

# Identification of the Most Suitable Location in Kaduwela Area to Establish a Mega Quarry Site to Supply Aggregate Requirements of Mega Projects in Colombo

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**Abstract:** Western Megapolis Project is a massive scale development project. The scale of the project demands huge amount of coarse aggregates for its construction. Most of these projects are concentrated within or on the periphery of Colombo district. Hence, the requirement to find a coarse aggregate source within Colombo district, closer to metropolitan area is inevitable. This project was carried out in order to identify the most suitable location to establish a mega quarry to address the above issue. Initially a desk study was carried out to analyse spatial data in order to get a rough idea about suitable locations. Field visits were carried out to observe prospective lands, collect rock samples and to gather sociological data through a questionnaire survey. The suitable location was determined by considering the distance to Colombo metropolitan area, rock outcrops, current mining activities, existing settlements, land ownership etc. The quality of rock samples were investigated through Aggregate Impact Value (AIV) and Los Angeles Abrasion Value (LAAV) tests. The volume of aggregates that can be extracted was calculated and compared with estimated aggregate demand. It was concluded that the aggregate requirement of considered construction projects could be satisfied by implementing the Mega Quarry project.

**Keywords:** Aggregate Quality, Coarse Aggregates, Kaduwela, Megapolis Project, Mega Quarry, Mining

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## 1. Introduction

Megapolis project is currently proposed for the Western region of Sri Lanka and the main target area is Colombo metropolitan area. The project was initially proposed in 2015 and expected to be implemented at the beginning of 2016. The implementation of the development project will be carried out in three phases and expected to be completed by 2030 [1].

For the Megapolis project, it is recommended to establish quarry sites within Colombo metropolitan area to supply the rock aggregates [2]. A mega

quarry is preferred over many small quarries to reduce the adverse socio-economic impacts associated with quarry mining activities. For the purpose, Kaduwela area is identified as having good potential to establish a mega quarry, since large quantities of granite are identified in the area and currently many quarry mining activities are ongoing in the area as well.

## 2. Study Area

The proposed rock is mainly consisted of high grade metamorphic rock with mainly hornblend biotite gneiss.

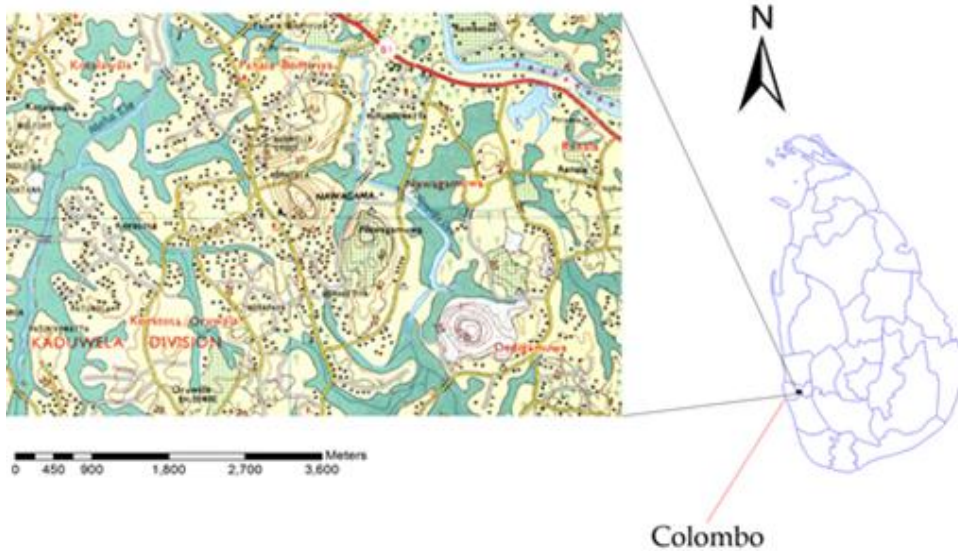


Figure 1: Study area - Kaduwela, Colombo

Currently, a few “A” grade and several “B” and “C” grade metal quarries are in operation in the Kaduwela area with the promise of a large quantity of rocks which can be mined and utilized as coarse aggregates for the construction and road works. But, the exact quantity and quality of the rocks still remain unknown. Preliminary tonnage estimation and quality analyses are required.

### 3. Methodology

A step wise approach is followed to reach the desired objectives of this research project.

For the preliminary understanding of the project, all the relevant data and information were gathered through literature reviews and desk studies. Satellite map of the area was obtained from Google Map and fundamental spatial analyses were done using the map. Field visits were made to the study area and with all the necessary information were obtained from the field. Samples were also collected from the area for rock quality

analysis. Ore reserve estimation was done using “Surfer 8” software.

#### 3.1 Rock quality analysis

High quality rock aggregates are mainly required for road and other national construction works in the Megapolis project along with national and domestic requirements. Los Angeles Abrasion Value (LA AV) and Aggregate Impact Value (AIV) Tests [3] were carried out using the samples collected from the field.

#### 3.2 Socio-economic analysis

A questionnaire survey was carried out using a prepared set of questions. Survey was done covering more than half of the houses within a 200 m radius of existing quarries in the area. A discussion was also held with the Grama Niladhari of the area. Environmental, sociological and economic effects due to the quarrying activities [4] were analysed based on the information obtained.

#### 3.3 Demand estimation

The estimation of the aggregate requirement was done based on the information available in “Western

Region Megapolis Master Plan". According to the information in the Plan, five major projects were identified and coarse aggregate requirement for each of the projects was estimated. The identified projects are:

- Construction of New Kelani Bridge and elevated road to Colombo Port and Fort area
- Construction of Elevated Urban Expressway from New Kelani Bridge to Battaramulla
- Housing project for low income groups
- Housing for middle income groups
- Relocation of government offices
- "The High Rise" (Central Business District)

The required aggregate quantity was estimated as follows. First, the concrete requirement for each structure was estimated and then the aggregate requirement was determined by multiplying that value by the coarse aggregate percentage of concrete.

The concrete requirement was estimated by the size of the building in terms of floor area. Number of floors was estimated based on the available information in the plan. A regular grid structure was assumed with suitable grid spacing. The dimensions of members (beams, columns and slabs) were assumed considering typical values and above assumed values. The concrete requirement for both the expressways was calculated by imagining a single structure running for the total length of 15 km. The cross section of the structure was determined by assuming reasonable values for members. (Cantilevers, piers, super structure) [5].

## 4. Results and Discussion

### 4.1 Aggregate testing results

In the field, the outcrops and mined rock boulders were observed as having a high amount of quartz and garnet. The LAAV and AIV test results indicated slightly lower values as well.

Calculated LAAV and AIV results are as follows:

Table 1: Rock aggregate test results

Test	Result (%)
Los Angeles Abrasion Value Test (LAAV)	39.12
Aggregate Impact Value Test (AIV)	15.58

\*Aggregates with AIV of 10-20% are categorised as "Strong" and maximum permissible LAAV of 40% is preferred for the rock aggregates.

Grama Niladhari of the area confirmed that there were no severe environmental or sociological issues associated with the quarrying activities in the area. According to the information obtained from the Grama Niladhari office, there are nearly forty houses around the proposed rock quarrying area.

### 4.3 Tonnage calculation

Volume calculation of the outcrops was done using "Surfer 8" software (Figure 2) as follows.

The average volume of the outcrop  
 $= 2.07 \times 10^7 \text{ m}^3$

Recoverable volume of aggregates  
 $= 2.07 \times 10^7 \text{ m}^3 \times 1.6 \times 0.9 = 2.98 \times 10^7 \text{ m}^3$   
 (Expansion factor - 1.6, Wastage factor - 0.1)

Tonnage of the aggregates available in outcrop =  $8.05 \times 10^7 \text{ Mt}$

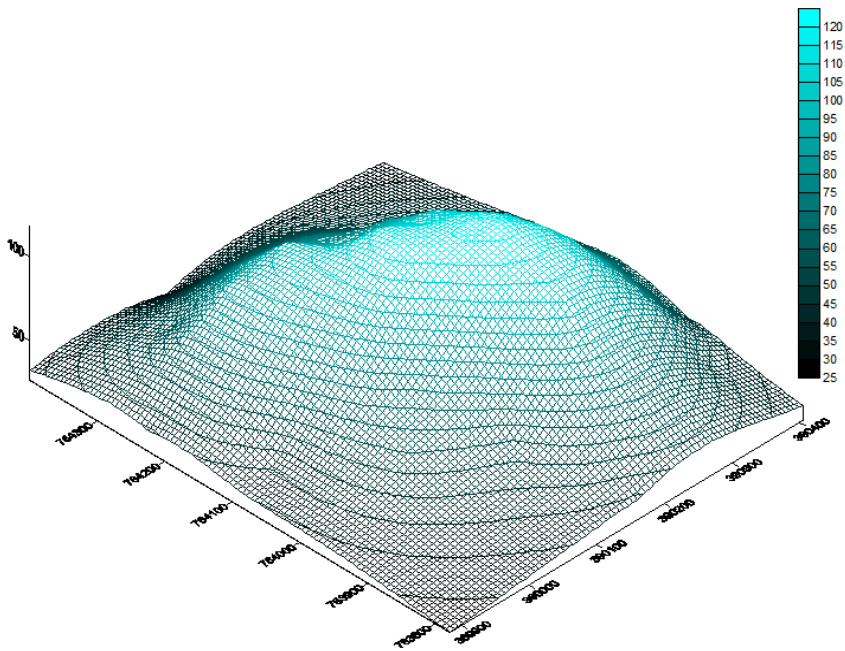


Figure 2: 3D Map of the area drawn using “Surfer 8” software

#### 4.4 Demand estimation

Volume of concrete required for the construction of above projects can be summarized as follows.

Table 2: Demand estimation for each project

Item	Volume (m <sup>3</sup> )
Elevated expressways	166,341
Housing for low income groups	1,339,563
Housing for middle income groups	8,733,121
Government offices relocation	176,068
The high rise	1,241,682
<b>Total</b>	<b>11,656,775</b>

$$\begin{aligned}
 &\text{Total Aggregate Requirement (T.A.R)} \\
 &= (166,340.875 + 1,339,563.09 + 8,733,120.61 + 176,067.56 + 1,241,682) \\
 &\times 45\% \\
 &= 5,263,548.36 \text{ m}^3
 \end{aligned}$$

#### 5. Conclusions

This research study was carried out considering all the environmental, sociological and economic factors associated with the project. The establishment of a mega quarry in Kaduwela area is inevitable, since the development of the country and key significance of the Megapolis project.

Based on the research findings it can be concluded that the identified location is ideal for the establishment of a mega quarry to supply coarse aggregates for the proposed projects.

The abrasion value obtained from LAAV test was almost equal to the preferred maximum value for the rock aggregates. Hence, further experiments are recommended in large scale to assess the suitability of the rock aggregates for concreting and surface works.

The existing road network is adequate for current quarrying activities in the area. However, it is not enough to support large scale operations of a mega quarry. Therefore, the road network should be developed prior to the commencement of quarry operations.

Our preliminary volume estimation of rock outcrop shows that  $29.8 \times 10^6$  m<sup>3</sup> of rock aggregates can be produced from the rock outcrop. Therefore, the calculated Total Aggregate Requirement (T.A.R) of  $5.26 \times 10^6$  m<sup>3</sup> can be satisfied through the production from a mega quarry in the proposed area.

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