Cost estimation and Development of Cash Flow on Mining Operation (IML/A category quarry operation)

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Abstract: More than 70 quarry operations are conducted under the IML/A Category license all over the country. The high demand of metal aggregates for the construction industry (road and buildings constructions) has made industrial quarry operations one of the most profitable mining operations in Sri Lanka. However, present economic situation and increase the number of IML/A category quarries in Kaluthara District (13 quarries) causing problems in aggregate industry in this area. Manufactured sand produced in quarries has become a better solution for scarce sand resources as well as to increase the quarry operation revenue. During this study three quarry sites in Kaluthara District were studied in detail and cost benefit analysis was made. Among these TAMAC quarry site was the main source for the study. Selection of a quarry site with low operation cost with minimum damage to the environment plays the major role in success. Proper blasting techniques, crusher plant design, selection of machinery and friendly environmental could increase net profits and help to continue operations in a sustainable manner.

Keywords: Crusher, Machineries, Sustainable, Quarry,

1 Introduction

Although there are more than seventy quarry sites in Sri Lanka with IML/A category licenses, most of them do not operate in a profitable manner. In addition to that, due to poor planning at the initial stage and high capital cost has been used for poor selection of machinery cause to increase in the production cost. Under this situation they spend less amount of money for proper environmental protection, safety and workers welfare.

Therefore, this study highlights proper machinery to be purchased and reduction of the cost of production with consideration on environmental protection and sustainable development. Study covers the identification of main costing items, calculation of costs, and preparing cost estimation for an IML/A category quarry and crusher plan.

2 Methodology

Cost estimation and development of cash flow statement for an IML/A category

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quarry site and crusher plant, following steps were under taken in this study. Activities (past, present) of three major quarry sites in Kaluthura district were studied. Lanka quarries Thalagala (OP-15), Maga quarry Neboda (OP-4) and TAMAC quarry Nehina (OP-Newly stated) OP- Operational period.

Production levels and cash follow levels of each site were also studied.

Capital cost, recurrent cost and cash follow statement for new an IML/A quarry site were studied.

Following assumptions were made

- Monthly production target is 10,000 m^3.
- Capacity of the crusher plant is 80m^3/h
- Lease land for 15 years
- Capital cost depreciated to six years.

3 Results and Discussion

According to the present market value, suitable machineries (given in the table 1) and 80 tons/m^3 crusher plant with cone crusher will cost approximately 75 millions.

The study showed the number of machineries used in three different quarry sites with different production targets 12000 m^3, 8000 m^3, and 6000 m^3 were sufficient for their production. However, delay in production was mainly due to poor maintenance of machineries. Purchase of large number of machinery has caused to increase the capital investment and production cost. Capital investment can be reduced by keeping only the essential machineries. Proper maintenance of machineries, may reduce the cost of stand by machineries maintenance of proper contacts with machinery suppliers is essential to hire the machineries during the machinery breakdown and to continue the production, without affecting the production targets.

In Lanka quarries, distance from the quarry to the crusher plant was more than 600 m. therefore had to use large number of dump trucks.

Table 1. Quarry machineries details at Lanka quarry (Q_1), Maga quarry (Q_2), TAMAC quarry (Q_3) and proposed quarry (Q_4).

Machineries	Quantity (No)			
	Q_1	Q_2	Q_3	Q_4
Excavators	2	2	1	1
Breakers	2	1	1	1
Wheel loaders	2	2	1	1
Air compressors	3	2	1	1
Dump trucks	3	2	1	2

Table 2. Quarry blasting details at Lanka quarry, Maga quarry and TAMAC quarry.

Parameters	Lanka	Maga	TAMAC
No of holes per blast	20	20	15
Hole depth(m)	3.6	3	3
Hole angle(^{0})	10	5	10
Spacing(m)	1.4	1.3	1.2
Burden(m)	1.3	1.2	1.1
Initiating system	E.D	E.D	E.D
Base charge	DM	DM	Dm
Column charge	ANFO	ANFO	ANFO
Production level(m^3)	12000	8,000	6,000

ED - Electric detonator, DM – Dynamite
ANFO - Ammonium Nitrate + Fuel Oil

Table 3. Current prices of explosive.

Explosive type	Price(Rs)
Electric Detonators(ED)4m	102.00
Dynamite (per Kg)	780.00
Emulsion(per Kg)	585.00
Ammonium Nitrate (per Kg)	90.00
Fuel oil (per litter)	75.20

Number of dump trucks could be minimized by reducing the distance from quarry to crusher plant.

Therefore two dump trucks could have been sufficient for the proposed quarry and crusher plant.

According to our observations, some quarries have permanent breakers. The breaker can be used as an excavator by replacing breaker unit by the excavator bucket in the case of excavator breakdown. Therefore the need to keep stand by excavator can be eliminated by keeping a rubble stock, which can be directly fed to the crusher plant. Therefore one excavator with breaker unit (200 m^3) and an excavator are sufficient to the proposed quarry and crusher plant.

Using large number of air compressors cause to increase capital cost, maintenance cost and fuel cost. Keeping of stand by compressor can be avoided by having drilling stock. Therefore two air compressors (300CFM) would be sufficient for the proposed 10,000m^3 quarry site.

In Lanka quarries wheel loaders are sometimes used to feed rubble to the crusher plant. Using a wheel loader with dump trucks to feed rubble to the crusher plant will increase the cost. Main duties of the wheel loader should be loading the productions (aggregates) to the trucks and transport the extra production to the stock piles. So one wheel loader is enough for the proposed site. But the maintenance of the wheel loader should be done properly and contacts should be kept with the machine suppliers to hire a JCB or wheel loader. It is essential to continue the production during any breakdown of the wheel loader.

Selection of the generator is very important in the selection of machineries. Having over capacity generators increase the capital cost, maintenance cost and also fuel cost. According to the design of the crusher plant, the 600KVA generator is required to provide the required power for motors.

To achieve the target, the proposed crusher plant can be designed as given in figure 1.

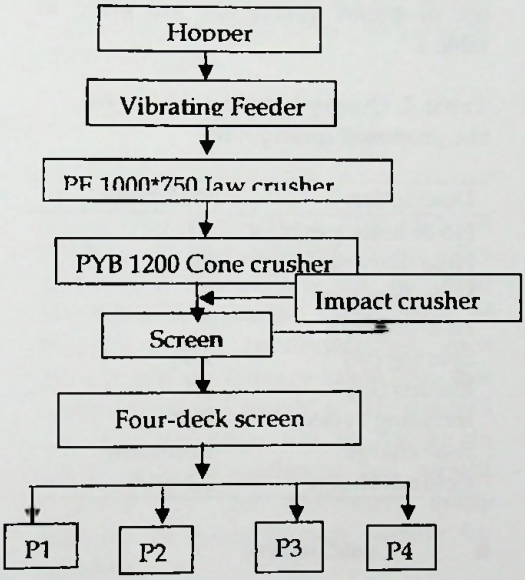

Figure 1. Flow diagram of the proposed crusher plant design.

Generally Dynamite is used as the base charge for blasting in most quarry site. But the blasting cost can be reduced approximately by 4 Rs/m^3 by using Emulsion. As our study was based on the quarry industry, it was essential to optimize the fragmentation in the point of economic view. This can be achieved by using optimum quantity of column

and base charges. The variation of cost and fragmentation can be show in figure 2.

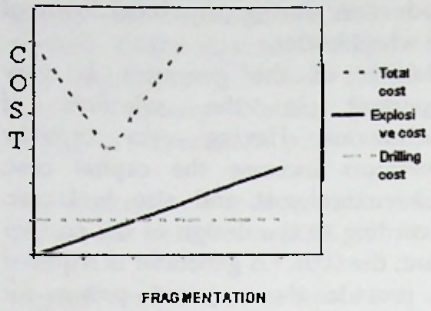

Figure 2. Variation of costs with fragmentation.

Other important blasting parameters for the proposed quarry site are given in table 4.

Table 4. Quarry blasting details for the proposed quarry site.

Description	Parameter
No of holes per blast	20
Hole diameter(mm)	34
Hole depth(m)	3
Hole angle(^{0})	8
Spacing (m)	1.3
Burden (m)	1.1
Initiating system	E.D
Base charge	Emulsion
Column charge	ANFO

4 Conclusion

This study shows the cash flow analysis of quarry and crusher plant having monthly production of 10,000 m^3. The required capital investment for this site is 80 million ruppies. Aggregate production cost is approximately 730Rs/m^3. On the basis of above the best capital cost depreciation period is considered as six years.

The below given costs are the most suitable cost values for the economical operation of 10,000 m^3 /month metal quarry.

Land owner payment	31 Rs/m^3
Royalty cost	3 Rs/m^3
Legal cost	2 Rs/m^3
Drilling cost	90Rs/m^3
Blasting cost	80Rs/m^3
Breaker cost	40Rs/m^3
Loading & Transport cost	105 Rs/m^3
Crushing cost	180 Rs/m^3
Development & Installation cost	75 Rs/m^3
Staff salary	35 Rs/m^3
Production cost	636 Rs/m^3
Over head 15%	95 Rs/m^3
Expected production cost (With over heads)	731 Rs/m^3

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