statements in the draft Selangor Structure Plan indicate that future development will be done in a more systematic manner and will not be influenced by developers' demands.

And while sources warn of more forested land disappearing from the Petaling district, the draft plan states that Selangor will gazette and conserve environmentally sensitive areas.

The draft plan says the State will limit the opening of green areas and focus development in already developed sectors.

If the State keeps all its promises this time, we won't find ourselves over-drawing yet again, from our green bank.

A5: Article on the Sungai Buloh and Bukit Cherakah Forest Reserve de-gazettements. *(The New Sunday Times – 14 August 2005)*

Khir: Selangor to see further progress after Aug 31

SHAH ALAM: The state government will not slack in giving those living in the state a better quality of life after it is declared a "developed state" on Aug 31.

Mentri Besar Datuk Seri Dr Mohamad Khir Toyo said Selangor had already attained 58 out of 75 indicators used to gauge "developed status."

This 77.3% achievement was higher than the 70% required to be eligible for developed status based on the global competitiveness model, he said.

Dr Khir added, however, that the status did not mean that development in Selangor would slow down.

"Instead, it should open a new chapter for all, especially the policymakers and policy implementers," he said in a speech read by State Secretary Datuk Ramlan Othman at the soft launch of the state's developed status at the State Secretariat building here yesterday.

"The state government will ensure each and every resident of Selangor will benefit from the developed status that we will achieve in a few months' time," Dr Khir said.

Among areas to be further improved when Selangor becomes a "developed state" are the social-economic status of the people and the delivery system in the public and private sectors.

There will also be a more business-friendly environment and improved infrastructure and facilities.

A6: Article on the declaration of Selangor as a developed state.
(The Star – July 2005)

APPENDIX B

RESPONDENT'S PARTICALARS *

Name : ______________________________

Company : ______________________________

____

Position : ______________________________

E-mail Address : ______________________________

** Business card/ Company stamp*

SECTION 1 : GENERAL

1.1 Please identify which category of department you belong to:

- [ ] Upper Management
- [ ] Project Management
- [ ] Construction
- [ ] Engineering
- [ ] Building
- [ ] Others ______________

1.2 How many years of working experience do you possess?

- [ ] Less than 5 years
- [ ] 5 - 10 years
- [ ] 10 - 15 years
- [ ] Over 15 years

1.3 In your opinion, how are demolition projects usually executed?

You may select more than one option

- [ ] Consultant's advice
- [ ] Contractor's proposal
- [ ] Previous experience on similar projects
- [ ] Others (please specify) ______________________________

SECTION 2 : DEMOLITION OVERVIEW

2.1 In your opinion, please rate the following pertaining to how **extensive** demolition works are carried out in Malaysia.

Please circle one number for each item	Totally not extensive	Not extensive	Average	Extensive	Very extensive
Minor demolition works	1	2	3	4	5
Major demolition works	1	2	3	4	5

2.2 In your opinion, please rate the following pertaining to how **often** demolition works are executed involving these **job scopes.**

Please circle one number for each item	Very rarely	Rarely	Average	Frequently	Very frequently
Solely to demolish only	1	2	3	4	5
To demolish and redevelop, i.e. demolition forms part of the project package	1	2	3	4	5

2.3 In your opinion, please rate the following pertaining to the **reasons** for demolition projects in Malaysia.

Please circle one number for each item	**Very rarely**	**Rarely**	**Average**	**Frequently**	**Very frequently**
Destroyed or damaged due to fire	1	2	3	4	5
Abandoned or vacant	1	2	3	4	5
Destroyed or damaged due to natural disasters, i.e. flooding & landslides	1	2	3	4	5
Not suitable for anticipated use, i.e. outdated design & appearance, specific problem with structural materials or systems	1	2	3	4	5
Building's physical condition, i.e. dilapidated, deteriorated	1	2	3	4	5
Area redevelopment, i.e. increasing land values & economic prospects, land takeover due to the expiration of lease period	1	2	3	4	5
Costs of maintenance too expensive	1	2	3	4	5
Building refurbishment, renovation, conversion	1	2	3	4	5
Urban restructuring, i.e. changes in the nation's master plan, due to govt. policies, changes in land use	1	2	3	4	5
Infrastructure development, i.e. construction, upgrading & expansion of highways	1	2	3	4	5

2.4 In your opinion, please rate the following:

Please circle one number for each item	**Totally disagree**	**Disagree**	**Average**	**Agree**	**Strongly agree**
Demolition usually destroys many structures that should be preserved	1	2	3	4	5
Demolition unnecessarily overcrowds landfills with debris	1	2	3	4	5
Major demolition operations are simple and unsophisticated	1	2	3	4	5
Demolition operations are dangerous	1	2	3	4	5
Major demolition operations are costly	1	2	3	4	5

2.5 In your opinion, please rate how government bodies and agencies fare in terms of **participation** and **contribution** in demolition projects.

Please circle one number for each item	**Extremely poor**	**Below average**	**Average**	**Above average**	**Excellent**
Quality of involvement & contributions	1	2	3	4	5
Level of competence & experience	1	2	3	4	5

2.6 Please complete the following pertaining to the types of structures demolished based on pa demolition records *(tick the relevant boxes and circle the approximate ages).*

(Tick the relevant boxes)

You m select m than o optio

(Circle the app

	STRUCTURES	MATERIALS: R.C/ Concrete	Steel & Other metals	Masonry	Timber/ Wood	Asphalt	Asbestos & Lead	Hazardous chemicals	Plastics/ Vinyl	Insulation material	AGE (YR
A. RESIDENTIAL	Low rise flats, apartments										0-25, +25, +50, +
	Medium rise flats, apartments										0-25, +25, +50, +
	High rise flats, apartments										0-25, +25, +50, +
	Housing schemes										0-25, +25, +50, +
B. COMMERCIAL	Offices & Shop lots										0-25, +25, +50, +
	Shopping centers										0-25, +25, +50, +
	Convention centers										0-25, +25, +50, +
	Hotels										0-25, +25, +50, +
C. INDUSTRIAL	Small scaled factories										0-25, +25, +50, +
	Large scaled factories, plants										0-25, +25, +50, +
	Garages & Workshops										0-25, +25, +50, +
	Refineries										0-25, +25, +50, +
D. PUBLIC	Sport centers & Stadiums										0-25, +25, +50, +
	Multi-purpose halls										0-25, +25, +50, +
	Educational institutions										0-25, +25, +50, +
	Hospitals										0-25, +25, +50, +
	Places of worship										0-25, +25, +50, +
E. CIVIL & INFRASTRUCTURE	Bridges										0-25, +25, +50, +
	Abutments & Embankments										0-25, +25, +50, +
	Water retaining structures										0-25, +25, +50, +
	Retaining walls										0-25, +25, +50, +
	Drainage & Irrigation										0-25, +25, +50, +
	Railway stations										0-25, +25, +50, +
	Bus terminals										0-25, +25, +50, +
	Ports & Jetties										0-25, +25, +50, +
F. SPECIALIZED	Underground structures										0-25, +25, +50, +
	Offshore structures										0-25, +25, +50, +
	Telecomunication, Energy & Radio transmission towers										0-25, +25, +50, +

SECTION 3 : DEMOLITION TECHNIQUES

3.1 In your opinion, please rate the following pertaining to the **demolition concepts** most **frequently** employed in demolition projects.

Please circle one number for each item	Not used	Seldom used	Average	Often used	Highly used
Progressive Demolition - controlled removal of sections in a structure whilst retaining its stability in order to avoid collapse during the works	1	2	3	4	5
Deliberate Collapse Mechanisms - removal of key structural members to cause complete collapse of the whole or part of the structure	1	2	3	4	5
Deliberate Removal of Elements - removal of selected parts of the structure by dismantling	1	2	3	4	5

3.2 In your opinion, please rate the following pertaining to the **demolition techniques** most **frequently** employed in demolition projects.

Please circle one number for each item	Not used	Seldom used	Average	Often used	Highly used
Demolition by Hand - various hammers, cutting by diamond drilling and sawing, bursting, crushing and splitting	1	2	3	4	5
Demolition by Towers and High Reach Cranes	1	2	3	4	5
Demolition by Machines with mechanical attachments - balling, wire rope pulling	1	2	3	4	5
Demolition by Machines with hydraulic attachments - shear, impact hammer, grinder, grapple, crusher, processor	1	2	3	4	5
Demolition by Chemical Agents - gas expansion bursters, expanding demolition agents, flame cutting, thermic lancing, explosives	1	2	3	4	5
Demolition by Water Jetting	1	2	3	4	5

3.3 Based on **question 3.2,** rate the following in terms of your **experience** and **expertise.**

Please circle one number for each item	Totally not capable	Not capable	Average	Capable	Highly capable
Demolition by Hand	1	2	3	4	5
Demolition by Towers and High Reach Cranes	1	2	3	4	5
Demolition by Machines with mechanical attachments	1	2	3	4	5
Demolition by Machines with hydraulic attachments	1	2	3	4	5
Demolition by Chemical Agents	1	2	3	4	5
Demolition by Water Jetting	1	2	3	4	5

3.4 In your opinion, please rate the following factors on how they **influence the selection of techniques** in demolition projects.

Please circle one number for each item	Totally not significant	Not significant	Average	Significant	Highly significant
Structural form of the structure	1	2	3	4	5
Scale and extent of demolition	1	2	3	4	5
Location of the structure, degree of confinement and adjacent structures	1	2	3	4	5
Permitted levels of nuisance	1	2	3	4	5
Previous use of the structure	1	2	3	4	5
Health and safety considerations	1	2	3	4	5
Environmental considerations	1	2	3	4	5
Time constraint	1	2	3	4	5
Past experience on a particular project	1	2	3	4	5
The management and transportation of the generated wastes and debris	1	2	3	4	5
The requirement for reuse & recycling	1	2	3	4	5
Monetary cost	1	2	3	4	5
Client's specification	1	2	3	4	5
Stability of the structure	1	2	3	4	5
The suitability of the structure to adapt to the technique(s) selected	1	2	3	4	5
Equipment & machinery performance requirements, efficiency and speed	1	2	3	4	5

SECTION 4 : DEMOLITION HEALTH & SAFETY

4.1 In your opinion, please rate the following **reasons** pertaining to how **frequently** they **cause demolition accidents** and **injuries** at site.

Please circle one number for each item	Very rarely	Rarely	Average	Frequently	Very frequently
Unsafe attitude, i.e. negligence	1	2	3	4	5
Not wearing proper protective gear	1	2	3	4	5
Lack of knowledge and experience	1	2	3	4	5
Poor site management	1	2	3	4	5
Unsafe procedures at the workplace	1	2	3	4	5
Unsafe conditions, i.e. hazardous materials, dangerous elevations	1	2	3	4	5

4.2 In your opinion, please rate the following pertaining to the **difficulties** often **encountered** when implementing **H & S** plans.

Please circle one number for each item	Totally disagree	Disagree	Average	Agree	Strongly agree
Care free attitude of workers	1	2	3	4	5
Unavoidable hazardous conditions at the project site	1	2	3	4	5
Lack of cooperation between workers and management	1	2	3	4	5
Poor H & S monitoring and enforcement	1	2	3	4	5

SECTION 5 : DEMOLITION WASTE MANAGEMENT

5.1 Do you select deconstruction techniques to salvage materials prior to demolition for reuse or recycling?

☐ Yes ☐ No ☐ Unsure

5.2 Do you conduct on-site separation of demolition debris and waste materials?

☐ Yes ☐ No ☐ Unsure

5.3 In your opinion, please rate the following **materials** as to how **frequently** they are **reused, recycled** and **disposed** from demolition projects.

A.	**REUSED/ RECYCLED**				
Please circle one number for each item	**Very rarely**	**Rarely**	**Average**	**Frequently**	**Very frequently**
Concrete	1	2	3	4	5
Steel	1	2	3	4	5
Other metals	1	2	3	4	5
Masonry	1	2	3	4	5
Timber/ Wood	1	2	3	4	5
Asphalt	1	2	3	4	5
Plastics/ Vinyl	1	2	3	4	5
Insulation material	1	2	3	4	5
B.	**DISPOSED**				
Please circle one number for each item	**Very rarely**	**Rarely**	**Average**	**Frequently**	**Very frequently**
Concrete	1	2	3	4	5
Steel	1	2	3	4	5
Other metals	1	2	3	4	5
Masonry	1	2	3	4	5
Timber/ Wood	1	2	3	4	5
Asphalt	1	2	3	4	5
Plastics/ Vinyl	1	2	3	4	5
Insulation material	1	2	3	4	5

5.4 In your opinion, please rate as to how **frequently** solid **demolition** debris such as **asphalt, masonry** and **concrete** are subjected to the following **purposes.**

Please circle one number for each item	**Very rarely**	**Rarely**	**Average**	**Frequently**	**Very frequently**
Concrete used as recycled aggregates	1	2	3	4	5
Masonry used as recycled soil	1	2	3	4	5
Asphalt processed and reused in new pavement construction	1	2	3	4	5
Concrete & masonry used as road base courses and drainage bedding layers	1	2	3	4	5
Concrete & masonry used for landfill eng or restoration	1	2	3	4	5
Concrete & masonry used as backfill material, for embankment construction	1	2	3	4	5
Disposed off at landfills	1	2	3	4	5

5.5 In your opinion, please rate the following:

Please circle one number for each item	Totally disagree	Disagree	Average	Agree	Strongly agree
Recycling delays the project completion	1	2	3	4	5
There is usually insufficient space on site to recycle	1	2	3	4	5
The requirements for separate waste containers and the presence of a variety of waste material makes recycling complicated	1	2	3	4	5
There are insufficient contract provisions and specifications on recycling	1	2	3	4	5
Recycling is too costly	1	2	3	4	5
It is difficult to get contractors or subcons to cooperate and participate in recycling	1	2	3	4	5

5.6 In your opinion, please rate the following pertaining to the **barriers** that often **affect** demolition **recycling** efforts.

Please circle one number for each item	Totally disagree	Disagree	Average	Agree	Strongly agree
Demolition debris are not statutorily banned from landfill disposal	1	2	3	4	5
Insufficient recycling facilities	1	2	3	4	5
Lack of recycling education and awareness	1	2	3	4	5
No demand for recycled content products or materials	1	2	3	4	5
Inadequate cost-benefit data	1	2	3	4	5

5.7 In your opinion, please rate the following **types of pollution** on how **frequently** they are **encountered** during demolition projects.

Please circle one number for each item	Very rarely	Rarely	Average	Frequently	Very frequently
Air pollution	1	2	3	4	5
Noise pollution	1	2	3	4	5
Water pollution	1	2	3	4	5
Soil contamination	1	2	3	4	5
Vibration	1	2	3	4	5

5.8 In your opinion, please rate the following pertaining to the **setbacks** often **faced** when **tackling environmental** issues.

Please circle one number for each item	Totally disagree	Disagree	Average	Agree	Strongly agree
The nature of the demolition works itself	1	2	3	4	5
Weather conditions	1	2	3	4	5
Lack of initiative and commitment from other project parties	1	2	3	4	5
Inadequate contract provisions and specifications on environmental mgmt.	1	2	3	4	5
Lack of environmental education and awareness	1	2	3	4	5
Cost implications	1	2	3	4	5

THANK YOU FOR YOUR PARTICIPATION

APPENDIX C

Table C1: Categorization of respondents departments.

Section 1: General Question 1.1	**Strata 3 Components**	**Weights**		**Upper management**		**Project management**		**Construction**		**Engineering**		**Building**		**Project management & Construction**		**Total Response**			
					%		**%**		**%**		**%**		**%**		**%**	**Nos.**		**%**	
Department Category	*Government*	2.083	3.671	0	0.00	1	2.70	0	0.00	0	0.00	5	13.51	0	0.00	6	37	16.22	100.00
	Developer	0.794		1	2.70	9	24.32	1	2.70	5	13.51	0	0.00	0	0.00	16		43.24	
	Contractor	0.794		0	0.00	2	5.41	9	24.32	1	2.70	0	0.00	3	8.11	15		40.54	
Weighted Percentage Mean (%)				**0.58**		**7.96**		**5.84**		**3.51**		**7.67**		**1.75**		**27.32 %**			
Equivalent Percentage (%)				**2.12**		**29.15**		**21.38**		**12.85**		**28.09**		**6.41**		**100.00 %**			

Table C2: Respondents working experience.

Section 1: General Question 1.2	**Strata 3 Components**	**Weights**		**Below 5 years**		**5 – 10 years**		**10 – 15 years**		**Above 15 years**		**Total Response**			
					%		**%**		**%**		**%**	**Nos.**		**%**	
Working experience	*Government*	2.083	3.671	0	0.00	2	5.41	1	2.70	3	8.11	6	37	16.22	100.00
	Developer	0.794		4	10.81	4	10.81	2	5.41	6	16.22	16		43.24	
	Contractor	0.794		3	8.11	3	8.11	2	5.41	7	18.92	15		40.54	
Weighted Percentage Mean (%)				**4.09**		**7.16**		**3.87**		**12.20**		**27.32 %**			
Equivalent Percentage (%)				**14.97**		**26.21**		**14.17**		**44.66**		**100.00 %**			

Table C3: Execution mode of demolition projects.

Section 1: General Question 1.3	**Strata 3 Components**	**Weights**		**Consultant's advice (a)**		**Contractor's proposal (b)**		**Previous experience (c)**		**(a) & (b)**		**(b) & (c)**		**(a), (b) & (c)**		**Total Response**			
					%		**%**		**%**		**%**		**%**		**%**	**Nos.**		**%**	
Execution of demolition projects	*Government*	2.083	3.671	2	5.41	0	0.00	0	0.00	3	8.11	1	2.70	0	0.00	6	37	16.22	100.00
	Developer	0.794		1	2.70	2	5.41	2	5.41	7	18.92	0	0.00	4	10.81	16		43.24	
	Contractor	0.794		3	8.11	1	2.70	0	0.00	6	16.22	3	8.11	2	5.41	15		40.54	
Weighted Percentage Mean (%)				**5.41**		**1.75**		**1.17**		**12.20**		**3.29**		**3.51**		**27.32 %**			
Equivalent Percentage (%)				**19.80**		**6.40**		**4.28**		**44.64**		**12.04**		**12.84**		**100.00 %**			

Table C4: Extensiveness rating of demolition works.

Section 2: Demolition Overview Question 2.1	**Strata 3 Components**	**Weights**		**Totally not extensive**		**Not extensive**		**Average**		**Extensive**		**Very extensive**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Minor demolition works	*Government*	2.083	3.671	0	0.00	1	2.70	2	5.41	3	8.11	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	3	8.11	6	16.22	4	10.81	3	8.11	16		43.24	
	Contractor	0.794		0	0.00	1	2.70	8	21.62	5	13.51	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**3.87**		**11.25**		**9.86**		**2.34**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**14.17**		**41.18**		**36.09**		**8.57**		**100.00 %**			
Major demolition works	*Government*	2.083	3.671	0	0.00	4	10.81	1	2.7	1	2.7	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	10	27.03	4	10.81	2	5.41	0	0.00	16		43.24	
	Contractor	0.794		2	5.41	8	21.62	3	8.11	2	5.41	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**1.17**		**16.66**		**5.62**		**3.87**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**4.28**		**60.98**		**20.57**		**14.17**		**0.00**		**100.00 %**			

Table C5: Frequency rating of demolition project job scopes.

Section 2: Demolition Overview Question 2.2	**Strata 3 Components**	**Weights**		**Very rarely**		**Rarely**		**Average**		**Frequently**		**Very frequently**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Solely to demolish only	*Government*	2.083	3.671	2	5.41	2	5.41	2	5.41	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		4	10.81	5	13.51	5	13.51	2	5.41	0	0.00	16		43.24	
	Contractor	0.794		7	18.92	4	10.81	2	5.41	1	2.70	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**9.5**		**8.33**		**7.16**		**1.75**		**0.58**		**27.32 %**			
Equivalent Percentage (%)				**34.77**		**30.49**		**26.21**		**6.41**		**2.12**		**100.00 %**			
To demolish and redevelop, i.e. demolition forms part of the project package	*Government*	2.083	3.671	1	2.70	1	2.70	1	2.70	3	8.11	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	3	8.11	6	16.22	4	10.81	3	8.11	16		43.24	
	Contractor	0.794		1	2.70	4	10.81	3	8.11	5	13.51	2	5.41	15		40.54	
Weighted Percentage Mean (%)				**2.12**		**5.62**		**6.79**		**9.86**		**2.92**		**27.32 %**			
Equivalent Percentage (%)				**7.76**		**20.57**		**24.85**		**36.09**		**10.69**		**100.00 %**			

Table C6: Frequency ranking of reasons for demolition projects.

Section 2: Demolition Overview Question 2.3	Strata 3 Components	Weights		Very rarely 1	Rarely 2	Average 3	Frequently 4	Very frequently 5	Total response		Mean	Weighted mean	Rank
Destroyed or damaged due to fire	*Government*	2.083	3.671	1	2	1	1	1	6	37	2.83	2.94	**4**
	Developer	0.794		0	1	10	4	1	16		3.31		
	Contractor	0.794		2	5	2	5	1	15		2.87		
Abandoned or vacant	*Government*	2.083	3.671	2	3	1	0	0	6	37	1.83	2.08	**9**
	Developer	0.794		2	6	3	5	0	16		2.69		
	Contractor	0.794		4	6	4	1	0	15		2.13		
Destroyed or damaged due to natural disasters, i.e. flooding & landslides	*Government*	2.083	3.671	1	4	0	1	0	6	37	2.17	2.12	**8**
	Developer	0.794		3	6	5	2	0	16		2.38		
	Contractor	0.794		6	7	2	0	0	15		1.73		
Not suitable for anticipated use, i.e. outdated design & appearance, specific problem with structural materials or systems	*Government*	2.083	3.671	0	4	1	0	1	6	37	2.67	2.46	**7**
	Developer	0.794		4	5	5	2	0	16		2.31		
	Contractor	0.794		6	4	3	2	0	15		2.07		
Building's physical condition, i.e. dilapidated, deteriorated	*Government*	2.083	3.671	0	3	2	1	0	6	37	2.67	2.50	**6**
	Developer	0.794		2	3	9	2	0	16		2.69		
	Contractor	0.794		6	5	4	0	0	15		1.87		
Area redevelopment, i.e. increasing land values & economic prospects, land takeover due to the expiration of lease period	*Government*	2.083	3.671	1	1	2	1	1	6	37	3.00	3.02	**3**
	Developer	0.794		0	4	5	5	2	16		3.31		
	Contractor	0.794		0	6	6	3	0	15		2.80		
Costs of maintenance too expensive	*Government*	2.083	3.671	2	2	1	1	0	6	37	2.17	2.05	**10**
	Developer	0.794		4	6	5	1	0	16		2.19		
	Contractor	0.794		7	7	1	0	0	15		1.60		
Building refurbishment, renovation, conversion	*Government*	2.083	3.671	0	1	1	3	1	6	37	3.67	3.52	**1**
	Developer	0.794		0	1	9	6	0	16		3.31		
	Contractor	0.794		1	4	3	3	4	15		3.33		

Table C6 (Cont.): Frequency ranking of reasons for demolition projects.

Section 2: Demolition Overview Question 2.3 (Cont.)	Strata 3 Components	Weights		Very rarely	Rarely	Average	Frequently	Very frequently	Total response		Mean	Weighted mean	Rank
				1	2	3	4	5					
Urban restructuring, i.e. changes in the nation's master plan, due to govt. policies, changes in land use	*Government*	2.083	3.671	0	3	3	0	0	6	37	2.50	2.56	**5**
	Developer	0.794		0	7	5	3	1	16		2.88		
	Contractor	0.794		3	6	3	3	0	15		2.40		
Infrastructure development, i.e. construction, upgrading & expansion of highways	*Government*	2.083	3.671	0	2	2	2	0	6	37	3.00	3.24	**2**
	Developer	0.794		0	0	9	5	2	16		3.56		
	Contractor	0.794		0	3	4	5	3	15		3.53		

Table C7: Agreement rating of demolition misconceptions.

Section 2: Demolition Overview Question 2.4	**Strata 3 Components**	**Weights**		**Totally disagree**		**Disagree**		**Average**		**Agree**		**Strongly agree**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Demolition usually destroys many structures that should be preserved	*Government*	2.083	3.671	0	0.00	2	5.41	0	0.00	4	10.81	0	0.00	6	37	16.22	100.00
	Developer	0.794		1	2.70	6	16.22	7	18.92	2	5.41	0	0.00	16		43.24	
	Contractor	0.794		1	2.70	7	18.92	5	13.51	2	5.41	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**1.17**		**10.67**		**7.01**		**8.47**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**4.28**		**39.06**		**25.66**		**31.00**		**0.00**		**100.00 %**			
Demolition unnecessarily overcrowds landfills with debris	*Government*	2.083	3.671	0	0.00	0	0.00	3	8.11	2	5.41	1	2.70	6	37	16.22	100.00
	Developer	0.794		1	2.70	5	13.51	6	16.22	4	10.81	0	0.00	16		43.24	
	Contractor	0.794		2	5.41	5	13.51	6	16.22	2	5.41	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**1.75**		**5.84**		**11.62**		**6.58**		**1.53**		**27.32 %**			
Equivalent Percentage (%)				**6.41**		**21.38**		**42.53**		**24.09**		**5.60**		**100.00 %**			
Major demolition operations are simple and unsophisticated	*Government*	2.083	3.671	0	0.00	2	5.41	2	5.41	2	5.41	0	0.00	6	37	16.22	100.00
	Developer	0.794		1	2.70	7	18.92	2	5.41	6	16.22	0	0.00	16		43.24	
	Contractor	0.794		3	8.11	4	10.81	6	16.22	1	2.70	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**2.34**		**9.50**		**7.75**		**7.16**		**0.58**		**27.32 %**			
Equivalent Percentage (%)				**8.57**		**34.77**		**28.37**		**26.21**		**2.12**		**100.00 %**			
Demolition operations are dangerous	*Government*	2.083	3.671	0	0.00	0	0.00	5	13.52	0	0.00	1	2.70	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	9	24.32	6	16.22	0	0.00	16		43.24	
	Contractor	0.794		0	0.00	2	5.41	2	5.41	7	18.92	4	10.81	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**1.75**		**14.10**		**7.60**		**3.87**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**6.41**		**51.61**		**27.82**		**14.17**		**100.00 %**			
Major demolition operations are costly	*Government*	2.083	3.671	0	0.00	0	0.00	1	2.70	4	10.81	1	2.70	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	7	18.92	7	18.92	1	2.70	16		43.24	
	Contractor	0.794		0	0.00	0	0.00	6	16.22	5	13.51	4	10.81	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**0.58**		**9.13**		**13.15**		**4.45**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**2.14**		**33.43**		**48.14**		**16.29**		**100.00 %**			

Table C8: Quality rating of government participation in demolition projects.

Section 2: Demolition Overview Question 2.5	**Strata 3 Components**	**Weights**		**Extremely poor**		**Below average**		**Average**		**Above average**		**Excellent**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Quality of involvement and contributions	*Government*	2.083	3.671	0	0.00	3	8.11	2	5.41	1	2.70	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	5	13.51	11	29.73	0	0.00	0	0.00	16		43.24	
	Contractor	0.794		0	0.00	4	10.81	11	29.73	0	0.00	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**9.86**		**15.93**		**1.53**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**36.09**		**58.31**		**5.60**		**0.00**		**100.00 %**			
Level of competence and experience	*Government*	2.083	3.671	0	0.00	3	8.11	3	8.11	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	5	13.51	11	29.73	0	0.00	0	0.00	16		43.24	
	Contractor	0.794		0	0.00	3	8.11	11	29.73	1	2.70	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**9.28**		**17.46**		**0.58**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**33.97**		**63.91**		**2.12**		**0.00**		**100.00 %**			

Table C9: Demolition projects by structural categorization.

Section 2: Demolition Overview Question 2.6	**Strata 3 Components**	**Weights**		**Residential**		**Commercial**		**Industrial**		**Public**		**Civil & Infrastructure**		**Specialized**		**Total Amount**			
					%		**%**		**%**		**%**		**%**		**%**	**Nos.**		**%**	
Structural Category	*Government*	2.083	3.671	10	3.08	9	2.77	9	2.77	15	4.62	17	5.23	7	2.15	67	325	20.62	100.00
	Developer	0.794		23	7.08	19	5.85	17	5.23	17	5.23	37	11.38	8	2.46	121		37.23	
	Contractor	0.794		23	7.08	20	6.15	20	6.15	22	6.77	45	13.85	7	2.15	137		42.15	
Weighted Percentage Mean (%)				**4.81**		**4.17**		**4.03**		**5.22**		**8.43**		**2.22**		**28.87 %**			
Equivalent Percentage (%)				**16.66**		**14.44**		**13.96**		**18.08**		**29.20**		**7.69**		**100.00 %**			

Table C10: Types of structures demolished in the Civil & Infrastructure category.

Section 2: Demolition Overview Question 2.6	**Strata 3 Components**	**Weights**		**Bridges**		**Abutments & Embankments**		**Water retaining**		**Retaining walls**		**Drainage & Irrigation**		**Continued**
					%		**%**		**%**		**%**		**%**	
Civil & Infrastructure Category - *Types of structures*	*Government*	2.083	3.671	3	3.03	2	2.02	2	2.02	2	2.02	2	2.02	
	Developer	0.794		6	6.06	6	6.06	2	2.02	6	6.06	8	8.08	
	Contractor	0.794		6	6.06	5	5.05	5	5.05	7	7.07	8	8.08	
Weighted Percentage Mean (%)				**4.34**		**3.55**		**2.68**		**3.99**		**4.64**		
Equivalent Percentage (%)				**15.69**		**12.83**		**9.69**		**14.43**		**16.78**		

Table C10 (Cont.): Types of structures demolished in the Civil & Infrastructure category.

Section 2: Demolition Overview Question 2.6 (Cont.)	**Strata 3 Components**	**Weights**		**Continued**	**Railway stations**		**Bus terminals**		**Ports & Jetties**		**Total Amount**			
						%		**%**		**%**	**Nos.**		**%**	
Civil & Infrastructure Category - *Types of structures (Cont.)*	*Government*	2.083	3.671		2	2.02	2	2.02	2	2.02	17	99	17.17	100.00
	Developer	0.794			4	4.04	3	3.03	2	2.02	37		37.37	
	Contractor	0.794			4	4.04	5	5.05	5	5.05	45		45.45	
Weighted Percentage Mean (%)					**2.89**		**2.89**		**2.68**		**27.66 %**			
Equivalent Percentage (%)					**10.45**		**10.45**		**9.69**		**100.00 %**			

Table C11: Composition of Civil & Infrastructure demolition debris.

Section 2: Demolition Overview Question 2.6	**Strata 3 Components**	**Weights**		**R.C/ Concrete**		**Steel & Other metals**		**Masonry**		**Timber/ Wood**		**Asphalt**		**Continued**
					%		**%**		**%**		**%**		**%**	
Civil & Infrastructure Category - *Types of materials*	*Government*	2.083	3.671	15	7.11	12	5.69	4	1.90	4	1.90	5	2.37	
	Developer	0.794		31	14.69	15	7.11	9	4.27	3	1.42	6	2.84	
	Contractor	0.794		40	18.96	28	13.27	9	4.27	13	6.16	3	1.42	
Weighted Percentage Mean (%)				**11.31**		**7.64**		**2.93**		**2.72**		**2.27**		
Equivalent Percentage (%)				**39.26**		**26.54**		**10.18**		**9.43**		**7.89**		

Table C11 (Cont.): Composition of Civil & Infrastructure demolition debris.

Section 2: Demolition Overview Question 2.6 (Cont.)	**Strata 3 Components**	**Weights**		**Continued**	**Asbestos & Lead**		**Hazardous chemicals**		**Plastics/ Vinyl**		**Insulation material**		**Total Amount**			
						%		**%**		**%**		**%**	**Nos.**		**%**	
Civil & Infrastructure Category *- Types of materials (Cont.)*	*Government*	2.083	3.671		0	0.00	0	0.00	2	0.95	1	0.47	43	211	20.38	100.00
	Developer	0.794			0	0.00	1	0.47	0	0.00	3	1.42	68		32.23	
	Contractor	0.794			1	0.47	1	0.47	1	0.47	4	1.90	100		47.39	
Weighted Percentage Mean (%)					**0.10**		**0.20**		**0.64**		**0.99**		**28.79 %**			
Equivalent Percentage (%)					**0.35**		**0.70**		**2.22**		**3.44**		**100.00 %**			

Table C12: Age of structures demolished in the Civil & Infrastructure category.

Section 2: Demolition Overview Question 2.6	**Strata 3 Components**	**Weights**		**0 – 25 Years**		**+ 25 Years**		**+ 50 Years**		**+ 75 Years**		**+ 100 Years**		**Total Amount**			
					%		**%**		**%**		**%**		**%**	**Nos.**		**%**	
Civil & Infrastructure Category *- Age of structures*	*Government*	2.083	3.671	1	0.85	8	6.78	9	7.63	3	2.54	6	5.08	27	118	22.88	100.00
	Developer	0.794		15	12.71	7	5.93	12	10.17	8	6.78	1	0.85	43		36.44	
	Contractor	0.794		9	7.63	8	6.78	13	11.02	14	11.87	4	3.39	48		40.68	
Weighted Percentage Mean (%)				**4.88**		**6.60**		**8.91**		**5.48**		**3.80**		**29.66 %**			
Equivalent Percentage (%)				**16.45**		**22.25**		**30.04**		**18.48**		**12.81**		**100.00 %**			

Table C13: Types of structures demolished in the Public category.

Section 2: Demolition Overview Question 2.6	**Strata 3 Components**	**Weights**		**Sport centers & Stadiums**		**Multi-purpose halls**		**Educational institutions**		**Hospitals**		**Places of worship**		**Total Amount**			
					%		**%**		**%**		**%**		**%**	**Nos.**		**%**	
Public Category *- Types of structures*	*Government*	2.083	3.671	3	5.56	3	5.56	3	5.56	2	3.70	4	7.41	15	54	27.78	100.00
	Developer	0.794		3	5.56	3	5.56	3	5.56	3	5.56	5	9.26	17		31.48	
	Contractor	0.794		4	7.41	3	5.56	4	7.41	4	7.41	7	12.96	22		40.74	
Weighted Percentage Mean (%)				**5.96**		**5.56**		**5.96**		**4.91**		**9.01**		**31.38 %**			
Equivalent Percentage (%)				**18.99**		**17.72**		**18.99**		**15.63**		**28.71**		**100.00 %**			

Table C14: Composition of Public demolition debris.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		R.C/ Concrete		Steel & Other metals		Masonry		Timber/ Wood		Asphalt		
					%		%		%		%		%	Continued
Public Category *- Types of materials*	*Government*	2.083	3.671	15	8.47	14	7.91	9	5.08	14	7.91	7	3.96	
	Developer	0.794		17	9.60	10	5.65	4	2.26	9	5.08	1	0.57	
	Contractor	0.794		22	12.43	13	7.35	7	3.96	8	4.52	2	1.13	
Weighted Percentage Mean (%)				**9.57**		**7.30**		**4.23**		**6.55**		**2.62**		
Equivalent Percentage (%)				**27.10**		**20.67**		**11.98**		**18.55**		**7.42**		

Table C14 (Cont.): Composition of Public demolition debris.

Section 2: Demolition Overview Question 2.6 (Cont.)	Strata 3 Components	Weights			Asbestos & Lead		Hazardous chemicals		Plastics/ Vinyl		Insulation material		Total Amount			
				Continued		%		%		%		%	Nos.		%	
Public Category *- Types of materials (Cont.)*	*Government*	2.083	3.671		0	0.00	1	0.57	6	3.39	3	1.70	69	177	38.98	100.00
	Developer	0.794			3	1.70	1	0.57	2	1.13	4	2.26	51		28.81	
	Contractor	0.794			1	0.57	1	0.57	2	1.13	1	0.57	57		32.21	
Weighted Percentage Mean (%)					**0.49**		**0.57**		**2.41**		**1.58**		**35.32 %**			
Equivalent Percentage (%)					**1.39**		**1.61**		**6.82**		**4.47**		**100.00 %**			

Table C15: Age of structures demolished in the Public category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		0 – 25 Years		+ 25 Years		+ 50 Years		+ 75 Years		+ 100 Years		Total Amount			
					%		%		%		%		%	Nos.		%	
Public Category *- Age of structures*	*Government*	2.083	3.671	4	7.69	6	11.54	3	5.77	1	1.92	3	5.77	17	52	32.69	100.00
	Developer	0.794		3	5.77	0	0.00	7	13.46	3	5.77	2	3.85	15		28.85	
	Contractor	0.794		1	1.92	1	1.92	8	15.38	8	15.38	2	3.85	20		38.46	
Weighted Percentage Mean (%)				**6.03**		**6.96**		**9.51**		**5.66**		**4.94**		**33.11 %**			
Equivalent Percentage (%)				**18.21**		**21.03**		**28.74**		**17.10**		**14.92**		**100.00 %**			

Table C16: Types of structures demolished in the Residential category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		Low rise		Medium rise		High rise		Housing schemes		Total Amount			
					%		%		%		%	Nos.		%	
Residential Category - Types of structures	Government	2.083	3.671	2	3.57	3	5.36	3	5.36	2	3.57	10	56	17.86	100.00
	Developer	0.794		7	12.50	5	8.93	5	8.93	6	10.71	23		41.07	
	Contractor	0.794		6	10.71	5	8.93	6	10.71	6	10.71	23		41.07	
Weighted Percentage Mean (%)				**7.05**		**6.90**		**7.29**		**6.66**		**27.90 %**			
Equivalent Percentage (%)				**25.27**		**24.73**		**26.13**		**23.87**		**100.00 %**			

Table C17: Composition of Residential demolition debris.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		R.C/ Concrete		Steel & Other metals		Masonry		Timber/ Wood		Asphalt		
					%		%		%		%		%	Continued
Residential Category - Types of materials	Government	2.083	3.671	10	8.47	7	5.93	5	4.24	6	5.08	5	4.24	
	Developer	0.794		22	18.65	2	1.70	5	4.24	6	5.08	0	0.00	
	Contractor	0.794		22	18.65	5	4.24	7	5.93	9	7.63	2	1.70	
Weighted Percentage Mean (%)				**12.87**		**4.65**		**4.61**		**5.63**		**2.77**		
Equivalent Percentage (%)				**40.54**		**14.65**		**14.52**		**17.73**		**8.72**		

Table C17 (Cont.): Composition of Residential demolition debris.

Section 2: Demolition Overview Question 2.6 (Cont.)	Strata 3 Components	Weights			Asbestos & Lead		Hazardous chemicals		Plastics/ Vinyl		Insulation material		Total Amount			
				Continued		%		%		%		%	Nos.		%	
Residential Category - Types of materials (Cont.)	Government	2.083	3.671		1	0.85	0	0.00	0	0.00	0	0.00	34	118	28.81	100.00
	Developer	0.794			0	0.00	0	0.00	0	0.00	1	0.85	36		30.51	
	Contractor	0.794			2	1.70	0	0.00	0	0.00	1	0.85	48		40.68	
Weighted Percentage Mean (%)					**0.85**		**0.00**		**0.00**		**0.37**		**31.75 %**			
Equivalent Percentage (%)					**2.68**		**0.00**		**0.00**		**1.17**		**100.00 %**			

Table C18: Age of structures demolished in the Residential category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		0 – 25 Years		+ 25 Years		+ 50 Years		+ 75 Years		+ 100 Years		Total Amount			
					%		%		%		%		%	Nos.		%	
Residential Category *- Age of structures*	*Government*	2.083	3.671	4	6.35	5	7.94	2	3.17	1	1.59	2	3.17	14	63	22.22	100.00
	Developer	0.794		6	9.52	6	9.52	9	14.29	3	4.76	1	1.59	25		39.68	
	Contractor	0.794		2	3.17	2	3.17	15	23.81	1	1.59	4	6.35	24		38.10	
Weighted Percentage Mean (%)				**6.35**		**7.25**		**10.04**		**2.28**		**3.52**		**29.43 %**			
Equivalent Percentage (%)				**21.58**		**24.64**		**34.12**		**7.75**		**11.96**		**100.00 %**			

Table C19: Types of structures demolished in the Commercial category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		Offices & Shop lots		Shopping centers		Convention centers		Hotels		Total Amount			
					%		%		%		%	Nos.		%	
Commercial Category *- Types of structures*	*Government*	2.083	3.671	3	6.25	2	4.17	2	4.17	2	4.17	9	48	18.75	100.00
	Developer	0.794		9	18.75	4	8.33	3	6.25	3	6.25	19		39.58	
	Contractor	0.794		7	14.59	4	8.33	4	8.33	5	10.42	20		41.67	
Weighted Percentage Mean (%)				**10.76**		**5.97**		**5.52**		**5.97**		**28.21 %**			
Equivalent Percentage (%)				**38.14**		**21.16**		**19.57**		**21.16**		**100.00 %**			

Table C20: Composition of Commercial demolition debris.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		R.C/ Concrete		Steel & Other metals		Masonry		Timber/ Wood		Asphalt	
					%		%		%		%		%
Commercial Category *- Types of materials*	*Government*	2.083	3.671	6	3.92	8	5.23	5	3.27	4	2.62	4	2.62
	Developer	0.794		18	11.76	9	5.88	10	6.54	7	4.58	0	0.00
	Contractor	0.794		20	13.07	11	7.19	10	6.54	10	6.54	1	0.65
Weighted Percentage Mean (%)				**7.60**		**5.80**		**4.69**		**3.89**		**1.63**	
Equivalent Percentage (%)				**25.59**		**19.53**		**15.79**		**13.10**		**5.49**	

Continued

Table C20 (Cont.): Composition of Commercial demolition debris.

Section 2: Demolition Overview Question 2.6 (Cont.)	Strata 3 Components	Weights		Continued	Asbestos & Lead		Hazardous chemicals		Plastics/ Vinyl		Insulation material		Total Amount			
						%		%		%		%	Nos.		%	
Commercial Category *- Types of materials (Cont.)*	*Government*	2.083	3.671		0	0.00	0	0.00	4	2.62	4	2.62	35	153	22.88	100.00
	Developer	0.794			3	1.96	0	0.00	3	1.96	4	2.62	54		35.29	
	Contractor	0.794			2	1.31	3	1.96	3	1.96	4	2.62	64		41.83	
Weighted Percentage Mean (%)					**0.71**		**0.42**		**2.34**		**2.62**		**29.70 %**			
Equivalent Percentage (%)					**2.39**		**1.41**		**7.88**		**8.82**		**100.00 %**			

Table C21: Age of structures demolished in the Commercial category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		0 – 25 Years		+ 25 Years		+ 50 Years		+ 75 Years		+ 100 Years		Total Amount			
					%		%		%		%		%	Nos.		%	
Commercial Category *- Age of structures*	*Government*	2.083	3.671	1	2.04	4	8.16	0	0.00	0	0.00	4	8.16	9	49	18.37	100.00
	Developer	0.794		3	6.12	2	4.08	5	10.20	5	10.20	2	4.08	17		34.69	
	Contractor	0.794		2	4.08	1	2.04	9	18.37	6	12.25	5	10.20	23		46.94	
Weighted Percentage Mean (%)				**3.36**		**5.95**		**6.18**		**4.86**		**7.72**		**28.08 %**			
Equivalent Percentage (%)				**11.97**		**21.19**		**22.02**		**17.32**		**27.49**		**100.00 %**			

Table C22: Types of structures demolished in the Industrial category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		Small scaled factories		Large scaled factories		Garages & Workshops		Refineries		Total Amount			
					%		%		%		%	Nos.		%	
Industrial Category *- Types of structures*	*Government*	2.083	3.671	2	4.35	2	4.35	3	6.52	2	4.35	9	46	19.57	100.00
	Developer	0.794		5	10.87	4	8.70	5	10.87	3	6.52	17		36.96	
	Contractor	0.794		5	10.87	4	8.70	7	15.22	4	8.7	20		43.48	
Weighted Percentage Mean (%)				**7.17**		**6.23**		**9.34**		**5.76**		**28.50 %**			
Equivalent Percentage (%)				**25.16**		**21.86**		**32.77**		**20.21**		**100.00 %**			

Table C23: Composition of Industrial demolition debris.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		R.C/ Concrete		Steel & Other metals		Masonry		Timber/ Wood		Asphalt		Continued
					%		%		%		%		%	
Industrial Category - *Types of materials*	*Government*	2.083	3.671	5	3.70	9	6.67	4	2.96	4	2.96	8	5.93	
	Developer	0.794		11	8.15	13	9.63	1	0.74	4	2.96	0	0.00	
	Contractor	0.794		11	8.15	17	12.60	4	2.96	7	5.19	0	0.00	
Weighted Percentage Mean (%)				**5.63**		**8.59**		**2.48**		**3.44**		**3.37**		
Equivalent Percentage (%)				**16.76**		**25.57**		**7.38**		**10.24**		**10.03**		

Table C23 (Cont.): Composition of Industrial demolition debris.

Section 2: Demolition Overview Question 2.6 (Cont.)	Strata 3 Components	Weights		Continued	Asbestos & Lead		Hazardous chemicals		Plastics/ Vinyl		Insulation material		Total Amount			
						%		%		%		%	Nos.		%	
Industrial Category - *Types of materials (Cont.)*	*Government*	2.083	3.671		4	2.96	4	2.96	4	2.96	4	2.96	46	135	34.07	100.00
	Developer	0.794			4	2.96	4	2.96	1	0.74	4	2.96	42		31.11	
	Contractor	0.794			2	1.48	4	2.96	1	0.74	1	0.74	47		34.82	
Weighted Percentage Mean (%)					**2.64**		**2.96**		**2.00**		**2.48**		**33.59 %**			
Equivalent Percentage (%)					**7.86**		**8.82**		**5.95**		**7.38**		**100.00 %**			

Table C24: Age of structures demolished in the Industrial category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		0 – 25 Years		+ 25 Years		+ 50 Years		+ 75 Years		+ 100 Years		Total Amount			
					%		%		%		%		%	Nos.		%	
Industrial Category - *Age of structures*	*Government*	2.083	3.671	1	2.22	4	8.89	1	2.22	1	2.22	2	4.44	9	45	20.00	100.00
	Developer	0.794		3	6.67	4	8.89	7	15.56	2	4.44	0	0.00	16		35.56	
	Contractor	0.794		2	4.44	1	2.22	5	11.11	8	17.78	4	8.89	20		44.44	
Weighted Percentage Mean (%)				**3.66**		**7.45**		**7.03**		**6.07**		**4.42**		**28.65 %**			
Equivalent Percentage (%)				**12.80**		**26.03**		**24.54**		**21.19**		**15.44**		**100.00 %**			

Table C25: Types of structures demolished in the Specialized category.

Section 2: Demolition Overview Question 2.6 (Cont.)	Strata 3 Components	Weights		Underground structures		Offshore structures		Telecommunication, Energy & Radio towers		Total Amount			
					%		%		%	Nos.		%	
Specialized Category *- Types of structures*	*Government*	2.083	3.671	2	9.09	2	9.09	3	13.64	7	22	31.82	100.00
	Developer	0.794		3	13.64	2	9.09	3	13.64	8		36.36	
	Contractor	0.794		4	18.18	1	4.55	2	9.09	7		31.82	
Weighted Percentage Mean (%)				**12.04**		**8.11**		**12.66**		**32.80 %**			
Equivalent Percentage (%)				**36.71**		**24.70**		**38.60**		**100.00 %**			

Table C26: Composition of demolition debris in the Specialized category.

Section 2: Demolition Overview Question 2.6	Strata 3 Components	Weights		R.C/ Concrete		Steel & Other metals		Masonry		Timber/ Wood		Asphalt		**Continued**
					%		%		%		%		%	
Specialized Category *- Types of materials*	*Government*	2.083	3.671	6	10.91	6	10.91	2	3.64	0	0.00	0	0.00	
	Developer	0.794		6	10.91	6	10.91	0	0.00	2	3.64	0	0.00	
	Contractor	0.794		6	10.91	6	10.91	3	5.45	2	3.64	0	0.00	
Weighted Percentage Mean (%)				**10.91**		**10.91**		**3.24**		**1.58**		**0.00**		
Equivalent Percentage (%)				**35.69**		**35.69**		**10.60**		**5.17**		**0.00**		

Table C26 (Cont.): Composition of demolition debris in the Specialized category.

Section 2: Demolition Overview Question 2.6 (Cont.)	Strata 3 Components	Weights		**Continued**	Asbestos & Lead		Hazardous chemicals		Plastics/ Vinyl		Insulation material		Total Amount			
						%		%		%		%	Nos.		%	
Specialized Category *- Types of materials (Cont.)*	*Government*	2.083	3.671		0	0.00	0	0.00	0	0.00	0	0.00	14	55	25.46	100.00
	Developer	0.794			0	0.00	3	5.45	0	0.00	4	7.27	21		38.18	
	Contractor	0.794			0	0.00	1	1.82	0	0.00	2	3.64	20		36.36	
Weighted Percentage Mean (%)					**0.00**		**1.57**		**0.00**		**2.36**		**30.57 %**			
Equivalent Percentage (%)					**0.00**		**5.14**		**0.00**		**7.72**		**100.00 %**			

Table C27: Age of structures demolished in the Specialized category.

Section 2: Demolition Overview Question 2.6	**Strata 3 Components**	**Weights**		**0 – 25 Years**		**+ 25 Years**		**+ 50 Years**		**+ 75 Years**		**+ 100 Years**		**Total Amount**			
					%		**%**		**%**		**%**		**%**	**Nos.**		**%**	
Specialized Category - *Age of structures*	*Government*	2.083	3.671	2	8.00	2	8.00	2	8.00	3	12.00	0	0.00	9	25	36.00	100.00
	Developer	0.794		1	4.00	1	4.00	3	12.00	4	16.00	0	0.00	9		36.00	
	Contractor	0.794		0	0.00	1	4.00	2	8.00	4	16.00	0	0.00	7		28.00	
Weighted Percentage Mean (%)				**5.40**		**6.27**		**8.87**		**13.73**		**0.00**		**34.27 %**			
Equivalent Percentage (%)				**15.76**		**18.30**		**25.88**		**40.06**		**0.00**		**100.00 %**			

Table C28: Frequency ranking of demolition concepts.

Section 3: Demolition Techniques Question 3.1	**Strata 3 Components**	**Weights**		**Not used**	**Seldom used**	**Average**	**Often used**	**Highly used**	**Total response**		**Mean**	**Weighted mean**	**Rank**
				1	**2**	**3**	**4**	**5**					
***Progressive Demolition* - controlled removal of sections in a structure whilst retaining its stability in order to avoid collapse during the works**	*Government*	2.083	3.671	0	0	2	3	1	6	37	3.83	3.80	**1**
	Developer	0.794		0	3	4	5	4	16		3.63		
	Contractor	0.794		0	1	4	6	4	15		3.87		
***Deliberate Collapse Mechanisms* - removal of key structural members to cause complete collapse of the whole or part of the structure**	*Government*	2.083	3.671	1	4	1	0	0	6	37	2.00	2.24	**3**
	Developer	0.794		3	5	4	4	0	16		2.56		
	Contractor	0.794		3	6	2	3	1	15		2.53		
***Deliberate Removal of Elements* - removal of selected parts of the structure by dismantling**	*Government*	2.083	3.671	0	0	3	3	0	6	37	3.50	3.32	**2**
	Developer	0.794		0	4	10	2	0	16		2.88		
	Contractor	0.794		1	3	5	3	3	15		3.27		

Table C29: Frequency ranking of demolition techniques.

<u>Section 3</u>: Demolition Techniques Question 3.2	Strata 3 Components	Weights		Not used	Seldom used	Average	Often used	Highly used	Total response		Mean	Weighted mean	Rank
				1	2	3	4	5					
Demolition by Hand **- various hammers, cutting by diamond drilling and sawing, bursting, crushing and splitting**	*Government*	2.083	3.671	0	1	1	2	2	6	37	3.83	3.65	**2**
	Developer	0.794		0	2	5	9	0	16		3.44		
	Contractor	0.794		1	1	5	7	1	15		3.40		
Demolition by Towers and High Reach Cranes	*Government*	2.083	3.671	0	2	2	2	0	6	37	3.00	2.86	**3**
	Developer	0.794		0	4	9	3	0	16		2.94		
	Contractor	0.794		3	6	3	3	0	15		2.40		
Demolition by Machines with mechanical attachments **- balling, wire rope pulling**	*Government*	2.083	3.671	1	2	2	1	0	6	37	2.50	2.70	**4**
	Developer	0.794		0	4	9	3	0	16		2.94		
	Contractor	0.794		1	3	7	3	1	15		3.00		
Demolition by Machines with hydraulic attachments **- shear, impact hammer, grinder, grapple, crusher, processor**	*Government*	2.083	3.671	1	0	1	2	2	6	37	3.67	3.75	**1**
	Developer	0.794		0	0	9	6	1	16		3.50		
	Contractor	0.794		0	0	3	6	6	15		4.20		
Demolition by Chemical Agents **- gas expansion bursters, expanding demolition agents, flame cutting, thermic lancing, explosives**	*Government*	2.083	3.671	3	2	1	0	0	6	37	1.67	1.91	**5**
	Developer	0.794		2	9	5	0	0	16		2.19		
	Contractor	0.794		3	7	3	2	0	15		2.27		
Demolition by Water Jetting	*Government*	2.083	3.671	4	2	0	0	0	6	37	1.33	1.55	**6**
	Developer	0.794		5	6	5	0	0	16		2.00		
	Contractor	0.794		8	4	3	0	0	15		1.67		

Table C30: Respondents' capability rating of demolition techniques.

<u>Section 3</u>: Demolition Techniques Question 3.3	Strata 3 Components	Weights		Totally not capable		Not capable		Average		Capable		Highly capable		Total Response			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Demolition by Hand	*Government*	2.083	3.671	0	0.00	2	5.41	1	2.70	2	5.41	1	2.70	6	37	16.22	100.00
	Developer	0.794		0	0.00	4	10.81	6	16.22	5	13.51	1	2.70	16		43.24	
	Contractor	0.794		2	5.41	1	2.70	6	16.22	3	8.11	3	8.11	15		40.54	
Weighted Percentage Mean (%)				**1.17**		**5.99**		**8.55**		**7.75**		**3.87**		**27.32 %**			
Equivalent Percentage (%)				**4.28**		**21.93**		**31.30**		**28.37**		**14.17**		**100.00 %**			
Demolition by Towers and High Reach Cranes	*Government*	2.083	3.671	0	0.00	2	5.41	0	0.00	4	10.81	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	3	8.11	9	24.32	3	8.11	1	2.70	16		43.24	
	Contractor	0.794		0	0.00	6	16.22	3	8.11	3	8.11	3	8.11	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**8.33**		**7.01**		**9.64**		**2.34**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**30.49**		**25.66**		**35.29**		**8.57**		**100.00 %**			
Demolition by Machines with mechanical attachments	*Government*	2.083	3.671	0	0.00	2	5.41	0	0.00	2	5.41	2	5.41	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	7	18.92	8	21.62	0	0.00	16		43.24	
	Contractor	0.794		0	0.00	0	0.00	3	8.11	7	18.92	5	13.51	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**3.65**		**5.85**		**11.84**		**5.99**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**13.56**		**21.41**		**43.34**		**21.93**		**100.00 %**			
Demolition by Machines with hydraulic attachments	*Government*	2.083	3.671	0	0.00	1	2.70	0	0.00	3	8.11	2	5.41	6	37	16.22	100.00
	Developer	0.794		0	0.00	2	5.41	5	13.51	8	21.62	1	2.70	16		43.24	
	Contractor	0.794		0	0.00	0	0.00	2	5.41	6	16.22	7	18.92	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**2.70**		**4.09**		**12.79**		**7.75**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**9.88**		**14.97**		**46.82**		**28.37**		**100.00 %**			
Demolition by Chemical Agents	*Government*	2.083	3.671	0	0.00	4	10.81	1	2.70	0	0.00	1	2.70	6	37	16.22	100.00
	Developer	0.794		1	2.70	6	16.22	6	16.22	3	8.11	0	0.00	16		43.24	
	Contractor	0.794		4	10.81	4	10.81	5	13.51	1	2.70	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**2.92**		**11.98**		**7.96**		**2.34**		**2.12**		**27.32 %**			
Equivalent Percentage (%)				**10.69**		**43.85**		**29.14**		**8.57**		**7.76**		**100.00 %**			

Table C30 (Cont.): Respondents' capability rating of demolition techniques.

Section 3: Demolition Techniques Question 3.3 (Cont.)	**Strata 3 Components**	**Weights**		**Totally not capable**		**Not capable**		**Average**		**Capable**		**Highly capable**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Demolition by Water Jetting	*Government*	2.083	3.671	0	0.00	4	10.81	2	5.41	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		3	8.11	7	18.92	6	16.22	0	0.00	0	0.00	16		43.24	
	Contractor	0.794		4	10.81	6	16.22	4	10.81	1	2.70	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**4.09**		**13.73**		**8.92**		**0.58**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**14.97**		**50.26**		**32.65**		**2.12**		**0.00**		**100.00 %**			

Table C31: Significance ranking pertaining to demolition techniques selection criteria.

Section 3: Demolition Techniques Question 3.4	**Strata 3 Components**	**Weights**		**Totally not significant**	**Not significant**	**Average**	**Significant**	**Highly significant**	**Total response**		**Mean**	**Weighted mean**	**Rank**
				1	**2**	**3**	**4**	**5**					
Structural form of the structure	*Government*	2.083	3.671	0	0	1	3	2	6	37	4.17	4.19	**2**
	Developer	0.794		0	0	4	9	3	16		3.94		
	Contractor	0.794		0	0	2	4	9	15		4.47		
Scale and extent of demolition	*Government*	2.083	3.671	0	0	1	3	2	6	37	4.17	4.09	**3**
	Developer	0.794		0	0	4	10	2	16		3.88		
	Contractor	0.794		0	0	3	8	4	15		4.07		
Location of the structure, degree of confinement and adjacent structures	*Government*	2.083	3.671	0	0	1	3	2	6	37	4.17	4.24	**1**
	Developer	0.794		0	0	3	4	9	16		4.38		
	Contractor	0.794		0	1	1	6	7	15		4.27		
Permitted levels of nuisance	*Government*	2.083	3.671	0	0	3	2	1	6	37	3.67	3.70	**9**
	Developer	0.794		0	0	5	9	2	16		3.81		
	Contractor	0.794		0	1	5	7	2	15		3.67		
Previous use of the structure	*Government*	2.083	3.671	0	2	4	0	0	6	37	2.67	2.94	**13**
	Developer	0.794		2	0	7	7	0	16		3.19		
	Contractor	0.794		0	1	9	3	2	15		3.40		

Table C31 (Cont.): Significance ranking pertaining to demolition techniques selection criteria.

Section 3: Demolition Techniques Question 3.4 (Cont.)	**Strata 3 Components**	**Weights**		**Totally not significant (1)**	**Not significant (2)**	**Average (3)**	**Significant (4)**	**Highly significant (5)**	**Total response**		**Mean**	**Weighted mean**	**Rank**
Health and safety considerations	*Government*	2.083	3.671	0	0	2	3	1	6	37	3.83	4.00	**5**
	Developer	0.794		0	0	4	5	7	16		4.19		
	Contractor	0.794		0	0	3	5	7	15		4.27		
Environmental considerations	*Government*	2.083	3.671	0	0	2	4	0	6	37	3.67	3.86	**7**
	Developer	0.794		0	0	4	6	6	16		4.13		
	Contractor	0.794		0	0	4	6	5	15		4.07		
Time constraint	*Government*	2.083	3.671	0	0	0	6	0	6	37	4.00	3.86	**7**
	Developer	0.794		0	2	4	8	2	16		3.63		
	Contractor	0.794		0	0	6	7	2	15		3.73		
Past experience on a particular project	*Government*	2.083	3.671	0	0	3	3	0	6	37	3.50	3.58	**11**
	Developer	0.794		0	0	7	9	0	16		3.56		
	Contractor	0.794		0	0	6	6	3	15		3.80		
The management and transportation of the generated wastes and debris	*Government*	2.083	3.671	0	1	4	1	0	6	37	3.00	3.21	**12**
	Developer	0.794		0	1	8	6	1	16		3.44		
	Contractor	0.794		0	1	7	5	2	15		3.53		
The requirement for reuse & recycling	*Government*	2.083	3.671	0	3	2	1	0	6	37	2.67	2.87	**14**
	Developer	0.794		0	2	9	4	1	16		3.25		
	Contractor	0.794		0	4	8	2	1	15		3.00		
Monetary cost	*Government*	2.083	3.671	0	0	1	4	1	6	37	4.00	4.08	**4**
	Developer	0.794		0	0	3	6	7	16		4.25		
	Contractor	0.794		0	0	2	9	4	15		4.13		
Client's specification	*Government*	2.083	3.671	0	1	2	2	1	6	37	3.50	3.60	**10**
	Developer	0.794		0	0	5	7	4	16		3.94		
	Contractor	0.794		1	1	3	9	1	15		3.53		
Stability of the structure	*Government*	2.083	3.671	0	1	2	2	1	6	37	3.50	3.86	**7**
	Developer	0.794		0	0	2	6	8	16		4.38		
	Contractor	0.794		0	0	2	7	6	15		4.27		

Table C31 (Cont.): Significance ranking pertaining to demolition techniques selection criteria.

Section 3: Demolition Techniques Question 3.4 (Cont.)	**Strata 3 Components**	**Weights**		**Totally not significant**	**Not significant**	**Average**	**Significant**	**Highly significant**	**Total response**		**Mean**	**Weighted mean**	**Rank**
				1	**2**	**3**	**4**	**5**					
The suitability of the structure to adapt to the technique(s) selected	*Government*	2.083	3.671	0	0	3	2	1	6	37	3.67	3.87	**6**
	Developer	0.794		0	0	4	7	5	16		4.06		
	Contractor	0.794		0	0	2	8	5	15		4.20		
Equipment & machinery performance requirements, efficiency and speed	*Government*	2.083	3.671	0	0	2	4	0	6	37	3.67	3.74	**8**
	Developer	0.794		0	0	5	8	3	16		3.88		
	Contractor	0.794		0	0	5	8	2	15		3.80		

Table C32: Frequency ranking of accident and injury causes.

Section 4: Demolition H & S Question 4.1	Strata 3 Components	Weights		Very rarely	Rarely	Average	Frequently	Very frequently	Total response		Mean	Weighted mean	Rank
				1	2	3	4	5					
Unsafe attitude, i.e. negligence	*Government*	2.083	3.671	0	1	1	3	1	6	37	3.67	3.83	**1**
	Developer	0.794		0	0	3	8	4	16		3.81		
	Contractor	0.794		0	1	2	4	8	15		4.27		
Not wearing proper protective gear	*Government*	2.083	3.671	0	1	2	3	0	6	37	3.33	3.48	**4**
	Developer	0.794		0	1	4	9	2	16		3.75		
	Contractor	0.794		1	2	2	7	3	15		3.60		
Lack of knowledge and experience	*Government*	2.083	3.671	0	2	1	3	0	6	37	3.17	3.35	**5**
	Developer	0.794		0	1	5	8	2	16		3.69		
	Contractor	0.794		0	3	4	6	2	15		3.47		
Poor site management	*Government*	2.083	3.671	0	0	1	5	0	6	37	3.83	3.72	**2**
	Developer	0.794		0	2	3	7	4	16		3.81		
	Contractor	0.794		0	2	7	5	1	15		3.33		
Unsafe procedures at the workplace	*Government*	2.083	3.671	0	0	2	4	0	6	37	3.67	3.69	**3**
	Developer	0.794		0	2	3	7	4	16		3.81		
	Contractor	0.794		0	2	4	7	2	15		3.60		
Unsafe conditions, i.e. hazardous materials, dangerous elevations	*Government*	2.083	3.671	0	1	3	2	0	6	37	3.17	3.25	**6**
	Developer	0.794		1	2	4	6	3	16		3.50		
	Contractor	0.794		0	4	4	7	0	15		3.20		

Table C33: Agreement ranking of difficulties encountered in H & S implementation.

Section 4: Demolition H & S Question 4.2	Strata 3 Components	Weights		Totally disagree	Disagree	Average	Agree	Strongly agree	Total response		Mean	Weighted mean	Rank
				1	2	3	4	5					
Care free attitude of workers	*Government*	2.083	3.671	0	0	2	2	2	6	37	4.00	3.99	**1**
	Developer	0.794		0	0	4	9	3	16		3.94		
	Contractor	0.794		0	1	3	6	5	15		4.00		
Unavoidable hazardous conditions at the project site	*Government*	2.083	3.671	0	0	3	3	0	6	37	3.50	3.32	**4**
	Developer	0.794		1	1	7	6	1	16		3.31		
	Contractor	0.794		0	3	11	1	0	15		2.87		
Lack of cooperation between workers and management	*Government*	2.083	3.671	0	0	2	4	0	6	37	3.67	3.49	**3**
	Developer	0.794		0	1	9	3	3	16		3.50		
	Contractor	0.794		0	5	7	1	2	15		3.00		
Poor H & S monitoring and enforcement	*Government*	2.083	3.671	0	0	1	4	1	6	37	4.00	3.83	**2**
	Developer	0.794		0	0	5	9	2	16		3.81		
	Contractor	0.794		0	1	8	5	1	15		3.40		

Table C34: Percentage of responses pertaining to the issue of proper deconstruction.

Section 5: Demolition Waste Management Question 5.1	**Strata 3 Components**	**Weights**		**Yes**		**No**		**Unsure**		**Total Response**			
					%		**%**		**%**	**Nos.**		**%**	
Selection of deconstruction techniques to salvage materials prior to demolition for reuse or recycling	*Government*	2.083	3.671	1	2.70	2	5.41	3	8.11	6	37	16.22	100.00
	Developer	0.794		11	29.73	4	10.81	1	2.70	16		43.24	
	Contractor	0.794		12	32.43	2	5.41	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**14.98**		**6.58**		**5.77**		**27.32 %**			
Equivalent Percentage (%)				**54.83**		**24.05**		**21.12**		**100.00 %**			

Table C35: Percentage of responses pertaining to the issue of on-site separation.

Section 5: Demolition Waste Management Question 5.2	**Strata 3 Components**	**Weights**		**Yes**		**No**		**Unsure**		**Total Response**			
					%		**%**		**%**	**Nos.**		**%**	
On-site separation of demolition debris and waste materials	*Government*	2.083	3.671	3	8.11	2	5.41	1	2.70	6	37	16.22	100.00
	Developer	0.794		10	27.03	6	16.22	0	0.00	16		43.24	
	Contractor	0.794		12	32.43	2	5.41	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**17.46**		**7.75**		**2.12**		**27.32 %**			
Equivalent Percentage (%)				**63.89**		**28.36**		**7.76**		**100.00 %**			

Table C36: Frequency rating of reused/ recycled waste materials.

Section 5: Demolition Waste Mgmt. Part A – Reused/ Recycled Question 5.3	**Strata 3 Components**	**Weights**		**Very rarely**		**Rarely**		**Average**		**Frequently**		**Very frequently**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Concrete	*Government*	2.083	3.671	1	2.70	2	5.41	1	2.70	2	5.41	0	0.00	6	37	16.22	100.00
	Developer	0.794		10	27.03	4	10.81	0	0.00	2	5.41	0	0.00	16		43.24	
	Contractor	0.794		9	24.32	2	5.41	2	5.41	0	0.00	2	5.41	15		40.54	
Weighted Percentage Mean (%)				**12.64**		**6.58**		**2.70**		**4.24**		**1.17**		**27.32 %**			
Equivalent Percentage (%)				**46.27**		**24.09**		**9.88**		**15.52**		**4.28**		**100.00 %**			
Steel	*Government*	2.083	3.671	0	0.00	0	0.00	2	5.41	2	5.41	2	5.41	6	37	16.22	100.00
	Developer	0.794		2	5.41	1	2.70	2	5.41	9	24.32	2	5.41	16		43.24	
	Contractor	0.794		1	2.70	1	2.70	3	8.11	3	8.11	7	18.92	15		40.54	
Weighted Percentage Mean (%)				**1.75**		**1.17**		**5.99**		**10.08**		**8.33**		**27.32 %**			
Equivalent Percentage (%)				**6.41**		**4.28**		**21.93**		**36.90**		**30.50**		**100.00 %**			
Other metals	*Government*	2.083	3.671	0	0.00	1	2.70	3	8.11	2	5.41	0	0.00	6	37	16.22	100.00
	Developer	0.794		2	5.41	2	5.41	3	8.11	7	18.92	2	5.41	16		43.24	
	Contractor	0.794		2	5.41	2	5.41	5	13.51	3	8.11	3	8.11	15		40.54	
Weighted Percentage Mean (%)				**2.34**		**3.87**		**9.28**		**8.92**		**2.92**		**27.32 %**			
Equivalent Percentage (%)				**8.57**		**14.17**		**33.97**		**32.65**		**10.69**		**100.00 %**			
Masonry	*Government*	2.083	3.671	1	2.70	3	8.11	2	5.41	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		8	21.62	4	10.81	3	8.11	1	2.70	0	0.00	16		43.24	
	Contractor	0.794		6	16.22	4	10.81	3	8.11	2	5.41	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**9.72**		**9.28**		**6.58**		**1.75**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**35.57**		**33.96**		**24.08**		**6.41**		**0.00**		**100.00 %**			
Timber/ Wood	*Government*	2.083	3.671	0	0.00	0	0.00	4	10.81	2	5.41	0	0.00	6	37	16.22	100.00
	Developer	0.794		3	8.11	4	10.81	7	18.92	2	5.41	0	0.00	16		43.24	
	Contractor	0.794		4	10.81	6	16.22	4	10.81	0	0.00	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**4.09**		**5.85**		**12.56**		**4.24**		**0.58**		**27.32 %**			
Equivalent Percentage (%)				**14.97**		**21.41**		**45.97**		**15.53**		**2.12**		**100.00 %**			

Table C36 (Cont.): Frequency rating of reused/ recycled waste materials.

Section 5: Demolition Waste Mgmt. Part A – Reused/ Recycled Question 5.3 (Cont.)	**Strata 3 Components**	**Weights**		**Very rarely**		**Rarely**		**Average**		**Frequently**		**Very frequently**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Asphalt	*Government*	2.083	3.671	2	5.41	2	5.41	2	5.41	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		9	24.32	4	10.81	2	5.41	1	2.70	0	0.00	16		43.24	
	Contractor	0.794		9	24.32	3	8.11	2	5.41	0	0.00	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**13.59**		**7.16**		**5.41**		**0.58**		**0.58**		**27.32 %**			
Equivalent Percentage (%)				**49.74**		**26.21**		**19.81**		**2.12**		**2.12**		**100.00 %**			
Plastics/ Vinyl	*Government*	2.083	3.671	1	2.70	4	10.81	1	2.70	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		8	21.62	8	21.62	0	0.00	0	0.00	0	0.00	16		43.24	
	Contractor	0.794		8	21.62	4	10.81	2	5.41	1	2.70	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**10.88**		**13.15**		**2.70**		**0.58**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**39.82**		**48.18**		**9.88**		**2.12**		**0.00**		**100.00 %**			
Insulation material	*Government*	2.083	3.671	2	5.41	3	8.11	1	2.70	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		10	27.03	5	13.51	1	2.70	0	0.00	0	0.00	16		43.24	
	Contractor	0.794		8	21.62	6	16.22	0	0.00	1	2.70	0	0.00	15		40.54	
Weighted Percentage Mean (%)				**13.59**		**11.03**		**2.12**		**0.58**		**0.00**		**27.32 %**			
Equivalent Percentage (%)				**49.74**		**40.37**		**7.77**		**2.12**		**0.00**		**100.00 %**			

Table C37: Frequency rating of disposed waste materials.

Section 5: Demolition Waste Mgmt. Part B – Disposed Question 5.3	**Strata 3 Components**	**Weights**		**Very rarely**		**Rarely**		**Average**		**Frequently**		**Very frequently**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Concrete	*Government*	2.083	3.671	0	0.00	1	2.70	2	5.41	1	2.70	2	5.41	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	2	5.41	10	27.03	3	8.11	16		43.24	
	Contractor	0.794		1	2.70	0	0.00	3	8.11	2	5.41	9	24.32	15		40.54	
Weighted Percentage Mean (%)				**0.58**		**2.12**		**5.99**		**8.55**		**10.08**		**27.32 %**			
Equivalent Percentage (%)				**2.12**		**7.76**		**21.93**		**31.30**		**36.90**		**100.00 %**			
Steel	*Government*	2.083	3.671	3	8.11	0	0.00	3	8.11	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		4	10.81	7	18.92	2	5.41	2	5.41	1	2.70	16		43.24	
	Contractor	0.794		8	21.62	4	10.81	0	0.00	2	5.41	1	2.70	15		40.54	
Weighted Percentage Mean (%)				**11.62**		**6.43**		**5.77**		**2.34**		**1.17**		**27.32 %**			
Equivalent Percentage (%)				**42.53**		**23.54**		**21.12**		**8.57**		**4.28**		**100.00 %**			
Other metals	*Government*	2.083	3.671	0	0.00	1	2.70	5	13.51	0	0.00	0	0.00	6	37	16.22	100.00
	Developer	0.794		2	5.41	7	18.92	2	5.41	3	8.11	2	5.41	16		43.24	
	Contractor	0.794		5	13.51	3	8.11	4	10.81	1	2.70	2	5.41	15		40.54	
Weighted Percentage Mean (%)				**4.09**		**7.38**		**11.17**		**2.34**		**2.34**		**27.32 %**			
Equivalent Percentage (%)				**14.97**		**27.01**		**40.89**		**8.57**		**8.57**		**100.00 %**			
Masonry	*Government*	2.083	3.671	0	0.00	0	0.00	3	8.11	2	5.41	1	2.70	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	2	5.41	10	27.03	3	8.11	16		43.24	
	Contractor	0.794		1	2.70	2	5.41	2	5.41	4	10.81	6	16.22	15		40.54	
Weighted Percentage Mean (%)				**0.58**		**1.75**		**6.94**		**11.25**		**6.79**		**27.32 %**			
Equivalent Percentage (%)				**2.12**		**6.43**		**25.42**		**41.18**		**24.85**		**100.00 %**			
Timber/ Wood	*Government*	2.083	3.671	0	0.00	1	2.70	4	10.81	1	2.70	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	8	21.62	5	13.51	2	5.41	16		43.24	
	Contractor	0.794		0	0.00	1	2.70	6	16.22	5	13.51	3	8.11	15		40.54	
Weighted Percentage Mean (%)				**0.00**		**2.70**		**14.32**		**7.38**		**2.92**		**27.32 %**			
Equivalent Percentage (%)				**0.00**		**9.88**		**52.42**		**27.01**		**10.69**		**100.00 %**			

Table C37 (Cont.): Frequency rating of disposed waste materials.

Section 5: Demolition Waste Mgmt. Part B – Disposed Question 5.3 (Cont.)	**Strata 3 Components**	**Weights**		**Very rarely**		**Rarely**		**Average**		**Frequently**		**Very frequently**		**Total Response**			
				1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**Nos.**		**%**	
Asphalt	*Government*	2.083	3.671	0	0.00	1	2.70	2	5.41	2	5.41	1	2.70	6	37	16.22	100.00
	Developer	0.794		0	0.00	2	5.41	2	5.41	9	24.32	3	8.11	16		43.24	
	Contractor	0.794		1	2.70	1	2.70	2	5.41	4	10.81	7	18.92	15		40.54	
Weighted Percentage Mean (%)				**0.58**		**3.29**		**5.41**		**10.67**		**7.38**		**27.32 %**			
Equivalent Percentage (%)				**2.12**		**12.04**		**19.80**		**39.06**		**27.01**		**100.00 %**			
Plastics/ Vinyl	*Government*	2.083	3.671	0	0.00	1	2.70	2	5.41	3	8.11	0	0.00	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	0	0.00	10	27.03	5	13.51	16		43.24	
	Contractor	0.794		1	2.70	0	0.00	4	10.81	5	13.51	5	13.51	15		40.54	
Weighted Percentage Mean (%)				**0.58**		**2.12**		**5.41**		**13.37**		**5.84**		**27.32 %**			
Equivalent Percentage (%)				**2.12**		**7.76**		**19.80**		**48.94**		**21.38**		**100.00 %**			
Insulation material	*Government*	2.083	3.671	0	0.00	0	0.00	2	5.41	3	8.11	1	2.70	6	37	16.22	100.00
	Developer	0.794		0	0.00	1	2.70	1	2.70	8	21.62	6	16.22	16		43.24	
	Contractor	0.794		1	2.70	1	2.70	2	5.41	7	18.92	4	10.81	15		40.54	
Weighted Percentage Mean (%)				**0.58**		**1.17**		**4.82**		**13.37**		**7.38**		**27.32 %**			
Equivalent Percentage (%)				**2.12**		**4.28**		**17.64**		**48.94**		**27.02**		**100.00 %**			

Table C38: Frequency ranking of solid waste utilization.

Section 5: Demolition Waste Management Question 5.4	**Strata 3 Components**	**Weights**		**Very rarely**	**Rarely**	**Average**	**Frequently**	**Very frequently**	**Total response**		**Mean**	**Weighted mean**	**Rank**
				1	**2**	**3**	**4**	**5**					
Concrete used as recycled aggregates	*Government*	2.083	3.671	2	2	0	2	0	6	37	2.33	2.29	**7**
	Developer	0.794		3	10	2	1	0	16		2.06		
	Contractor	0.794		4	5	4	0	2	15		2.40		
Masonry used as recycled soil	*Government*	2.083	3.671	0	4	1	1	0	6	37	2.50	2.41	**5**
	Developer	0.794		3	7	4	2	0	16		2.31		
	Contractor	0.794		4	8	0	1	2	15		2.27		
Asphalt processed and reused in new pavement construction	*Government*	2.083	3.671	0	5	0	1	0	6	37	2.33	2.35	**6**
	Developer	0.794		0	9	4	3	0	16		2.63		
	Contractor	0.794		4	6	4	1	0	15		2.13		
Concrete & masonry used as road base courses and drainage bedding layers	*Government*	2.083	3.671	0	2	1	3	0	6	37	3.17	3.03	**4**
	Developer	0.794		1	5	8	2	0	16		2.69		
	Contractor	0.794		3	1	7	1	3	15		3.00		
Concrete & masonry used for landfill engineering or restoration	*Government*	2.083	3.671	0	1	1	3	1	6	37	3.67	3.40	**2**
	Developer	0.794		1	4	9	2	0	16		2.75		
	Contractor	0.794		0	2	8	3	2	15		3.33		
Concrete & masonry used as backfill material, for embankment construction	*Government*	2.083	3.671	0	1	2	3	0	6	37	3.33	3.08	**3**
	Developer	0.794		0	6	9	1	0	16		2.69		
	Contractor	0.794		2	6	2	3	2	15		2.80		
Disposed off at landfills	*Government*	2.083	3.671	0	1	0	2	3	6	37	4.17	3.91	**1**
	Developer	0.794		0	2	8	6	0	16		3.25		
	Contractor	0.794		0	1	4	6	4	15		3.87		

Table C39: Agreement ranking pertaining to demolition recycling conceptions.

Section 5: Demolition Waste Management Question 5.5	**Strata 3 Components**	**Weights**		**Totally disagree**	**Disagree**	**Average**	**Agree**	**Strongly agree**	**Total response**		**Mean**	**Weighted mean**	**Rank**
				1	**2**	**3**	**4**	**5**					
Recycling delays the project completion	*Government*	2.083	3.671	0	2	2	2	0	6	37	3.00	2.92	**6**
	Developer	0.794		0	7	6	2	1	16		2.81		
	Contractor	0.794		1	5	5	4	0	15		2.80		
There is usually insufficient space on site to recycle	*Government*	2.083	3.671	0	1	1	4	0	6	37	3.50	3.51	**4**
	Developer	0.794		0	4	5	7	0	16		3.19		
	Contractor	0.794		0	1	2	10	2	15		3.87		
The requirements for separate waste containers and the presence of a variety of waste material makes recycling complicated	*Government*	2.083	3.671	0	0	2	3	1	6	37	3.83	3.70	**3**
	Developer	0.794		0	1	7	8	0	16		3.44		
	Contractor	0.794		0	2	3	9	1	15		3.60		
There are insufficient contract provisions and specifications on recycling	*Government*	2.083	3.671	0	0	2	4	0	6	37	3.67	3.73	**2**
	Developer	0.794		0	1	6	8	1	16		3.56		
	Contractor	0.794		0	1	1	9	4	15		4.07		
Recycling is costly	*Government*	2.083	3.671	0	2	0	4	0	6	37	3.33	3.24	**5**
	Developer	0.794		0	4	6	5	1	16		3.19		
	Contractor	0.794		0	4	6	5	0	15		3.07		
It is difficult to get contractors or sub-cons to cooperate and participate in recycling	*Government*	2.083	3.671	0	1	0	4	1	6	37	3.83	3.79	**1**
	Developer	0.794		0	1	5	7	3	16		3.75		
	Contractor	0.794		0	1	4	8	2	15		3.73		

Table C40: Agreement ranking of barriers affecting demolition recycling efforts.

Section 5: Demolition Waste Management Question 5.6	Strata 3 Components	Weights		Totally disagree	Disagree	Average	Agree	Strongly agree	Total response		Mean	Weighted mean	Rank
				1	2	3	4	5					
Demolition debris are not statutorily banned from landfill disposal	*Government*	2.083	3.671	0	0	1	5	0	6	37	3.83	3.72	**5**
	Developer	0.794		0	2	5	8	1	16		3.50		
	Contractor	0.794		0	0	7	6	2	15		3.67		
Insufficient recycling facilities	*Government*	2.083	3.671	0	0	1	5	0	6	37	3.83	3.82	**4**
	Developer	0.794		0	0	5	9	2	16		3.81		
	Contractor	0.794		0	1	3	9	2	15		3.80		
Lack of recycling education and awareness	*Government*	2.083	3.671	0	0	1	4	1	6	37	4.00	3.93	**2**
	Developer	0.794		0	0	3	11	2	16		3.94		
	Contractor	0.794		0	0	6	7	2	15		3.73		
No demand for recycled content products or materials	*Government*	2.083	3.671	0	0	0	4	2	6	37	4.33	3.94	**1**
	Developer	0.794		0	3	6	5	2	16		3.38		
	Contractor	0.794		0	2	6	5	2	15		3.47		
Inadequate cost-benefit data	*Government*	2.083	3.671	0	0	1	4	1	6	37	4.00	3.86	**3**
	Developer	0.794		0	0	7	7	2	16		3.69		
	Contractor	0.794		0	1	4	9	1	15		3.67		

Table C41: Frequency ranking on pollution types encountered during demolition works.

Section 5: Demolition Waste Management Question 5.7	Strata 3 Components	Weights		Very rarely	Rarely	Average	Frequently	Very frequently	Total response		Mean	Weighted mean	Rank
				1	**2**	**3**	**4**	**5**					
Air pollution	*Government*	2.083	3.671	1	0	1	1	3	6	37	3.83	3.80	**2**
	Developer	0.794		0	1	5	9	1	16		3.63		
	Contractor	0.794		0	2	2	7	4	15		3.87		
Noise pollution	*Government*	2.083	3.671	0	0	2	2	2	6	37	4.00	4.00	**1**
	Developer	0.794		0	1	3	9	3	16		3.88		
	Contractor	0.794		0	0	4	5	6	15		4.13		
Water pollution	*Government*	2.083	3.671	0	2	3	1	0	6	37	2.83	3.06	**4**
	Developer	0.794		0	0	9	7	0	16		3.44		
	Contractor	0.794		0	1	9	5	0	15		3.27		
Soil contamination	*Government*	2.083	3.671	1	2	3	0	0	6	37	2.33	2.63	**5**
	Developer	0.794		0	3	6	6	1	16		3.31		
	Contractor	0.794		1	5	6	3	0	15		2.73		
Vibration	*Government*	2.083	3.671	0	2	2	1	1	6	37	3.17	3.43	**3**
	Developer	0.794		0	2	4	7	3	16		3.69		
	Contractor	0.794		0	0	6	5	4	15		3.87		

Table C42: Agreement ranking of setbacks faced in tackling environmental issues.

Section 5: Demolition Waste Management Question 5.8	Strata 3 Components	Weights		Totally disagree	Disagree	Average	Agree	Strongly agree	Total response		Mean	Weighted mean	Rank
				1	2	3	4	5					
The nature of the demolition works itself	*Government*	2.083	3.671	0	0	1	5	0	6	37	3.83	3.63	**3**
	Developer	0.794		0	2	8	6	0	16		3.25		
	Contractor	0.794		1	0	5	9	0	15		3.47		
Weather conditions	*Government*	2.083	3.671	0	1	3	2	0	6	37	3.17	3.15	**6**
	Developer	0.794		0	3	8	5	0	16		3.13		
	Contractor	0.794		1	1	8	5	0	15		3.13		
Lack of initiative and commitment from other project parties	*Government*	2.083	3.671	0	0	3	3	0	6	37	3.50	3.56	**4**
	Developer	0.794		0	0	6	8	2	16		3.75		
	Contractor	0.794		0	1	6	7	1	15		3.53		
Inadequate contract provisions and specifications on environmental management	*Government*	2.083	3.671	0	0	2	4	0	6	37	3.67	3.55	**5**
	Developer	0.794		0	2	5	7	2	16		3.56		
	Contractor	0.794		0	2	8	5	0	15		3.20		
Lack of environmental education and awareness	*Government*	2.083	3.671	0	0	0	6	0	6	37	4.00	3.81	**2**
	Developer	0.794		0	0	6	9	1	16		3.69		
	Contractor	0.794		0	2	6	6	1	15		3.40		
Cost implications	*Government*	2.083	3.671	0	0	0	4	2	6	37	4.33	4.11	**1**
	Developer	0.794		0	1	7	4	4	16		3.69		
	Contractor	0.794		0	1	2	9	3	15		3.93		

APPENDIX D

RM800m terminal conversion

Subang's Terminal One will be developed as part of an aerospace hub plan

NICHE SERVICE : An artist's impression (front and back view) of the aircraft conversion and landing gear centre; (Inset) Ahmad

■ **By FAUZIAH ISMAIL**

NADI and its joint-venture partners will invest RM800 million to re-develop Terminal One of the Sultan Abdul Aziz Shah Airport in Subang into an independent commercial maintenance, repair and overhaul (MRO), passenger-to-freighter (PTF) aircraft conversion and landing gear centre.

Nadi (National Aerospace and Defence Industries Bhd), through subsidiary Subang Aviation Services Sdn Bhd (SAS) and its joint-venture partners, is to establish the centre within the next two years.

Its first 747-400 passenger-to-freighter conversion is expected in 2008. Commercial and landing gear MRO can already be undertaken at Nadi's Airod facility in Subang.

The project is a component of the proposed Malaysian International Aerospace Centre (MIAC), which will be launched by Prime Minister Datuk Seri Abdullah Ahmad Badawi today.

MIAC is aimed at positioning Malaysia as a leading player in the aviation and aerospace industry in the Asia-Pacific region.

Under Nadi's plans for Terminal One, of which the land is leased from Malaysian Airports Holding Bhd, there will be four wide-body aircraft (B747-400) and three narrow-body aircraft (B737-400) hangars and supporting and backshop facilities to support total airframe MRO.

Nadi has teamed up with AAR LGS of the US for the establishment of the landing gear facility while it is finalising details with a technology provider for the PTF conversion facility. The technology provider will outsource all B737-400 conversion to SAS.

The landing gear facility alone is expected to require investments of up to US$15 million (US$1 = RM3.75) while the PTF conversion facility is expected to cost US$26 million.

Once in operation, SAS hopes to undertake MRO of 12 wide-body Boeings and convert nine 737 passenger aircraft into freighters a year.

The PTF conversion business is expected to contribute 70 per cent to SAS' revenue, Nadi president Tan Sri Ahmad Johan said yesterday.

"We will be among the few that will have the PTF conversion capabilities," he told a media briefing at Nadi's headquarters in Subang.

"We are in the right time-frame to provide this niche service in view of the expanding and increasing market demand for independent MRO services and cargo aircraft," he said.

Article D1: Article on the proposed Subang Airport Terminal conversion project. This project will see demolition works being carried at an extensive level. *(The New Straits Times – 12 August 2005)*

(a)

(b)

(c)

(d)

Figure D1 (a-c): Demolition works being carried out on a bungalow as part of the *Jalan Lingkaran Tengah* Project in Seremban, Negeri Sembilan; (d) All that is left standing after site clearance.

(a) (b)

(c)

Figure D2 (a): The Pekeliling Flats in Kuala Lumpur which are scheduled for demolition end of this year, (b-c) Demolition works in progress on existing shop lots in Kuala Lumpur and Seremban respectively. All these projects fall under the category of area redevelopment. Most buildings are demolished to cater for new development due to increasing land values and economic prospects.

Figure D3: Structures damaged or destroyed by fire are frequently demolished to eliminate the possibility of collapse.

Two hurt as old facade crumbles

RUBBLE EVERYWHERE: Firemen at the scene of the collapse. — NST picture by Nik Hariff Hassan

KUALA LUMPUR, Wed. — Two people were seriously injured when part of the facade of two pre-war shophouses in Jalan Sultan fell on them tonight.

The victims were a man in his 50s and an Indonesian woman in her 40s. They were taken to the Kuala Lumpur Hospital with injuries to their heads and limbs.

The unidentified man was selling lottery tickets outside one of the shophouses while the woman, whom police identified as Katrina Nona, was walking along Jalan Sultan when the incident occurred at 7pm.

Witnesses said the facade collapsed when lightning struck the buildings, but police and Fire and Rescue Department officials could not confirm this.

Dang Wangi police chief Assistant Commissioner Kamal Pasha Jamal said police were still trying to identify the injured man.

He said the Indonesian woman was still half-conscious.

Kamal Pasha said people living on the first floor of the two-storey shophouses were told to evacuate the place pending a report by a structural engineer tomorrow.

Firemen who were the first to respond to the emergency cleared the debris.

Witness A. Kanayah said he helped pull the man and the woman out of the debris after the incident.

Kanayah, who rents a room in a nearby shophouse, said he saw the man being hit on the head by falling debris.

"He was knocked unconscious and I think that was when more debris fell on his leg and broke it.

"I also saw the woman being hit as she walked by.

"Someone called the Fire and Rescue Department and one of their vans was the first vehicle to arrive.

"We put the man and woman in the van to be taken to hospital," he said.

Kanayah said the woman regained consciousness as she was being put into the van.

He said she was shocked when a fireman told her that she was hit on the head by falling debris.

Article D2: Article on the collapse of two pre-war shophouses in Kuala Lumpur. Many pre-war buildings are well above 100 years old and only time will reveal when these structures are to be demolished.
(The New Straits Times – 14 April 2005)

(b)

(b)

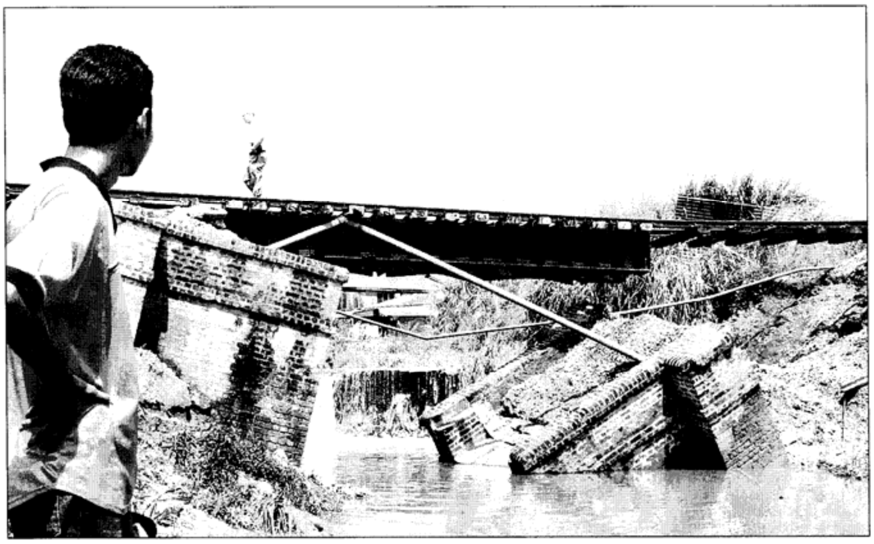
(c)

(d)

Figure D4 (a-c): These buildings have been abandoned and have deteriorated to such an extent that they are extremely dangerous. They not only become an eyesore but also provide excellent environment for drug addicts and pest breeding; (d) A clear indicator, (year 1920), reflecting the age of many existing buildings. All snapshots were taken in Seremban, Negeri Sembilan.

Train services disrupted

■ By R. Sittamparam



INTO THE RIVER: A resident looking at the collapsed bridge yesterday. — NST picture by Shahrul M. Zain

JOHOR BARU, Tues. — Northbound and southbound train services from here that were disrupted following the collapse of a railway bridge in Kulai yesterday, will be back to normal on Saturday.

Keretapi Tanah Melayu Bhd managing director Datuk Mohd Salleh Abdullah said workers were working round the clock to erect a temporary bridge over Sungai Skudai at Batu 21, Taman Nam Tak in Kulai.

Heavy rains caused Sungai Skudai to burst its banks and erode the concrete embankments supporting the bridge at Km724.4 of the Kulai-Sedenak line at 4.30pm yesterday.

The incident severed all rail links between the north and south from here. An average of eight train services ply that route daily.

Yesterday, disaster was averted when villagers informed police of the collapsed bridge.

Trains heading south had to offload their passengers at the Kluang station, from where buses transported them to their destinations.

Speaking after visiting the erosion site, Salleh said a new bridge costing RM3 million will be built, with completion expected in 10 months.

He said until Saturday, passengers would be transferred between Kluang station and Kempas Baru station by bus.

Resident Chong Chee Heong, 54, said he heard a loud noise and rushed out to see one side of the concrete embankments in the river.

He said he informed a municipal councillor of the disaster that could happen if a train were to pass the collapsed stretch.

Salleh said KTMB would construct 11 new railway bridges in the peninsula under the Ninth Malaysia Plan, while 79 would undergo repairs or upgrading. The biggest allocation of RM20 million would be for a new bridge in Kuala Kangsar.

Article D3: Article on a collapsed rail bridge due to flooding. The bridge will be demolished to make way for a new one.
(The New Straits Times – 25 May 2005)

(a) (b)

Figure D5 (a-b): The aftermath of a massive landslide in Kuala Lumpur. Demolition is usually needed to remove and clear away debris.

APPENDIX E

(a)

(b)

(c)

Figure E1 (a-c): Demolition of a seasonal fruit stall in progress. The temporary structure was built without valid permit and was considered trespassing on government land. The works were executed under the authority of Majlis Bandaraya Melaka Bersejarah.

(a)

(b)

(c)

Figure E2 (a-c): Demolition of a dilapidated house in progress. The house posed serious danger to the public and was ideal grounds for mosquito breeding and drug addicts. The works were executed under the authority of Majlis Bandaraya Melaka Bersejarah.

(a)

(b)

Figure E3 (a-b): Demolition works in progress on an illegal slab extension over the back lane of a shop lot. The works were executed under the authority of Majlis Perbandaran Petaling Jaya.

Figure E4: Demolition of squatter houses in progress. The works were executed under the authority of Majlis Perbandaran Petaling Jaya.

Structures 'unrelated to agriculture' demolished

■ By Rosli Zakaria and Ajitpal Singh

BESUT, Sun. — The "Sky Kingdom" came tumbling down today when district office workers demolished several structures in the commune.

The demolition team arrived at 2.30pm in several lorries amid tight police security to prevent retaliation from followers of cult leader Ariffin Mohamad a.k.a. "Ayah Pin".

Officials were tight-lipped, but sources said a recent court order obtained by the district office allowed the demolition.

Ariffin's first wife Che Minah Ramli, 58, had failed to appear at the district office to explain why structures unrelated to agriculture had been erected in the commune.

The Land Office had issued a notice on July 18, giving her until yesterday to reply.

The 65-year-old Ariffin, now in hiding, had turned two hectares of agriculture land into a commune for his followers.

Among the structures demolished were a giant teapot, umbrella, an assembly area, a shelter, a concrete boat and a platform under construction.

The media were barred from entering the commune and were told to leave as the demolition exercise got underway.

Personnel from the Public Works Department, Tenaga Nasional Bhd and Syarikat Air Terengganu were also involved in the exercise.

Lorries loaded with debris were later seen leaving the area.

Sources say demolition work would be completed tonight.

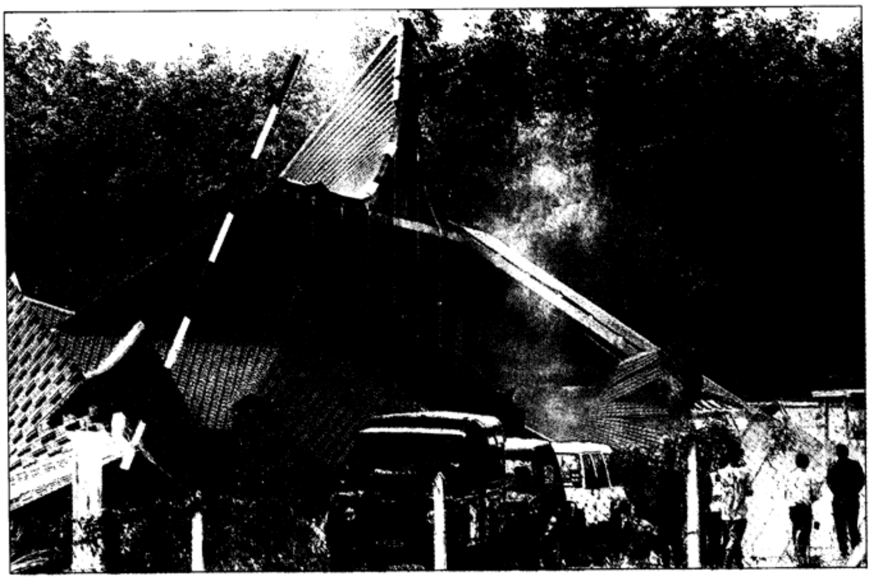
State Islam Hadhari development committee deputy chairman Ramli Noh said the demolition was part of efforts to stop the cult.

"Activities at the commune have raised many questions," he said. "The Religious Affairs Department will continue to hunt for Ayah Pin together with police."

On July 2, 21 followers were detained by Religious Affairs officers; 16 days later, a mob of about 50 people torched structures and vehicles in the commune.

On July 28, another 48 followers were detained and later charged in the Besut Syariah Lower Court.

Their case is now pending.



REDUCED TO RUBBLE: The hall being torn down yesterday.

BULLDOZED: The giant teapot being demolished.

Article E1: Article on demolition of illegal structures built on land designated for agricultural purposes.
(The New Straits Times – 1 August 2005)

TORN DOWN: Kuantan Municipal Council personnel using back hoes to demolish the Super Cowboy Enterprise building in Kuantan yesterday.

Wholesaler faces the music

Kuantan council demolishes building

KUANTAN: The Kuantan Municipal Council's patience finally ran out and it tore down a building occupied by a wholesaler that had ignored its notices for seven years.

Council public relations officer Mohd Shahrul Kamri Mohd Shainuddin said the council had sent Super Cowboy Enterprise seven notices listing the laws flouted since July 10, 1998.

"On Feb 24, the technical committee of the council met and made a final decision that no more leeway would be given to this stubborn entrepreneur," he said before the council demolished the building.

He said the council was people-friendly and tried to help errant businessmen who might not have understood the laws but in this instance it had to act "in all fairness to genuine and law-abiding businesspeople."

The operation was led by the council's town-planning officer Yusoff Husain who had a 100-strong team to remove the company's goods from the premises before pulling down the numerous illegal canopies and extensions.

The owner Yeoh Yong Foo, who was at the site yesterday, said he had been expanding the premises as he could not find an alternative site suitable for his business.

And when he wanted to buy over the land, the price quoted was too high, he said.

However, he said, he had recently bought a row of seven shophouses in Jalan Datuk Wong Ah Jang, about 700m away.

"I hope to start the business soon and I have applied for the licence five days ago," he said.

He said the 50-member staff of the wholesale shop would be paid their salaries for this month and he hoped that they would return to work for him.

The council said that if Yeoh applied for a licence for a proper shop, the council would treat the application as a new application and that he would not be blacklisted.

Article E2: Article on demolition of illegal structures built without valid permit.
(The Star – 6 May 2005)