CRITICAL EVALUATION OF THE QUARRYING METHOD AT ARUWAKKALU LIMESTONE OPEN - PIT

by

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Abstract

The future of cement production at Puttalam Cement Factory greatly depends on the rational utilization of limestone and the quality of limestone quarried from the Aruwakkalu limestone open - pit. These factors have a direct relevance to the existing quarrying method. Since a quarrying method consists of stripping operations and quarrying operations, this paper critically analyzes the existing stripping operations and quarrying operations at Aruwakkalu open - pit and, suggestions for improvements in the existing quarrying method are made.

1.0 Introduction

The Aruwakkalu limestone deposit which lies about 27 Km North of Puttalam, has been a source of raw material for the cement industry since 1969. The Puttalam Cement Factory situated at Palavi, about 7 Km from Puttalam, has been consuming 700,000 tons of limestone annually. As limestone is the major raw material for cement production, the future of cement industry depends on the rational utilization and the quality of limestone.

In Puttalam cement, the chemical composition of limestone as the major raw material should meet the following requirements :

Component	Range
i. $CaCO_3$	> 76%
ii. SiO_2	12.5% - 18%
iii. Al_2O_3	1.8% - 3.5%
iv. Fe_2O_3	1.5% - 2.5%
v. MgO	< 2%

The chemical composition of limestone in Aruwakkalu area is highly variable. Therefore, in order to maintain the quality of required raw material, to utilize the limestone rationally and, to minimize the production cost, the quarrying method at Aruwakkalu open - pit has to be continuously evaluated.

2.0 Description of the Existing Quarrying Method

2.1 Stripping Operations

Before commencing quarrying operations, red earth formation overlying the limestone has to be completely removed. The thickness of this overburden varies from 3m to 20m. The stripping operations, mainly developing towards the North, are a single bench operation. Some stripping work is being carried out on the West bank of the quarry and this work is bounded on the West by the coast line. In the initial stage of stripping, excavated overburden had been dumped along the South boundary of the quarry covering a considerable area (Figure 1).

As the overburden contains unconsolidated substances, it can be removed without drilling and blasting. One bulldozer, one push shovel of $3.2m^3$ bucket capacity and three dumpers of 30 tonne carrying capacity each are employed in stripping work. After bulldozing the overburden, the push shovel loads out the dumpers which transport the waste material to a new waste dump located 1 Km away from the East bank of the quarry.

2.2 Quarrying Operations

The limestone quarried at Aruwakkalu is sorted into the following two grades.

(a) Low grade siliceous limestone where $CaCO_3$ content is 65% - 76%, (loose material).

(b) High grade limestone, where $CaCO_3$ content is more than 76%, (hard material)

Quarrying of limestone is carried out using a single bench. Siliceous limestone formation overlying the

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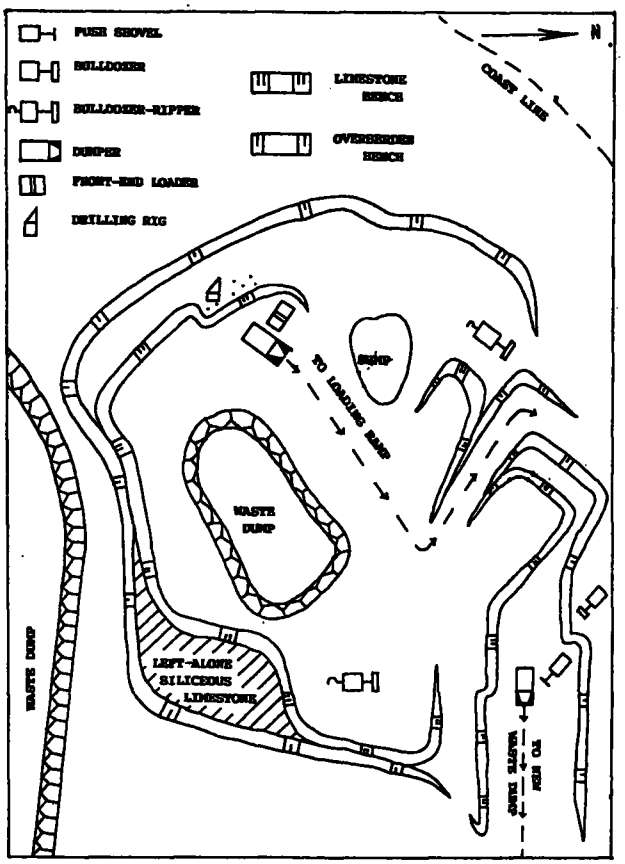

Figure 1 - Plan View of the Existing Quarrying Method

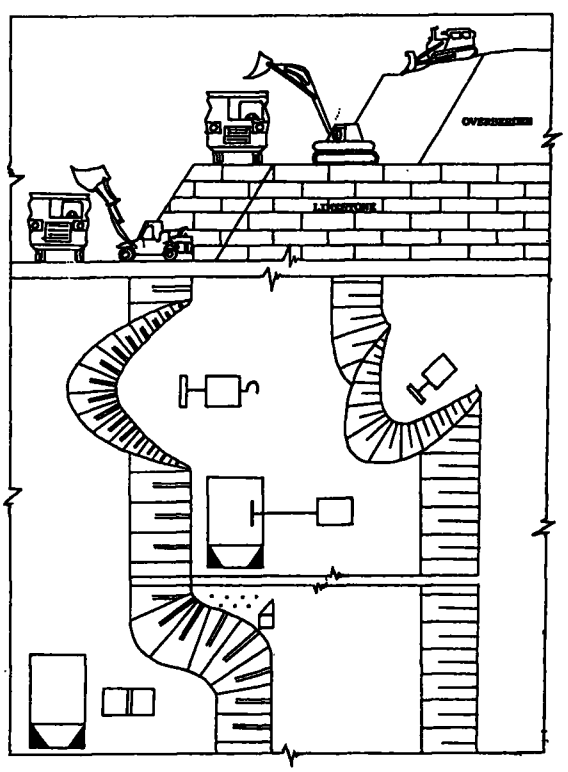

Figure 2 - Existing Quarrying Method (Section and Plan)

high grade limestone is ripped with two bulldozer - rippers before drilling and blasting operations are commenced to loosen the hard material. The ripped material is loaded into dumpers with a front-end loader of 2.7m^3 bucket capacity and transported to the loading ramp (Figures 1 and 2). At the loading ramp this material is separately unloaded to blend with the high grade limestone when loaded into rail cars. Where the siliceous limestone pockets extend as far as the bottom of the quarry covering large areas, part of those pockets are ripped and the rest is either left alone or removed to the waste dump.

Drilling of vertical boreholes in the high grade limestone is done with a crawler-mounted percussion drill. 75 mm diameter bore holes with the depth varying from 6m to 12m are drilled on a 2.5m x 2.5m grid.

A mixture of ammonium nitrate and fuel oil (ANFO) is used as the explosive. After blasting, a front-end loader of 2.7m^3 bucket capacity, loads the loosened high grade limestone into the dumpers which haul the material to the loading ramp. Then the high grade limestone is loaded into rail cars with low grade limestone to get the required raw material quality and transported to the cement factory at Palavi. Three dumpers of 3 tonne carrying capacity are engaged in haulage of both high grade limestone and low grade limestone.

3.0 Discussion and Suggestions for Improvements in the Existing Quarrying Method

3.1 Overburden handling and waste dumps

It is pointed out that the red earth removed with the push shovel is hauled with dumpers to the waste dump which lies about 1 Km away from the East bank of the quarry. Such external waste dumps not only destroy areas of vegetation, but, also make it impossible to quarry limestone reserves beneath them. Internal dumps will facilitate subsequent land reclamation and revegetation, minimizing environmental hazards. Hence, dumping of excavated overburden into quarried-out area seems to be the most suitable arrangement. This can easily be practiced with a scraper-bulldozer combination-SBC (Figure 3).

Scraper-bulldozer combinations find their greatest use in unconsolidated materials that require no loosening up before loading. It is proved that SBC has its prominent advantages in loading and haulding overburden where the haulage distance does not exceed 1 Km. (Pfleider, E.P., 1968). Therefore,

(i) It is imperative to replace the push shovel and three dumpers employed in stripping operations with a scraper-bulldozer combination which considerably reduces operating costs. (In this context, it is advisable to lease a tractor wheel scraper rather than purchasing it).

(ii) It is strongly recommended to practice inpit dumping to minimize the environmental hazards and, the initial cost of land reclamation and revegetation as well.

3.2 Cement Raw Material Handling and Bench System

It is pointed out that there are high losses of low grade siliceous limestone during quarrying due to large siliceous limestone pockets which are a common sight in Aruwakkalu quarry. Hence, on the basis of the rational utilization of limestone, establishment of two raw material benches which reduces the earlier bench height by half, seems to be the most practical option (Figure 4). Double - bench system needs twice the working face area leading to the selective quarrying of limestone. This enables practicing of blending of limestone in the process of transporting, instead of blending at the loading ramp which accounts for a higher proportion of operating costs.

Furthermore, one push shovel and three dumpers released from stripping work are in reserve. Therefore,

(i) It is imperative to establish the Double - bench system for the maximum utilization of low grade siliceous limestone.

(ii) It is essential to employ the push shovel and one more truck in quarrying operations to practise the blending of limestone in the process of transporting. (In this context, it is advisable to lease the remaining two dumpers to any other organization).

4.0 Acknowledgements

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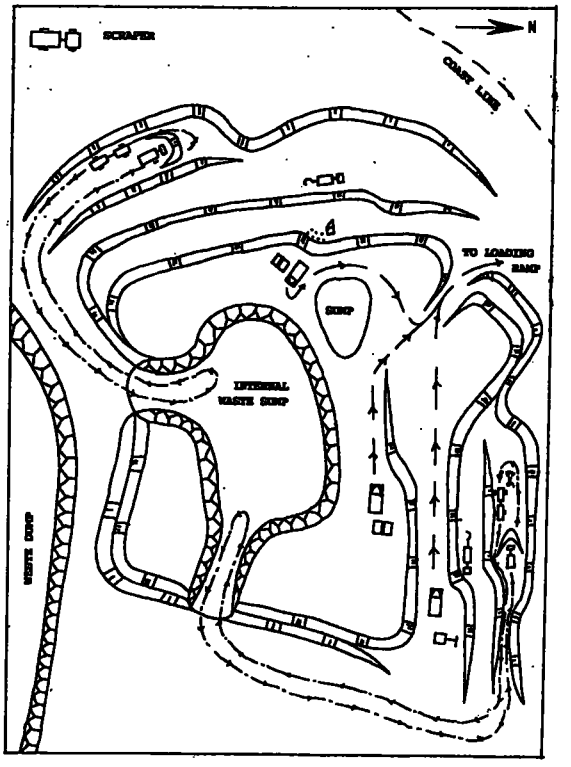

Figure 3 - Plan View of the Proposed Quarrying Method

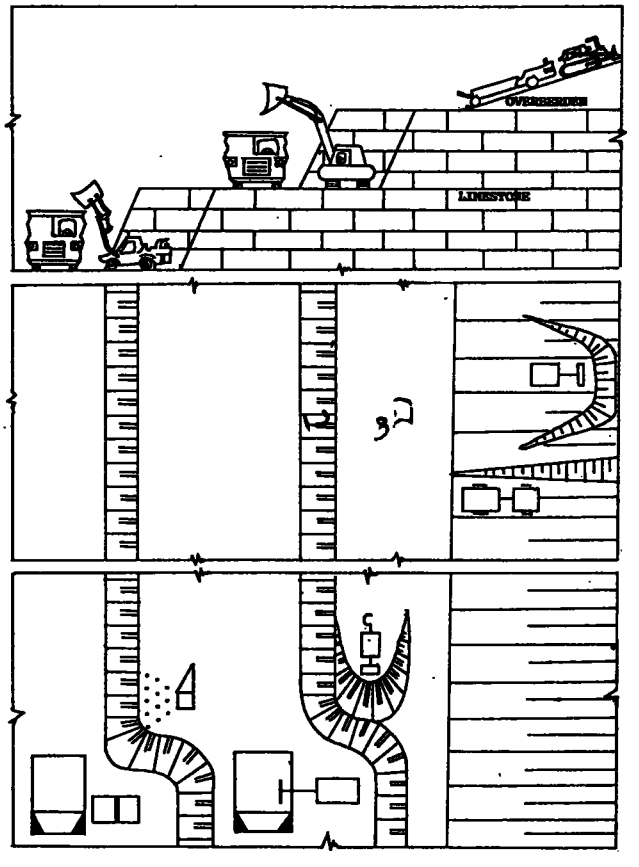

Figure 4 - Proposed Quarrying Method (Section and Plan)