CHAPTER – 6

TECHNO-ECONOMIC ANALYSIS

6.1 INTRODUCTION

The cost of construction materials is increases incrementally. A primary purpose of the economic analysis is to attempt the estimate costs for a commercial size remediation. It was expected that stabilization/solidification technologies would be less expensive than most other technologies, such as incineration, landfill etc. Solidification/Stabilization (S/S) has proven to be a cost effective treatment technique for managing many heterogeneous waste materials. The S/S process incorporates binder reagents, such as cement, and designed to treat these wastes by improving physical aspects of the waste and chemically altering hazardous constituents within the waste [6.1 – 6.5].

The waste product of one industry is recycled as a substitute for virgin raw material of another industry, thereby reducing the environmental impact. Over a billion tons of construction and demolition wastes are being disposed of in road-bases and landfills every year, in spite the fact that cost-effective technologies are available to recycle most of it as a partial replacement for fine aggregate in concrete mixtures. There is increasing concern now that the choice of construction materials must also be governed by environmental considerations [6.4 – 6.6].

6.2 BASIS OF ECONOMIC ANALYSIS

The economic analysis was prepared by breaking into three groups. These were described in detail as they apply to the S/S process. The categories are as follows:
6.2.1 Price Rise

**Cement**: India, being the second largest cement producer in the world after China with a total capacity of 151.2 Million Tones (MT), has got a huge cement industry. Government of India giving boost to various infrastructure projects, housing facilities and road networks, the cement industry in India is currently growing at an enviable pace. More growth in the Indian cement industry is expected in the coming years. In India, the cost of cement during 1995 was Rs. 1.25/kg and in 2005 the price increased almost five times [6.3,6.6].

**Sand**: In India, river sand is used for construction. Over a period of 15 years from the year 1995 the price of sand has increased six times.

Cost is also increases due to high transportation costs of these raw materials.

6.2.2 Environmental Basis

**Cement**: The cement industry contributes about 5% to global anthropogenic CO₂ emissions, making the cement industry an important sector for CO₂ emission mitigation strategies. CO₂ is emitted from the calcination process of limestone, from combustion of fuels in the kiln, as well as from power generation [6.2].

**Sand**: Quantity of sand is reduced due to high demand, slow generation and it is also affect aquatic animal and vegetation.

6.2.3 Disposal or Landfill

Concrete has become the most widely used construction material primarily because of its affordability. In free market economy, costs are driven by supply and demand. Silica
fume, for example, started out as a waste product that would need to be disposed of at
great cost. But once it was understood that if used to replace a certain fraction of the
cement it would greatly improve the properties of mix its cost turned from a negative
value to a multiple of that of cement. Likewise, fly ash needed to be disposed of or
landfill creating environmental burden, not mentioning the ungainly sights that still mar
the landscapes of industrialization. But once it was recognized as a valuable cement
substitute, its cost reached a value cost to that of portland cement.

6.3 COST ESTIMATION

Costs of used materials are:

Cost of cement (43 Grade): 240 Rs/50 Kg
Cost of Sand (Narmada River Commercial Grade): 12500 Rs/500 ft²
Cost of Aggregate (10mm Down Commercial Grade): 5100 Rs/10 m
Landfilling Cost: 5000 Rs/Ton
Transportation Cost of Waste Material: 100 Rs/Km

6.3.1 Simple Unit Cost Formula

A project is decomposed into “n” elements for cost estimation. Let $Q_i$ be the quantity of
the $i^{th}$ element and $u_i$ is the corresponding unit cost. Then, the total cost of a sample is
given by eq. (6.1).

$$ Y = \sum_{i=1}^{n} u_i Q_i $$

(6.1)
Where, \( n \) is the number of units. Based on characteristics of the construction site, the technology employed, or the management of the construction process, the estimated unit cost, \( u_i \) for each element may be adjusted [6.7,6.8].

6.3.2 Formula Based on Labor, Material and Equipment

Consider the simple case for which costs of labor, material and equipment are assigned to all tasks. A project can be decomposed into \( n \) tasks. Let \( Q_i \) be the quantity of work for task \( i \), \( M_i \) be the unit material cost of task \( i \), \( E_i \) be the unit equipment rate for task \( i \), \( L_i \) be the units of labor required per unit of \( Q_i \), and \( W_i \) be the wage rate associated with \( L_i \). In this case, the total cost \( y \) is given in eq. (6.2).

\[
Y = \sum_{i=1}^{n} y_i = \sum_{i=1}^{n} Q_i (M_i + E_i + W_i L_i)
\]  

(6.2)

Note that \( W_i L_i \) yields the labor cost per unit of \( Q_i \), or the labor unit cost of task \( i \). Consequently, the units for all terms in Equation (6.2) are consistent [6.7,6.8].

6.3.3 Allocation of Joint Costs

Difficult causal relationship b/w element and associated costs-Joint costs are prorated in proportion of basic costs of elements For example; \( F \) being overhead associated with different elements in eq. (6.3).

\[
F_i = F \times y_i / y
\]  

(6.3)

Then total cost can be written as in eq. (6.4).

\[
L_i = y_i + F_i
\]  

(6.4)
6.3.4 Estimation of Operating Costs - Time stream of costs over the life of a roadway

The time stream of costs over the life of a roadway depends upon the intervals at which rehabilitation is carried out. If the rehabilitation strategy and the traffic are known, the time stream of costs can be estimated.

Using a life cycle model which predicts the economic life of highway pavement on the basis of the effects of traffic and other factors, an optimal schedule for rehabilitation can be developed. For example, a time stream of costs and resurfacing projects for one pavement section is shown in figure 6.1. As described, the routine maintenance costs increase as the pavement ages, but decline after each new resurfacing. As the pavement continues to age, resurfacing becomes more frequent until the roadway is completely reconstructed at the end of 35 years [6.7,6.8].

![Figure 6.1: Time Stream of Costs over the Life of a Highway Pavement](image_url)
<table>
<thead>
<tr>
<th>Sample Code</th>
<th>Capital Cost of Developed Concrete (Rs)</th>
<th>Weight of Treated Waste (gm)</th>
<th>Cost Benefit on Developed Concrete (Rs)</th>
<th>Total Cost Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cp</td>
<td>29153.94</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>1428.6</td>
<td>1796.607</td>
<td>1803.75</td>
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<td>6253.245</td>
<td>6275.694</td>
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<tr>
<td>S2</td>
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<td>3571.5</td>
<td>4966.241</td>
<td>4984.099</td>
</tr>
<tr>
<td>Fp</td>
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<td>2142.9</td>
<td>2694.905</td>
<td>2705.62</td>
</tr>
<tr>
<td>F1</td>
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<tr>
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<tr>
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<td>3593.089</td>
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</tr>
</tbody>
</table>

6.4 CONCLUSION

Developed concrete samples are more economic than fly ash replaced concrete. Cost samples F1 & F2 found durable and more cost beneficial in comparison to other samples. Saving after preparing a developed concrete is 746.1 – 532.84 Rs/100 ft². Replacement of cement and sand develop economic concrete and reduce CO₂ emission during the manufacturer of Portland cement.
REFERENCES


[6.3] Indian cement industry forecast 2010, RNCOS online business research 1-14.


[6.8] file:///G:/Th/chapter%206%20&%207/05_Cost_Estimation.html.