Quarrying and Sustainability during Urbanization: Gebze District Case

Abstract:

The requirement of construction materials increases along with developing urbanization. Despite the most of quarries are established in rural or semi rural areas, their locations remain in or close to the urban areas in parallel with the expansion of residential areas in proportion to the rate of urbanization. Continuing population growth, social, industrial and economic developments require more construction materials. Gebze region uses approximately 8,000,000 tons of aggregate per year for construction sector. The present quarries are planned to be abandoned in the following years. Regardless of potential problems, it is important for planning to estimate future recourses. Nowadays, there are public housing, organized industrial zones and highway projects at planning and construction stages. Nevertheless, Ballıkayalar National Park is close to likely potential material quarries. By avoiding the national park area, the availability and the quality of materials should be established at an early stage, as material production and transportation costs can be an important consideration when selecting a design solution.

Introduction:

Turkey is a tectonically active region and is struck by frequent destructive earthquakes. After the devastating earthquakes occurred in 1999, the compulsory lower concrete class is defined as C20 by the "regulation on construction of buildings in disaster areas". As one of the concrete component, quality of aggregates due to their petrographical, physical and mechanical properties becomes more important. This led the aggregate producers to find the material meet the qualifying requirements. The major Marmara earthquake in 1999 had a number of effects on the characteristics of residential demand in Marmara Region. The urban residential demand was affected because the earthquake encouraged many of the residents of older buildings to search for newer building which comply with the earthquake safety regulations. The earthquake also had an important effect on suburban residential demand (Mert and Yilmaz 2009). In parallel with rapidly developing residential areas, the need for building material also increased. Quarries, in general, are sought and established outside the immediate vicinity of residential areas. However, they remain within cities depending on the speed of the development of cities. With growing construction in Gebze and Anatolian side of Istanbul, demand of aggregates has become high that present quarry sites within these areas remain in and around residential areas and will not be sufficient to meet the requirements.

For that reason, investigations of rock outcrops from which suitable aggregates may be quarried is sought to meet the current and future demands of aggregates suitable not only for the building and infrastructures but also for the roads or transport networks in and around the region.

Annual production of aggregate in Istanbul and its vicinities totals about 77.053.000 tons in 2005. This figure is the Turkey's largest mining activities. Annual crushed and building stone production is about 12.200.000 tons in Asian side of Istanbul. The production is about 8.000.000 tons in and around Gebze district. Annual production is consumed in the same year and no stock transfer is done to the following year. Annual crushed stone requirement of Asian side of Istanbul is supported by the quarries in Gebze District. 62,624,000 tons out of 77.053.000 tons crushed stone is produced in Istanbul which is much less than its own production (ITO, 2004). This study aims to explore and evaluate the suitability of natural crushed rock aggregates in Gebze District for the future need of the region and propose some measurements about present quarries that will be abandoned.

Present Quarry sites

As well as the quarrying is a temporary activity, it creates disturbed landscape behind and quarrying with no diverse environmental impact is almost impossible. The main effect of quarrying is to create big holes in topography. In addition to this, abandoned quarries also damages ecological, climatic, hydrological, hydrogeological, geotechnical and geological conditions. Abandoned quarries bring along damages resulting in safety problems and inverse environmental impacts. Restoration is turning the land to its original conditions that is seldom possible because we do not currently have the level of information and skill required to return ecosystems exactly to their original structure (Langer and Belinda, 1988).

Quarries are located in the north east of Gebze district. Crushed stone and aggregate production region is designated as mass housing area. Although, the quarry sites are already used as mass housing area, it is not yet known what measures will be taking. There are some certain measures described in engineering geological aspect. Quarrying activities created large holes with steep slopes in the area. Quarries with steep slopes are susceptible to rock falls, toppling and slope instabilities. Acceptable slope stabilities for quarrying activities are not probably convenient for housing estate. Therefore, stability of slopes should be designated for long-term uses. Supports of the slopes are likely to be needed due to discontinuities and weathering properties of the faces. According to the field studies and stability analyses preventing measurements should be considered in reclamation of process the quarry sites.

Foundation settlement is a common problem that has resulted from built houses in the grounds of abandoned quarries. Most of the quarries reached below water table. Quarrying is made by pumping the water out of pits. Measurements to the mass housing impact should be taking as groundwater is a vulnerable material against contamination.

Investigation of Suitable deposits

The optimal land use of abandoned quarries can be determined according to the characteristics of their nearby environment. In addition to the quality of potential aggregate and crushed stone sources, land-use choices, economic and environmental concerns are to be considered whether the source is large and widespread or not. Future quarry sites should be designated as such in planning schemes and provided with surrounding buffer zones to avoid urban encroachment (McNally, 1988). The integration of aggregate production within land management planning process would preserve the natural resource stock of aggregate and also be economically efficient (Poulin, 1996). Search for aggregate is time consuming and exhausting. Field studies for aggregate locations are carried out following the collecting of related data of the previous studies of the area. Prospective areas for reserves of possible sources of aggregates are investigated taking into consideration of planning and commercial aspects of the area. Ballıkayalar natural park region is close to the present quarries (Fig. 1). The future quarries should be established far enough from Ballıkayalar National Park. On the other hand, transportation of material will possibly increase the price due to the distance to the market. By forcing the region to import aggregates from large distances, supply of aggregate will cost higher in proportion to present-day average cost of 5 Trl / Km for material transportation.

Generally, aggregate resource maps are produced by geological surveys followed by geotechnical properties description of aggregates applying some field and laboratory tests. Specifications are to meet by aggregates set by national and international norms.

Durability of aggregates for use in construction and transportation projects is of considerable importance. If the aggregate deteriorates then the constructed facility requires premature repair, rehabilitation or replacement. Thus, specifications are to meet by aggregates that are set by national and international standards norms.

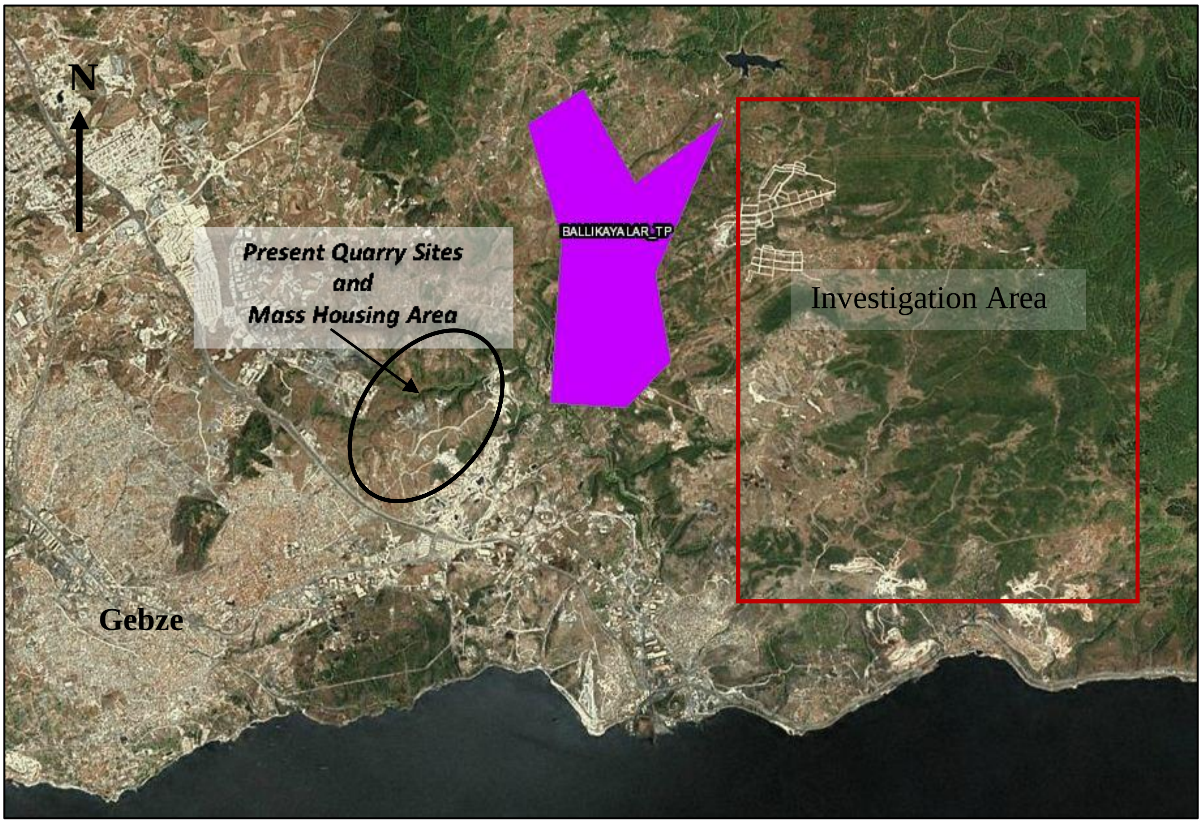

Figure 1. Investigation Area

Aggregate Properties

Despite the abundance of aggregate deposits, they are finite and non renewable sources. Identification of aggregate sources should be done in advance of planning decisions (Ross and Bobrowsky, 2005). Potential aggregate resources are dependent on geological conditions. Different rock types have different properties that describe their quality as construction material. For this reason, a wide range of empirical tests are devised to describe the behavior of aggregates such as water absorption, strength, abrasion resistance, polishing value, impact value, crushing value, flakiness, resistance to weathering,

For this reason, different formations around the region were investigated employing some aggregate tests. The geological units are Kurtköy, Kapaklı, Demirciler and Ballıkaya formations outcrop in the investigation area. Specific gravity, water absorption, uniaxial compressive strength (UCS), Los Angeles Abrasion value (LAV), aggregate impact value (AIV), aggregate crushing value (ACV) and Flakiness tests are carried out (Table 1.).

Table 1. Some Properties of Rocks in Investigation Area

Formation	Specific Gravity (gr/cm^3)	Water Absorption (%)	UCS (MPa)	LAV (%)	AIV (%)	ACV (%)	Flakiness Index (%)
Kurtköy	2,70-2,72	0,45-0,60	46-58	18-25	12-16	15-24	15,5
Kapaklı	2,68-2,70	0,50-0,82	49-55	18-24	8-11	18-23	13,4
Demirciler	2,71-2,72	0,65-0,78	65 -85	19-28	13-18	20-27	23,2
Ballıkaya	2,69-2,71	0,75-0,95	52-67	17-26	14-17	18-25	25,4

In broad sense, uniaxial Compression Strength (UCS) values of rocks are an indication for suitability of rocks for Different engineering uses. According to their UCS values, rocks may be suitable for low-grade roadbase when the UCS values below 50MPa. Rocks with 50–100 MPa UCS values may be suitable for crushed roadbase or aggregate in low-strength concrete and rocks with 100–200 MPa UCS values may be suitable for good-quality crushed roadbase and concrete aggregate. Higher values are desirable for very-high-strength concrete and best quality ballast (McNally G, H. 1998).

According to the Los Angeles abrasion value test, allowable loss upper limit is below 50% after 500 cycles (TS 706 and ASTM C33). Allowable value for road aggregate is 30% for road aggregate (TS 706). Allowable value of AIV is 25% for high traffic and 50% for other concrete types (BS 812 Part122 1990). Aggregate crushing value is allowed to be less than 30% (BS 812 Part 105.2 1990). According to the standards, all formations provide the requirements when the results are discussed together.

Conclusions

Although, the quarry sites are already used as mass housing area, the reclamation and restoration of the present quarry sites should be evaluated regarding the geotechnical aspect as slope stability, groundwater and settlement problems that is determined likely to be in these areas.

It is essential to access available supply of suitable or high quality aggregate if we wish to maintain the construction industry. Given the right information and access to suitable resources in appropriate geologic settings, aggregate producers can meet the region’s demand for aggregate without causing undue harm to the environment. As the rock properties of the investigated formations provide the norms, these areas could be considered as future sites along with planning schemes.

The overall cost to society and the economy of mining aggregate can be minimized by locating the pits and quarries as close as possible to the construction sites. Despite the increase in overall costs of material is inevitable as regard to the transportation of materials to the market, the investigated areas have the characteristic of to be closest that will reduce the cost.

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