ISLAND WIDE CONSTRUCTION RAW MATERIAL SURVEY

REPORT ON GALLE DISTRICT

by

K.A.G. Sameera
( Geologist )

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GEOLOGICAL SURVEY & MINES BUREAU
No. 569, Epitamulla Road,
Pitakotte.
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1. Introduction

Over the past two decades, state as well as private sector organizations initiated rapid development work throughout the country in a large scale.

Of these projects, Port City development project, construction of expressways (i.e. Northern and Central expressways, extension of Southern expressway to Hambantota and Mattala), extension of Southern Railway line from Matara to Kataragama and construction of a massive building complex for the Ministry of Defense and Three Forces Head Quarters in Pelawatta and other government office complexes in Battaramulla, construction of irrigation and hydro power projects in many parts of the country, construction of multi storied apartment complexes in urban and suburban areas, are the most significant. For these projects, huge quantities of building raw materials (sand, rock and soil / gravel) are required.

Being the regulatory authority on Mines and Minerals Act No. 33 of 1992 and amended Act No. 66 of 2009, it is the responsibility of the GSMB to identify mineral resources in the country, including building raw materials, required for various industries and development projects, initiated by the state as well as the private sector.

In the recent past, the contractors of various development projects have complained about the difficulties faced by them when identifying suitable localities for extracting and supplying building raw materials needed for the major development projects, currently initiated in many parts of the country. This has resulted in delaying construction work of some of the government high priority development projects.

This matter was reported to Mr. R. Paskaralingam, Senior Advisor to the Ministry of National Policies and Economic Affairs by the relevant parties at the progress review meetings of the government development projects, held at the Ministry. Subsequently a request was made to the Director General, GSMB by Mr. R. Paskaralingam, to immediately initiate an island wide survey to identify minable locations of building raw materials (sand, rock and soil / gravel) and to estimate their resources in order to use them as per the requirements of the projects.

Accordingly, GSMB has commenced an island wide construction raw materials survey in early 2017. This report including maps, tables and annexes is the output of the survey conducted in Galle district.
2. Objectives

- Conducting field surveys to identify suitable sites for mining construction raw material (sand/gravels and rocks) resources.
- Identification of mining related issues and environmental concerns.
- Preparation of construction raw material resources map.
- Assessment of mineable quantities of construction raw materials in identified locations and optimum extraction limits.

3. Methodology

Initially, all the available data on construction raw material occurrences within the district was assembled and resource map of the district was prepared (both soft and hard copies). All topographic maps (1: 50,000) which cover entire district was collected.

After preparing all the documents, the assigned field crew left to Galle district to commence field investigations in late December 2017. The field camp was established in Baddegama which is situated at the centre of the district.

Field work in entire district was conducted in two month and during this period all the accessible areas in the district were covered. After completing field investigations, field crew closed the camp and returned to head office in late February 2018 and commenced final map preparation work.

4. Area and Boundary

Galle district which is located in the Southern Province towards southwest of Sri Lanka, lies between 5.97° - 6.44° of northern latitudes and between 79.99° - 80.49° of northern longitudes. It has a land area of approximately 1651.6 square kilometers. The district is bounded on the north by Kalutara and Rathnapura districts, on the east by Matara district and on the west by Indian Ocean. The district is comprised of nineteen Divisional Secretariat (Fig. 01) Divisions and 896 Grama Niladhari Divisions.
5. Location and Accessibility

The area covered by Galle district lies within 1:50,000 sheets of Matugama, Rakwana, Ambalangoda, Morawaka, Balapitiya, Aluthgama and Galle. The main township in the District is Galle while Ambalangoda, Hikkaduwa, Baddegama, Alpitiya, Neluwa and Imaduwa are the other towns. Most of the coastal area are popular destinations of both foreign and local tourists.
Galle district is the most populated district in the southern Sri Lanka. It can be easily reached by southern expressway (Kottawa – Matara). In addition it can be accessed by Colombo – Wellawaya (A2) main road. These main roads are connected by a fair network of provincial roads (“A” & “B” grade) and Pradeshiya Sabha roads (“C”) exist within the district. Also the main coastal towns of the district are connected by Colombo – Matara railway line.

6. Climate

Galle district lies within the wet zone of Sri Lanka. It has a humid tropical climate. The average annual rainfall is about 2000 – 2500 mm. The area receives most of the rainfall during the southwest monsoon from May to September and the rest during the northeast monsoon from October to December. Inter monsoonal thunder storms are also common. Flooding is common in low lands in the district during May – July and February is the driest month. Temperature is generally uniform within the district and average annual temperature is about 28 °C.

7. Physiography and Drainage

The main physiographic feature of the district is a series of parallel ridges running in NW and SE direction and is mainly confined to the central parts of the district. The resultant land form has distinctive photo-pattern consisting of a dense pattern of narrow flat swampy valleys separated by ridges. The highest altitude of 393 meters above MSL is reported from Neluwa. Hiniduma, Thibbotuwava, Kabaragala, Kondagala, Kekirihena, Wadiyahena and Balagala mountains are significant among the small mountains in the Galle district.

A number of major streams drained through the district, discharge to the sea within the south – south western coast. Gin ganga is the longest river (116 km) flowing through the district, and it starts from the Gongala mountains in Deniyaya (Sinharaja rain forest) and discharges to the sea at Gintota area. Second longest river within the district is Bentota river, running along the northwestern boundary of the southern province and discharges to the sea at Bentota. In addition, some smaller rivers such as Madu ganga starts and flow close to the coastal areas. There are four lakes within the district.

Over the flatland areas of the west, a dendritic draining pattern has developed while the central and north eastern part displays a trellis drainage pattern. Streams running parallel to the regional strike and running along joints perpendicular to the strike make up the trellis pattern.

Vast areas of the ground in the lowlands are subjected to serious flooding during wet season. This has resulted in the development of deep and extensive alluvial deposits along the lower reaches of the major river systems draining the district.
8. Outline of Geology

Nine-tenths of the geological basement of Sri Lanka consists of Precambrian metamorphic rocks and the rest of the area is represented by Mesozoic (Jurassic), Tertiary (Miocene) and Quaternary sedimentary formations and a few occurrences of intrusive igneous rocks. The high-grade Precambrian basement of Sri Lanka is divided into three major units namely the Highland Complex (HC), the Wanni Complex (WC) and the Vijayan Complex (VC) (Fig. 02) (Kröner et al., 1991; Cooray, 1994).

Geologically entire Galle district is underlain by highly deformed Proterozoic metamorphic rocks which belong to the Highland Complex with crustal residence ages between 2 – 3 Ga. However, there are notable lithological differences between lithologies in this area and rest of the Highland Complex. Lack of the prominent bands of quartzite, marble and garnet sillimanite graphite schist (Khondalite) and the occurrence of wollastonite bearing calc granulites are noteworthy within this part of the Highland complex. In addition rocks undergone relatively low pressure (5 - 6 kbr) metamorphism compared to the rocks in rest of the Highland complex of Sri Lanka.

Major rock types that occur within the area are charnockites, charnockitic gneisses and garnetiferous quartzo-feldspathic rocks. In addition wollastonite and scapolite bearing calc gneisses and mappable bands or lenses of cordierite bearing pelitic gneisses occur within the Galle district. Towards the northeastern edge of the map, in the Sinharaja rain forest area, amphibolites, hornblende and pyroxene rich rocks are interlayered with minor metasediments and charnockitic rocks.

Regional structures run in NW-SE direction except for the southeastern edge, where rocks strike in E-W direction probably due to cross folding.

Several quaternary deposits such as beach rock, unconsolidated sand, inland coral and laterite found along the coastal belt of the Galle district. Beach rock (littoral Sandstone) occurs at Kaikawala and Koggala and unconsolidated sands occurs around Bentota and Ambalangoda. In addition some inland sand deposits found around Kosgoda and Uragaha area. Inland coral deposits occur along the coastal plain and may extend about 1km inland as pockets and lenses around Hikkaduwa, Ahangama and Akurala area. Most of the laterite formations developed in situ over the crystalline basement have thicknesses from 1 or 2 meters to over several meters and it is well exposed around Balapitiya area.
Figure 02. Simplified geological map of Sri Lanka showing Galle district.
9. Construction Raw Materials

9.1. Types of Raw Materials and Types of Data Acquired

During the field investigations special attention was given for locating rock, soil and gravel occurrences. Although two major rivers flow through the district, occurrences of large deposits of river sand is rare and mining of river sand is also rare (due to environmental concerns). But there is a significant number of completely mined out pits and a few working inland sand pits (sand bearing soil washing) in the western part of the district. This type of mining usually last for few months and then refilled the location with soils. Due to environmental problems, improper filling of the land and their small size, these locations were not considered during the field investigations.

Mineable quantities of construction materials identified in all the investigated locations were assessed during field investigations. In each of these identified locations, mineable depths, widths, and lengths or area of rock/gravel/soil commodities were identified / estimated based on the field relations of each and every identified rock/gravel/soil body. The mineable quantity of rock/gravel/soil at each location is given in the Annexures 01 and 02.

Also following additional information on these rock/gravel/soil occurrences, were also gathered during field investigations. These data are also given in Annexures 01 and 02.

- Mineral Type
- GPS Co-ordinates
- Divisional Secretariat Division
- Grama Niladari Division
- Occurrence (above surface/below surface)
- Mined Out Volume (Currently Mining and Previously Mined Bodies)
- Mineable Depth
- Mineable Height
- Mineable Width
- Mineable Quantity (New Occurrences)
- Remaining Mineable Quantity (Currently Mining & Previously Mined Bodies)
- Present Status (New Occurrence/Currently Mining Body/Abandoned Body)
- Present Status
- Geology
- Lithology
- Land used Type
- Land ownerships
- Distance to Close by Structures (well, house, religious place, school, etc.)
- Number of Houses within 100m Distance
- Availability of Access Roads to Identified Locations
9.1.1. Rock Occurrences

Rock aggregate is one of the most essential commodities used in the construction industry. Different sizes of broken and crushed rocks, varying from fine powder to boulder size, are produced according to the requirements of construction industry, mainly for road construction and other related development activities.

Any rock, to be used as a construction material, must be strong and be able to withstand the stresses placed upon it. In this respect, many of the crystalline rocks of the country can be considered as suitable rocks for production of rock aggregates.

However, in order to set-up an economically viable quarry project, sufficient reserves of suitable rocks should be made available in an easily accessible location. Further, to operate it in a sustainable manner, it should also be located in an environmentally non sensitive area where impacts are not significant or impacts could be mitigated without causing detrimental damages to the existing environment.

Hard rock exposer are found within the entire area of the Galle district except at some quaternary deposits in the coastal areas. More than 100 localities of new, abandoned and currently mining rock exposures were identified within the Galle district. Most of them are located in the South, Southeast and Southwest of the district and a lesser number is located in the Northeast of the district as part of it is cultivated and the other part is forest reserve.

Most of the rock exposures are associated with mountain ridges and below surface mining is currently prohibited at those localities. Most of the currently mining rock quarries are “B” grade and few “A” grade quarries have been identified. Hard rock exposures are either charnockite, charnockitic gneiss, garnet biotite gneiss, garnet granulites or calc gneisses.

Based on the rock type, its suitability and remaining mineable quantity, rock occurrences can be categorized into the following

- Large
- Medium
- Small
- Working quarry
- Abandoned quarry
- New
- Metal
- Fillings
- Tile industry
Based on the remaining minable quantity (volume) of the observed rock exposures, they can be categorized into three main groups namely Large (>100 000 m\(^3\)), Medium (20 000 - 100 000 m\(^3\)) and Small (< 20 000 m\(^3\)). There are few occurrences of IML “A” grade quarries and a significant number of “B” and “C” grade quarries. Highest remaining minable volume is recorded in the quarry sites of 52, 57, 61 and 64. Both environmental and other issues should be investigated prior to starting mining in full capacity at these localities. Several rock quarries (~20) have medium and small size of minable quantities. The reserves of each rock quarry and other relevant information are given in Annexure 01.

The reserves were estimated using surface area of rock exposure and mineable height and data collected from quarry owners during field investigations. However, actual allowable mining depths as well as allowable surface areas for mining have to be determined only after a comprehensive assessment of environmental and sociological issues.

Plate - 01

Plate - 02

Plate - 01 and 02: Excavated faces of two large charnockitic rock quarries (R 52 and 60)

During the field work, a small number of new rock occurrences were also identified. Prior to commencement of mining activities at these locations suitability of rocks and environmental issues should be further considered. Several other rock exposures encountered during field work are located at top of ridges lying within the forest reservation areas and therefore not considered for further evaluation. The locations of R05, R55, and R102 are more favorable to start new quarry sites.
Plate - 03 and 04: New charnockitic rock exposures suitable for quarrying (rock aggregates (R 55 and 102))

A number of abandoned rock quarries were found within the Galle district. Some have been mined for Southern Expressway and subsequently abandoned due to their proximity to the road. But some other quarries were abandoned due to different reasons such as environmental problems, cancellation of license due to illegal or improper mining activities and unsuitability of rock for metal. Only some abandoned quarries (around 20) are marked during field investigations and out of them quarry number R02, 03, 37, 47, 49, 53, 56, 58, 74, 75, 76 and 107 can be operated subject to conditions. If the demand for construction materials is increased in the future, these quarries would be useful.

Plate - 05: An abandoned quarry with charnockitic outcrop used as metal or filling materials (R 38)
Plate - 06: An abandoned quarry with charnockitic to granulitic can use as filling material (R 56)
There is a significant number of currently operating quarries (around 80) within the Galle district. Some of them are large and most of them are medium (IML”B” grade) size quarries.

Different types of rocks have been identified during field investigations within Galle district. Depending on the type of rock its strength would differ, accordingly suitability as a construction material would also vary. Most of the rock exposures are charnockite or charnockitic gneisses. They are strong (except high fracturing/jointing) enough to use as metal. Some rocks are garnet granulite to quartzofeldspathic. Even though they are strong, most of the quarry owners are reluctant to use it to produce metal as it damages the crusher (R 47, 56). So, some of these rock quarries were abandoned and others were not working properly. These rocks can be used for construction of Gabion walls. There are several rock quarries of garnet biotite gneissic rock composition (R 107,105,100,99,94,74,65,58,57,56,49,48,43,42 and 27). They are not much strong as charnockite and are normally not used as metal. But some of these rocks possess attractive appearance and can be used to produce tiles. A working quarry which produces large (~2*2m) blocks for tile industry was identified during field investigation (R 57). Similar rocks identified elsewhere in the district can be used in the tile industry. This type of layered rocks could also be used in gabion walls.

Plate – 07: A Garnet biotite gneiss quarry producing point rock pieces for walls (R 93)

Plate – 08: Large scale mining of garnet biotite gneiss rock pieces for tile industry (R 56)

Usually safety measures are poorly followed within quarry sites, most of the currently mining rock exposures have steep walls and benching is rare. Several rock quarries were abandoned due to ground water issues.
Plate - 09: A steep quarry face (R 17)
Plate - 10: A small water fall draining over a quarry face during rainy season (R 18)

9.1.2. Gravel/Soil Occurrences

Soil/gravel is mainly used as a filling material in road constructions and low land or marshy land reclamation to construct different building complexes. It is sometimes used in tea industry.

A thick soil/gravel profile above the weathered rocks is a common feature found in the district. Most of these soil bearing areas are cultivated with tea, palm, cinnamon or coconut and occasionally a bare land could be observed. During the field investigations some of these soil/gravel bearing mineable areas were identified and marked. The details of each of these localities are mentioned in the Annexure 02. Most of the localities are new occurrences.

Most of the areas within the Galle district except coastal areas have a relatively elevated terrain. These areas are rich in soil/gravel occurrences. In the construction of (e.g. Southern expressway), bulk of the soil/gravel requirements were met by cut and filling of ridges/hillocks found within the road track. So, it was not a major issue as currently seen in Hambantota district. But soil/gravel demand is high in the coastal areas since the construction activities are increased due to development of tourism industry. In order to supply soil/gravel for these areas, soil/gravel occurrences within a reasonable distance would be more useful.
Plate – 11: An abandoned gravel mining area within the Galle district (G 94)
Plate – 12: A new gravel bearing locality cultivated by tea (G 24)

During the field survey only the presently mineable occurrences were taken into account. But there is a much larger soil/gravel bearing area on cultivated ridges/hillocks. Specially in Karandeniya, Ambalangoda and Imaduwa areas, its thickness is about 5-10 meters. Cinnamon and/or tea is cultivated on these lands. However, these lands would have to be released in the future for soil/gravel mining, depending on the type of the construction project, soil demand, environmental and social conditions.

Plate – 13 and 14: Thick gravel cover over the charnockitic bed rock (G 74 and 64)

A significant number of rock quarries is having a gravel cover above the fresh rock within the Galle district. Some quarry owners are faced with difficulties in removing this gravel cover and exposing the fresh rock for mining due to regulatory issues. This gravel cover could be used as an alternative for gravel demand of the district.
Some of these locations are G 63, 64, 65, 74 etc. and details of them are mentioned in Annexure 02.

10. Conclusions

10.1. Rocks

- Almost all rock exposures within the district are associated with at least a small ridge/hillock and therefore below surface mining is not conducted at present. However, depending on the construction projects and demand below surface mining would have to be conducted in future within an adequate environmental and social framework.

- Except in forests and cultivated lands, rock outcrops are rare in elsewhere of the district to commence new quarries. However, some of the abandoned quarries can be restarted by taking suitable steps to solve the environmental and social problems associated with them.

- Total identified and estimated extractable volume of rocks in the Galle district is about 16 295 840 m$^3$.

10.2. Sand/Soil/Gravel

- Occurrences of large deposits of river sand are rare and mining of river sand is also rare (due to environmental concerns). No reserves are available at most of the inland sand mining areas marked in the base map. Inland sand mining has caused environmental and social problems due to improper mining and keeping the pits without proper rehabilitation. So finding sand for large construction projects at a reasonable distance is virtually impossible.

- Soil/Gravel demand is high in coastal areas due to the booming construction activities related with growing of tourism industry. But towards middle and NE part of the district soil demand is relatively less.

- Before opening a gravel pit in a particular area, the drainage pattern in and around it should be studied in order to avoid any adverse effect of mining to the nearby streams.

- Proper rehabilitation of gravel pits is lacking and these would create considerable environmental problems in the future.

- Total identified and estimated extractable volume of soil/gravel in the Galle district is about 820 439 m$^3$. 
11. Recommendations

11.1. Rocks

- It is necessary to identify the suitability of rocks (as an aggregate material and for tile manufacture) by considering the geological and geotechnical factors.

- In order to determine the suitability of rock materials for road construction and other structural work, representative rock samples from each and every quarry site will have to be subjected to strength analysis. By conducting some of the following tests as appropriate.
  1. Aggregate Impact Value (AIV)
  2. Los Angeles Abrasion Value (LAAV)
  3. 10% Fine Value
  4. Aggregate Crushing Value (ACV)
  5. Flakiness Index (FI)

- It is required to identify sites having large volume of rock material and clusters of smallest capacity sites and reserve these zones for mining purposes.

- Rock exposures should be mined with benching along proper angle and safety precautions should be followed.

11.2. Sand/Soil/Gravel

- When mining gravel/soil formations for use as a filling material, it is recommended to mine these formations, only above the general ground surface. This will avoid creation of unnecessary water logged pits in the area.

- The top soil layer should be used to backfill the excavated surface as it can help to re-establish the natural environment of the particular location. After completing mining activities, it is recommended to level the mined out area and grow local plants on the top of leveled area to avoid soil erosion.

- Steps will have to be taken to curb illegal mining activities
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