Minimizing C&D Waste through rehabilitation

Minimizing C&D Waste through rehabilitation

S. E. van der Meer, A.R. Pereira Roders, P. A. Erkelens
Eindhoven University of Technology
Vertigo 7.09, P.O. Box 513,
5600 MB Eindhoven, The Netherlands
s.e.v.d.meer@student.tue.nl

KEYWORDS

Reuse, Reprocessing, Recycling, Integral Chain Management, Rehabilitation

ABSTRACT

The Construction and Demolition Waste stream is becoming one of the largest waste streams. With the current attitude of society, this will generate serious problems. Landfill sites will be overloaded; the planet more polluted, and even, in countries were actions are being taken, society might deal with the overload of warehouses and recycled material stock.
To subvert this tendency the waste management should be changed into Integral Chain Management (ICM), not only when designing new buildings, but also when we are dealing with existing building rehabilitations. Supervised by the PhD researcher A. Pereira Roders and P. Erkelens, this paper was developed with the purpose of determining the viability of the Integral Chain Management, normally suitable for new building designs, when reframed for existing building rehabilitations. Hence, the ICM will have to deal with a pre-existence, where a considerable amount of natural resources has already been transformed and assembled without considering dismantling, deconstruction and adapt abilities.
To determine the viability of ICM, a scheme was developed were the ICM is adapted to deal with the existing building stock and the different methods to achieve ICM are explained. In conclusion, we can state that ICM is viable theoretically for the existing building stock; however, it may vary according to the design and building.

1 Introduction

The Construction and Demolition (C&D) Waste stream is becoming one of the largest waste streams. For example in the Netherlands, it had reached already 18 millions tonnes per year in 2001 [Ministry of VROM 2001]. The construction industry does not intend to stop building, neither intervening nor demolishing the existent built environment.
If society does not change attitude, in the near future, landfill sites will become more and more overloaded, and the planet more and more polluted. Moreover, in countries where the building sector already has some experience in reusing, reprocessing and recycling building elements and materials, society might deal with a “next level” phenomenon, which is the more and more overload of warehouses and recycled materials stock.
We believe that this problem can no longer be ignored; therefore, the current waste management should be altered. The problem already emerges in the design stage, when determining the building substance and characteristics. So, designers should start designing buildings, enabling them of dismantling, deconstruction and adapt abilities, not only with new, but also with “second-hand” components and materials. But is it possible to use all “second-hand” components and materials, i.e. to keep them in their own life cycle, when we are looking at existing building rehabilitations?

2 The Integral Chain Management

An option to minimize the C&D waste is to improve the current waste management, changing it into an Integral Chain Management (ICM). With ICM integrated in the building sector, all building materials must be kept in their own life cycle and degradation of materials must be limited. To achieve this goal, Growther [2000] describes four different scenarios in the figure "The four scenarios for materials reuse in the built environment": recycling, reprocessing, reuse and relocation.
This figure also describes their viable placement within the building process: the process from extraction of natural resources till waste for dumping, through processing into materials, manufacture into components, assembly into buildings, building use, and disassembly. To keep all materials within the built environment, they should go from the disassembly stage back to one of the other stages. It becomes then visible that relocation and reuse are preferable to reprocessing and recycling because in such case, materials only go one or two steps back in the building process, and the waste of resources and energy to convert it into functional is not so difficult for its effective achievement. It can then be concluded that according to Growther's theory relocation and reuse are the most environmentally beneficial uses of waste.

3 The parallel realities in rehabilitation

If relocation, reuse, reprocessing or recycling must be an option at the end of the service life, the design stage becomes very important. When designing a new building it is relatively easy to enable the design with dismantling, deconstruction and adapt abilities, but when dealing with the existing building stock it becomes harder to materialise such ideologies. When developing rehabilitation designs of existing buildings, a designer will have to deal with different realities: subtractions, remainings, connections and additions. Pereira Roders [2006] shows in the figure 'The four parallel realities in rehabilitation' the relation between these realities, within the pre-existence and new existence of existing buildings. When target of rehabilitation, the building's pre-existence is divided in subtractions and remainings while the new existence combines the pre-existent remainings and the new additions. The connections are added as a fourth parallel reality because they form a very important factor between the remainings and the added components, when considering future options.

4 ICM in existing building rehabilitation

When dealing with rehabilitation, the designer has to deal with a pre-existence and develop a new existence. This also means that ICM can be achieved, when keeping both subtractions and remainings within the built environment. The subtractions should be re-integrated in the building process of the rehabilitated building, or even of another building (new or existent). Not only the subtractions, but also the additions should be controlled in such design developments.
Pereira Roders [2006] has studied both Landsink [SDU, 1980] and Delft Ladder [Hendriks, 2000] and proposes the Eindhoven Ladder, oriented towards rehabilitation designs. The Eindhoven Ladder, based on ICM, is composed by 5 levels, plus level 0 (six in total), which in ideal procedures, should be only considered when the materials have surpassed their durability and can no longer fulfil any other purpose. Due to the fact that level 0 removes the subtractions out of the built environment range, it is not considered in the ICM method for rehabilitation designs, even if it is theoretically part of it.
Perceived through a ladder, level 0 is the first degree, but the worst environmental option regarding waste management. Level 5 can be seen as the last and the 'unreachable' degree, but in fact it is the best environmental option. When levels 1 till 5 can be applied, ICM is achieved, when dealing with rehabilitation designs of existing buildings (Fig. 1). The following subchapters will briefly describe the five levels of the Eindhoven ladder.

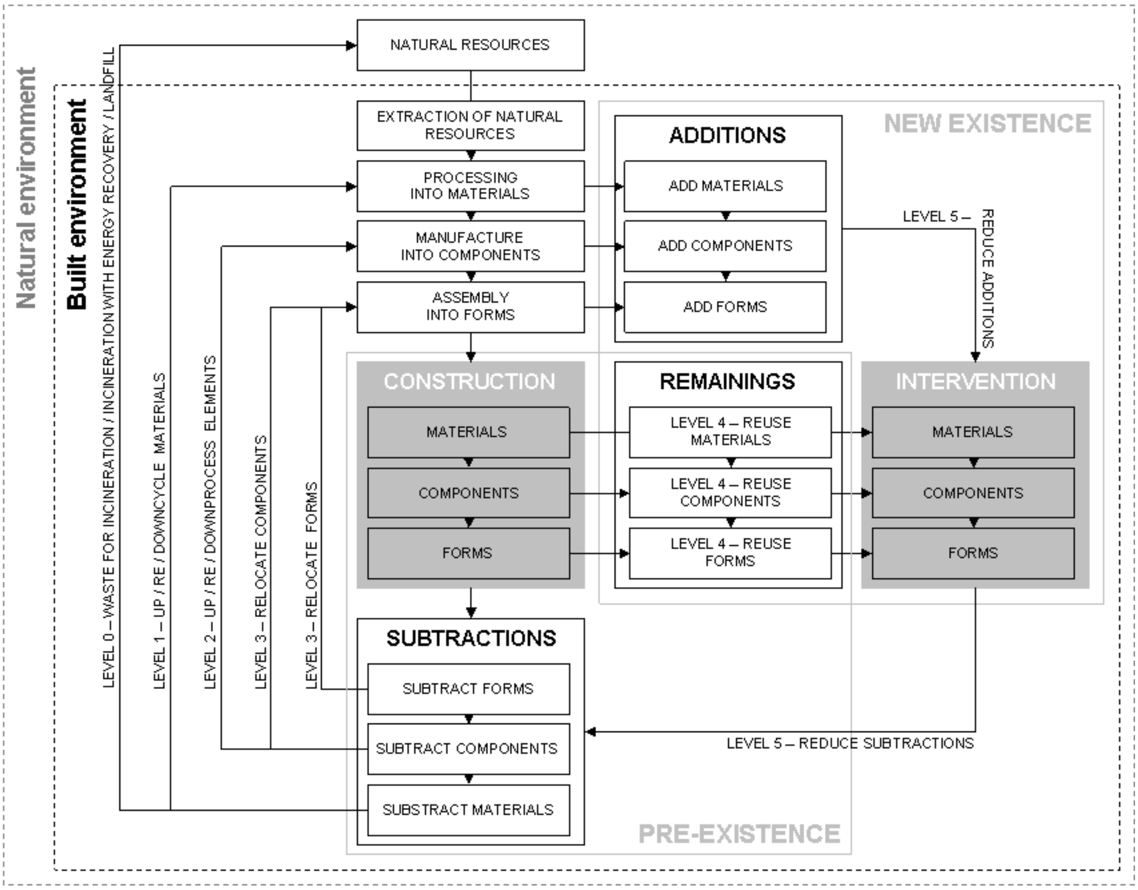

Figure 1. The ICM method integrated in the rehabilitation design stage [Pereira Roders, 2006]

4.1 Level 1 – Up / Re / Downcycle materials

The recycling is a process where ‘waste’ materials are manufactured to fulfil a new function. Three different recycling methods can be distinguished: downcycling, recycling and upcycling. These three methods can be defined as follows (De Jesus, 2005):

1. Upcycling: this means turning a low-grade material into a high-grade material. Up-cycling may include conversion of timber into wall-panelling.
2. Recycling: this means the manufacture of a new product using reclaimed or waste material, for example, turning scrap steel into new steel bars.
3. Downcycling: this means turning a high-grade material into a low-grade material. An example of down-cycling is converting concrete slab into coarse aggregate.

Recycling puts waste to new uses, thereby not only reducing waste ending up at landfill or inceneration sites, but also helping to conserve energy and resources. However, additional energy is still spent on manufacturing the materials. In the Netherlands some examples can already be found using recycled materials in new buildings, e.g. the ten ‘Respecthouses’, in Tilburg, realized by IBC Vastgoed (Fig. 2). Due to the large percentage of recycled materials used, this project received EU-subsidies. The emphasis of this project aimed at the making of new products from C&D waste, e.g. window frames made of old roof trusses.

4.2 Level 2 – Up / Re / Downprocess elements

The reprocessing of elements involves reconfiguration of existing elements or systems to restore its condition to “as good as new” (Durmisevic, 2002). Similar to recycling it can also be distinguished as: downprocessing, reprocessing and upprocessing. Respectivelly, the quality of the remanufactured product should retreat, meet, or surpass the tolerances and capabilities of a new product. Such methods, as recycling, also encount additional energy to be spent on remanufacturing those elements into components or systems. In the rehabilitation design of the Town Hall in Utrecht between 1997 and 2000, the architect Enric Miralles created a new façade with some subtracted elements (Fig. 3).

Old limestone frameworks of the demolished Registry Block were reprocessed and used as architectural elements in the façade [Jamar, 2000].

Figure 2. Respecthouse, Tilburg [van Hal, 1999]

Figure 3. Town Hall, Utrecht

4.3 Level 3 – Relocation of components / forms

The relocation of components / forms is based on prolonging the life of the building components by dismantling the component at the end of the buildings functional life cycle and relocating it to another (new or existing) building [Durmisevic, 2002]. The relocating components / forms can reduce or avoid embodied energy [Growther, 2000]. Therefore, relocation is more environmentally beneficial than recycling and reprocessing. However, energy is still required to dismantle the building and to transport the components.

In Portugal the architects Victor Mestre and Sofia Aleixo realised the rehabilitation of the Carlos Relvas Photographic Studio, in Golega, between 2000 and 2004 (Fig. 4). They chose to remove some elements of the previous intervention, in order to restore the coherence of the original photographic studio. So, the building was partly dismantled, and those components which were not relocated in the design, were sent to an archive. For example, the roof tiles were dismantled from the Photographic Studio and were relocated in the roof of the additioned building [das Neves, 2004].

Figure 4. Carlos Relvas Photographic Studio [das Neves, 2004]

Figure 5. Polynorm outside [Timmermans, 2005]

An example of relocation of forms is the Polynorm house, in the Netherlands (Fig. 5). The Polynorm houses (1950) were built with an industrial manufactured system based on structural steelwork (the polynorm system) in the district Strijp in Eindhoven. The 212 houses were dismantled at the end of 2005 and at the moment two of these houses will be relocated and rebuilt at the Eindhoven University of Technology [Timmermans, 2005].

4.4 Level 4 – Reuse remainings

The materials, components and forms of the building that will remain can be reused and form the new existence, together with the additions. This way of keeping the building materials in the built environment is the more environmentally beneficial than the earlier options, because hardly energy is required to keep / preserve the materials in the built environment. On the grounds of the Eindhoven University of Technology an example of reusing the remainings of a building can be found: Vertigo, the building for the Department of Architecture, Building and Planning. The main structure of reinforced concrete (primary elements) of the building, was reused, which lead to a reduction in the use of reinforced concrete of about 13.800 tonnes [de Jonge, 2002].

4.5 Level 5 – Reduce additions / subtractions

With a rehabilitation design, there are always sutractions and additions. Level 5 intends to integrate into the rehabilitation design stage, the reduction of unnecessary subtractions, as well as, of unnecessary additions. By not extracting natural resources for the additions, the designer will be preventing and preserving the natural resources. Consequently, also by not subtracting from the pre-existence, the designer will have more remainings to reuse, and won´t spend energy for the subtractions. Of course, there cannot be rehabilitation without additions and subtractions because the rehabilitation intervention improves the performance of the building. However, when considering the ICM, while designing and taking decisions, the probability of reaching higher degrees in the Eindhoven Ladder are considerable.

5 Conclusion

The viability of ICM for existing building rehabilitation designs, has reframed Growther´s four scenarios, within Pereira Roders's four parallel realities. The scheme shows the possibilities of keeping the building materials within the built environment. The examples presented show that it is already possible to use recycled, reprocessed or relocated building materials, components and forms, so it is possible to apply ICM to the existing building stock.

However, it is hard to determine if the materials in these examples, which went still to incineration / landfill sites, were effectively highly degraded or just had no other destination. If designers start using more second-hand materials, this market will grow and the possibilities for ICM in the existing building stock will increase. When the five levels are followed, as much as possible, the C&D Waste will decrease. However, the viability of these methods may vary according to the design and building.

6 References

Durmisevic, E. 2002, Design aspects of decomposable building structures, Conference proceedings of TG 39 conference 2002, Germany

Growther, P. 2000, 'Building Deconstruction in Australia', Meeting of Task Group 39 'Overview of Deconstruction in Selected Countries', Watford, England, 19 May 2000, pp. 14-44.

Hendriks, Ch.F. 2000, 'Nationaal congres Bouw- en Sloopafval, kwaliteit in de keten', the Netherlands, in Hendriks, 2001

Hendriks, Ch.F. & te Dorsthorst, B.J.H. 2001 'Re-use of construction at different levels: constructions, element or material', CIB World Building Congress, New Zeeland, April

Jamar, J. 2000, *The town hall of Utrecht*, Uitgeverij Matrijs, Utrecht; in Hendriks, 2001

de Jesus, A. 2005, 'Green Architrends; Demolition or deconstruction?', *Philippine Daily Inquirer*, B2-2

de Jonge et al 2002, 'Dilemmas, shifting between extremes', in *Bouwstenen: Beyond Sustainable Building*, Eindhoven University of Technology, Eindhoven, pp. 95-114.

Ministry of VROM (Housing, Spatial Planning and the Environment) 2001, *Construction and Demolition Waste*, Directorate for Substances, Waste and Radiation Protection, Factsheet, Ministry of VROM, The Hague, June.

das Neves, J.M. 2004, *Victor Mestre Sofia Aleixo – Restoration of time*, Caleidoscópio, Casal de Cambra

Pereira Roders, A. 2006, 'Re-architecture: lifespan rehabilitation of built heritage', Eindhoven University of Technology, Eindhoven, April (draft version).

SDU 1980, 'Report of parliamentary debates 1979-1980', Den Haag; in Hendriks, 2001

Timmermans, G. 2005, 'De Polynormwoning', *Bouwpers 10*, Eindhoven University of Technology, Eindhoven