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Comprehensive Study of Roads Construction Networks and various waste materials used as alternate mixes

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ABSTRACT

Naturally available materials like soil, stone aggregates, sand etc. had been used for construction of roads. For example, boulders, volcanic tuff and lime were used for the construction of Roman roads. Subsequently, as the civilization grew, some of the naturally available materials were processed further to derive new binding materials for example, bitumen, cement etc. Generation and properties of recycled materials varies from place to place and from time to time depending on the location and construction activity as well as type of construction projects at a given site.

Keywords: waste, alternate, roads, construction.

INTRODUCTION

Road Construction is vital to the economic development, trade and social integration. It facilitates smooth conveyance of both people and goods. Size of the road network, its quality and access has a bearing on transport costs. Besides, road network promote specialization, extend markets and thereby enable exploitation of the economies of scale. Global competition has made the existence of efficient road transport and logistics systems in delivery chain an absolute imperative. Easy accessibility, flexibility of operations, door-to-door service and reliability has earned road transport an increasingly higher share of both passenger and freight traffic vis-à-vis other transport modes. Transport demand in India has been growing rapidly. In recent years this demand has shifted mainly to the advantage of road transport, which carries about 87 per cent and 61 per cent of passenger and freight transport demand arising for land based modes of transport (i.e. roadways and railways taken together) respectively. Road transport has grown despite significant barriers to inter-State freight and passenger movement compared to inland waterways, railways and air which do not face rigorous *enroute* checks/barriers. Given the importance of road network, it is vital to have comprehensive data on road infrastructure to assist in policy planning and investment decisions.

Growth in Road Length

The total road length in India had increased significantly from 3.99 lakh km as on 31.3.1951 to 41.10 lakh km as on 31.3.2008. Concomitantly, the surfaced road had increased from 1.57 lakh km to around 20.36 lakh km over the same period. The increase in road length during 1950-51 through 2007-08 is depicted in Figure 1.

The share of the surfaced road length in the total road length also reflected an improvement. Surfaced road length accounted for 49.5 % of total road length as of 31.3.2008, compared with 39.3% of the total road length as of 31.3.1951.The total road length had expanded significantly since 1970s. It increased from 9.15 lakh km in March 1971 to 41.10 lakh km in March 2008 - an increase of 349 % over these 37 years yielding a compound annual growth rate (CAGR) of 4.1 %. The total road network in the country grew from 36.21 lakh in March 2004 to 41.10 lakh in March 2008 reflecting an increase of 4.89 lakh km yielding a CAGR of 3.2 % over this period.

Category wise Growth in Roads

As seen from the Table 1, the total surfaced road length grew from 3, 97,948 km (accounting for 43.5% of the total road length) in 1971 to 20,36,063 km (accounting for 49.5 % of the total road length) in 2008 reflecting a more than fivefold increase in surfaced road length. Category wise classification of road length showed that

during this period, the length of National Highways (NHs) increased from 23,838 km to 66,754 km – an increase of over 180 % or CAGR of 2.8 %. During the same period, the length of State Highways (SHs) increased from 56,765 km to 1, 54,522 km (an increase of over 172 % or CAGR of 2.7 %) and the length of Other PWD roads increased from 2,76,833 km in 1971 to 8,63,241 km in 2008 (an increase of about 212 % or CAGR of 3.1 %). Various categories of urban roads together expanded in length from 72,120 km to 3, 04,327 km reflecting an increase of over 322 % or CAGR of 3.97 %. The highest growth over these 37 years took place in respect of Rural Roads which increased from 3,54,530 km to 24,50,559 km (including 10,61,809 lakh km roads constructed under JRY & PMGSY)registering an increase of nearly 591 % and a CAGR of 5.4 %. The lowest growth, however, took place in the length of Project roads which increased from 1, 30,893 km in March 1971 to 2,70,189 km by March 2008 resulting in a growth of 106 % and a CAGR of 1.98 % only. The graphical representation of the growth trend of road length by category of roads between 1950-51 and 2007-08.

ROAD NETWORK EXPANSION CATEGORIES

The data compiled on road network can be broadly classified into five broad categories:

(1) National Highways (NHs)
(2) State Highways (SHs)
(3) Other PWD Roads
(4) Rural Roads
(5) Project Roads.

The National Highways, running across the length and breadth of the country, had a length of 66,754 km at the end of March 2008. National Highways comprise less than 2 per cent of the road network, but carry a high volume of the road-based traffic. State Highways (SHs) and Major District Roads (MDRs) constitute the secondary system of road transportation in the country. The State Highways connect National Highways, district headquarters, important towns, tourist locations and minor ports. The total length of State Highways is about 1,54,522 km. The remaining predominantly large segment of the total road network of about 3.89 million km is covered by the Other PWD Roads, Rural Roads and Project and Urban Roads. About 60 % of the total road length in India is accounted for by rural roads consisting of

(i) Panchayat Raj Roads (about 33 %) i.e. Zilla Parishad roads, Village Panchayat Roads and Panchayat Samiti roads; and

(ii) roads constructed under Jawahar Rojgar Yojna (JRY) and Pradhan Mantra Gram Sadak Yojana (PMGSY) accounting for a 26% share in rural roads.

Roads constructed under the JRY (about 22 %) are of limited value from the point of view of movement of heavy traffic as only about 20 % of such roads are surfaced. The decadal figures of the road network under all these categories are provided in the Table 3. As would be seen from the table, the aggregate length of roads, which was 0.4 million km in 1950-51, had increased more than 10 fold to 4.11 million km by 2007-08.

WASTE MATERIALS USED IN ROAD CONSTRUCTION

Several researchers have tried to incorporate bottom ash and fly ash in various layers of pavement. Fly ash has been used as bulk filler in construction of embankments and flyovers. However, due to corrosive nature of bottom ash, its usage near metallic structures is limited. Studies have indicated that bituminous concrete containing bottom ash is susceptible to rutting but more resistant to stripping. Some field studies have indicated increased skid resistance when bottom ash is used as top wearing course of road.

Flyash is generally final than portland cement (1 to 50 microns in diameter) and consists mostly of small spheres of glass of complex composition involving 40 to 50 percent silica oxide, 5 to 40 percent ferric oxide and 5 to 35 percent alumina oxide. It is useful in cement and concrete application. Fly ash is a pozzolan, a siliceous material which in the presence of water will react with calcium hydroxide at ordinary temperature to produce cementitious compound. It is removed from the plant by exhaust gas. Fly ash is a product of burning finely ground coal in a boiler to produce electricity.

Recycled Aggregate Concrete : With the concept of its use in making Bricks and Highway Pavement, the recycled aggregate concrete was used for casting curve, chute drain, median drain & side drain components of Highways. A concrete mix with recycled aggregate was designed in the grade of M 25 with cement content of 300 Kg/cum. Chute drain Components were pre-cast with this concrete mix. A typical chute drain element is shown in figure 8. This has been used at elevated road side embankment and is performing very well.

Figure 1: Stone Aggregates Alternatives

Figure 2: Fine Stone Aggregates used in Road construction

Silica Fume is used in concrete to improve its properties like compressive strength, bond strength and abrasion resistance; reduces permeability and therefore more durable and helps in protecting reinforcing steel from corrosion. Microsilica's high silica content is also high in purity and thus better pozzolanic properties. Reacting with calcium hydroxide (product of cement's pozzolanic reaction), microsilica will produce calcium silicates that will result in denser concrete with increased compressive strength like 100 MPa or more with is similar to mild steel. In the specific application like bridge deck overlays, water retaining structures or monumental structures; it is very useful.

Recycled Concrete Material (RCM), also known as crushed concrete is similar to demolition waste. Primary sources of RCM are demolition of existing concrete pavement, building slabs & foundations, bridge structures, curb and gutter and from commercial/private facilities etc. It is a reclaimed material. This material is crushed by mechanical means into manageable fragments and stockpiled.

Glass : When glass is properly crushed, this material exhibits physical properties similar to coarse sand. It has

very low water absorption. High angularity of this material, compared to rounded sand, may enhance the stability of Bituminous / asphalt mixes. In general, glass is known for its heat retention properties, which can help decrease the depth of frost penetration. Such material can be used in concrete construction as fine or course aggregate.

Crumb Rubber (CR): Shredding waste tyres and removing steel debris found in steel-belted tyres generate crumb rubber (CR). There are various mechanical methods used to shred apart these tyres to Crumb Rubber i.e. the crackermill, granulator, and micromill methods and others. CR can also be manufactured through the cryogenation method. This method involves fracturing the rubber after reducing the temperature with liquid nitrogen. CR is fine rubber particles ranging in size from 0.075mm to 0.475mm. It also gives better resistance to water exposure and flash and fire point. Thus CRMB is effectively used in bearing coat of Flexible pavements ie in SDBC layer. This is also good for use in hot climate roads.

Plastics Waste: Though, used Plastic is considered a pollution menace, but it can find its use in construction Industry/processes and thus can help solving the problem of pollution. Plastic waste or polythene begs is a form of a Polymer and its properties are similar to polymer to some extent.

Plastic bags are non degradable material, so it cannot be decomposed and used as organic manure. Some plastic bags can be reused or it can be reprocessed by converting it to granular form and then re-rolling it in the form of sheets. Rest of plastic bags is either land filled or incinerated. Both methods are not eco-friendly processes and they pollute the land and water bodies.

CONCLUSION

The waste materials are fly ash, blast furnace slag, cement kiln dust and industrial wastes posing problems in the disposal and being deposited near various industries. It is hoped that availability of suitable technology, appropriate legislation and awareness among all stakeholders would widen the possibilities of using some of the waste materials for sustainable road construction. Fly ash can be used in concrete admixtures to enhance the performance of concrete roads and bridges. The technologies and the materials used for development should complement the use of local resources and waste management. Possible use of several solid wastes along with waste water is described in this article. Out of the processing of waste like demolition waste one can make Concrete bricks, use in highways and roads.

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