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USE OF RECYCLE SOLID WASTE FOR CONSTRUCTIONOF ROAD PAVEMENTS

Avinash chaudhary, Mrs. Bina B. Patel, Mr. Kartik Zala

Department of Civil Engineering, Venus International Collage of Technology , Bhoyan Rathod, Dist. : Gandhinagar.
avinashchaudharybvm@gmail.com

ABSTRACT

Municipal solid waste (MSW) management is a major problem in world today. Current global MSW generation levels are approximately 1.7-1.9 billion metric tonnes per year, and are expected to increase to approximately 2.8 billion tonnes per year by 2025. MSW generation rates are influenced by economic development, the degree of industrialization, public habits, and local climate. A significant amount of debris resulting from various activities is currently disposed of in landfills. Landfilling of this debris results in a large burden on the world's natural resources and an increasingly expensive problem for solid waste management. Currently, the transportation industry is under increasing pressure to use alternate or secondary materials because of its high-volume consumption of bulk materials (such as natural fine and coarse aggregates) in road construction. Materials including industrial by-products, concrete aggregates, old asphalt pavement, scrap tyres, fly ash, steel slag, and plastics are often used as alternate materials for natural aggregates

KEYWORDS: solidwaste management, solidwastes,

1. INTRODUCTION

Over the years, there has been a continuous migration of people from rural and semi-urban areas to towns and cities. The proportion of population residing in urban areas has increased from 25.70% in 2001 to 36.83% in 2011. The number of class I cities has increased from 394 to 468 during 2001 to 2011, while class II cities have increased from 345 to 410 during the same period. The increase in the population in class I cities is very high as compared to that in class II cities. The uncontrolled growth in urban areas has left many Indian cities deficient in infrastructural services such as water supply, sewerage and municipal solid waste management. Most urban areas in the country are plagued by acute problems related to solid waste. Due to lack of serious efforts by town/city authorities, garbage and its management has become a tenacious problem and this notwithstanding the fact that the largest part of municipal expenditure is allotted to it. It is not uncommon to find 30-50% of staff and resources being utilized by Urban Local Bodies for these operations. Despite this, there has been a progressive decline in the standard of services with respect to collection and disposal of municipal solid waste including hospital and industrial wastes, as well as measures for ensuring adequacy of environmental sanitation and public hygiene. In many cities nearly half of solid waste generated remains unattended, giving rise to insanitary conditions especially in densely populated slums which in turn results in an increase in morbidity especially due to microbial and parasitic infections and infestations in all segments of population, with the urban slum dwellers and the waste handlers being the worst affected.

1.1 Problem Statement:

Production of synthetic and processed materials is vital for the growth of modern societies. Such production results in the creation of large quantities of solid waste materials (SWMs). Many of these SWMs remain in the environment for long periods of time and cause waste disposal problems. Existing landfills are reaching maximum capacity and new regulations have made the establishment of new landfills difficult. Disposal cost continues to increase while the number of accepted wastes at landfills continues to decrease.

One answer to these problems lies in the ability to develop beneficial and sustainable uses for these wastes by recycling complex SWMs into useful products. The reuse of industrial by-products in lieu of virgin traditional materials would relieve some of the burden associated with disposal, and may provide inexpensive substitutes.

2. Types of Solid waste

2.1 Reclaimed Asphalt Pavement:
Reclaimed asphalt pavement (RAP) is the term given to removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction, resurfacing, or to obtain access to buried utilities. When properly crushed and screened, RAP consists of high-quality, well-graded aggregates coated by asphalt cement.
Asphalt pavement is generally removed either by milling or full-depth removal. Milling entails removal of the pavement surface using a milling machine, which can remove up to 50 mm thickness in a single pass. Full-depth removal involves ripping and breaking the pavement using a rhino horn on a bulldozer and/or pneumatic pavement breakers. In most instances, the broken material is picked up and loaded into haul trucks by a front-end loader and transported to a central facility for processing. At this facility, the RAP is processed using a series of operations, including crushing, screening, conveying, and stacking.
2.2 Reclaimed Concrete Material:
Reclaimed concrete material (RCM) is sometimes referred to as recycled concrete pavement (RCP), or crushed concrete. In India, about 14.5 MT of solid wastes are generated annually from construction industries, which include wasted sand, gravel, bitumen, bricks, and masonry, concrete. It consists of high-quality, well-graded aggregates, bonded by a hardened cementitious paste. The aggregates comprise approximately 60–75% of the total volume of concrete. RCM is generated through the demolition of Portland cement concrete elements of roads, runways, and structures during road reconstruction, utility excavations, or demolition operations.
Solvents define a major portion of the environmental performance of a process and also influence safety and health issues. In the industry, selection of solvents for chemical processes and subsequently the waste-solvent management are based on economic, safety and logistical considerations[8]. The pharmaceutical industry has made significant efforts towards identifying organic solvents with a reduced ecological footprint as compared to traditional reactions. Green solvents such as water, liquid polymers, ionic liquids, bio-ethanol, supercritical fluids and ethyl lactate hold considerable additional promise.
2.3 Scrap Tyres:
Scrap tyres can be managed as a whole tire, a slit tire, a shredded or chipped tire, as ground rubber, or as a crumb rubber product. About 75 MT of tyres are discarded each year by India by the motorists.
A typical scrapped automobile tire weighs 9.1 kg.
Roughly 5.4–5.9 kg consists of recoverable rubber, composed of 35% natural rubber (latex) and 65% synthetic rubber. Steel-belted radial tyres are the predominant type of tire currently produced in the world.
Slit tyres are produced in tire cutting machines. These cutting machines can slit the tire into two halves or can separate the sidewalls from the tread of the tire.
The production of tire shreds or tire chips involves primary and secondary shredding. A tire shredder is a machine with a series of oscillating or reciprocating cutting edges, moving back and forth in opposite directions to create a shearing motion, that effectively cuts or shreds tyres as they are fed into the machine. The size of the tire shreds produced in the primary shredding process can vary from as large as 300–460 mm long by 100–230 mm wide, down to as small as 100–150 mm in length, depending on the manufacturer, model, and condition of the cutting edges.
2.4 Waste Glass:
Glass is a product of the super-cooling of a melted liquid mixture consisting primarily of sand (silicon dioxide) and soda ash (sodium carbonate) to a rigid condition, in which the super cooled material does not crystallize and retains the organization and internal structure of the melted liquid. When waste glass is crushed to sand size particles, similar to those of natural sand, it exhibits properties of an aggregate material.

3. MATIRAL TESTS

3.1RAP Mix Design Tests:
3.1.1. CBR Test:
The CBR test acts as an attempt to quantify the behavioural characteristics of a soil trying to resist deformation when subject to a locally applied force such as a wheel load. Developed in California before World War II, to this day it forms the basis for the pre-eminent empirical pavement design methodology used in the UK. The test does not measure any fundamental strength characteristic of the soil. It involves a cylindrical plunger being driven into a soil at a standard rate of penetration, with the level of resistance of the soil to this penetrative effort being measured. The test can be done either on site or in the laboratory. A diagrammatic representation of the laboratory apparatus is given in Fig.

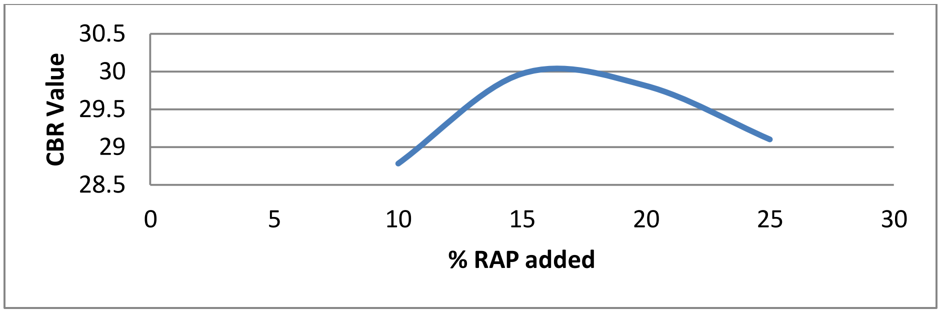
CBR test apparatus

If the test is done in the laboratory, it is important that the moisture content and dry density of the sample being tested should approximate as closely as possible those expected once the pavement is in place. All particles greater than 20 mm in diameter should first be removed. If done in situ, the test should be performed on a newly exposed soil surface at such a depth that seasonal variations in moisture content would not be expected.
At the start of the test, the plunger is seated under a force of 50 N for a soil with an expected CBR value of up to 30% or 250 N for an expected CBR greater than this. It then proceeds to penetrate the soil specimen at a uniform rate of 1 mm per minute. For every 0.25mm of penetration, up to a maximum of 7.5mm, the required loading is noted. A graph of force versus penetration is plotted and a smooth curve drawn through the relevant points. These values are compared against the standard force-penetration relationship for a soil with a 100% CBR.
The CBR is estimated at penetrations of 2.5mm and 5mm. The higher of the two values is taken.

3.1.2CBR test on RAP mix:

Cold mix RAP was being mixed in various proportions with coarse aggregates to find the optimum percentage of RAP that can be used to obtain the desired strength. CBR test was being conducted on the RAP mixed with coarse aggregates. The test results for various percentage of RAP mixed with coarse aggregates are as follows:

CBR Test Of Aggregates + RAP								
Penetration (mm)	Proving Ring Factor: 1Div = 0.4 Kg							
	Aggregates +10% RAP		Aggregates + 15% RAP		Aggregates + 20% RAP		Aggregates + 25% RAP	
	Dial Reading Of Proving Ring	Load (Kg)	Dial Reading Of Proving Ring	Load (Kg)	Dial Reading Of Proving Ring	Load (Kg)	Dial Reading Of Proving Ring	Load (Kg)
0.0	0	0.0	0	0.0	0	0.0	0	0.0
0.5	78	31.2	82	32.8	86	34.4	80	32.0
1.0	176	70.4	182	72.8	189	75.6	179	71.6
1.5	310	124.0	354	141.6	363	145.2	351	140.4
2.0	466	186.4	538	215.2	549	219.6	533	213.2
2.5	986	394.4	1000	400.0	1021	408.4	947	398.8
4.0	1310	524.0	1328	531.2	1398	559.2	1321	528.4
5.0	2023	809.2	2052	820.8	2098	839.2	2041	816.4
7.5	1563	625.2	1586	634.4	1616	646.4	1582	632.8
10.0	1657	670.0	1682	672.8	1728	691.2	1678	671.2
12.5	1760	704.0	1784	713.6	1808	723.2	1773	709.2
	CBR of agg. at 2.5mm penetration= 28.78		CBR of agg. at 2.5mm penetration= 29.97		CBR of agg. at 2.5mm penetration= 29.81		CBR of agg. at 2.5mm penetration= 29.1	



Graph of CBR Value against % RAP added

3.1.2 CONCLUSION

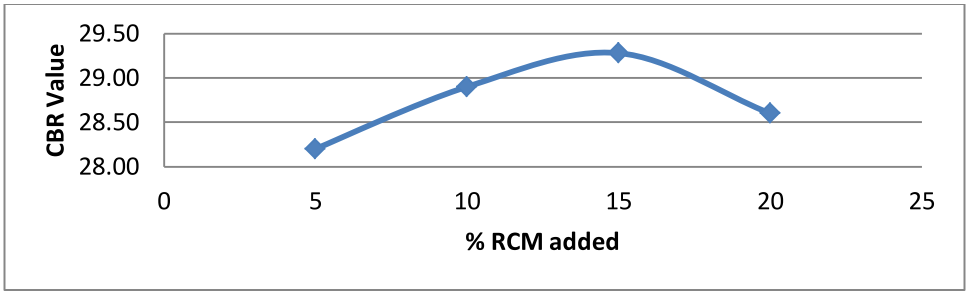
Thus the optimum value of RAP that can be used sub-base course construction = 20%.

3.2 CBR test on RCM mix:

RCM was being mixed in various proportions with coarse aggregates to find the optimum percentage of RCM that can be used to obtain the desired strength. CBR test was being conducted on the RCM mixed with coarse aggregates.

The test results for various percentage of RCM mixed with coarse aggregates are as follows:

CBR Test Of Aggregates + RCM								
Penetration (mm)	Proving Ring Factor: 1Div = 0.4 Kg							
	Aggregates + 5% RCM		Aggregates + 10% RCM		Aggregates + 15% RCM		Aggregates + 20% RCM	
	Dial Reading Of Proving Ring	Load (Kg)	Dial Reading Of Proving Ring	Load (Kg)	Dial Reading Of Proving Ring	Load (Kg)	Dial Reading Of Proving Ring	Load (Kg)
0.0	0	0.0	0	0.0	0	0.0	0	0.0
0.5	76	30.4	80	32.0	84	33.6	80	32.0
1.0	180	72.0	182	72.8	188	75.2	180	72.0
1.5	325	130.0	315	126.0	360	144.0	318	127.2
2.0	486	194.4	459	183.6	544	217.6	472	188.8
2.5	966	386.4	990	396.0	1003	401.2	980	392.0
4.0	1268	507.2	1315	526.0	1333	533.2	1288	515.2
5.0	1384	553.6	1433	573.2	1470	588.0	1399	559.6
7.5	1514	605.6	1575	630.0	1594	637.6	1530	612.0
10.0	1616	646.4	1680	672.0	1690	676.0	1645	658.0
12.5	1688	675.2	1760	704.0	1796	718.4	1720	688.0
	CBR of agg. at 2.5mm penetration= 28.20		CBR of agg. at 2.5mm penetration= 28.90		CBR of agg. at 2.5mm penetration= 29.28		CBR of agg. at 2.5mm penetration= 28.60	



Graph of CBR Value against % RCM added

3.2.1 CONCLUSION

Thus the optimum value of RCM that can be used sub-base course construction = 15%.

4. CONCLUSION

In this study various materials were studied and out of them four materials were chosen and collected for the further study.

So far based on the experimental investigations and the results obtained the following conclusions are made:

- From the various tests on aggregates it can be concluded that the aggregates falls in Grading II, for coarse-graded granular sub-base materials as per Section- 400 of Specifications for road and bridge works by IRC, and the values of various test falls in limits as specified by IRC Section- 400 and 500. Thus the aggregate is good for use in pavement construction.
- From the various tests on bitumen it can be concluded that the values of various test falls in limits as specified by IS 73- 1972. Thus the bitumen is good for use in pavement construction.
- The mix design test for bitumen was carried on bitumen for which optimum value of bitumen content was found out to be 5%.
- The mix design test for RAP was carried out for various layers of pavement. Optimum value of hot mix RAP to be used as aggregate substitute in binder course was found out to be 25%. Optimum value of cold mix RAP to be used as aggregate substitute in sub-base course was found out to be 20%.
- The mix design test for waste glass was carried out for various layers of pavement. Optimum value of waste glass to be used as soil substitute in sub-base course was found out to be 15%.
- The mix design test for RCM was carried out for various layers of pavement. Optimum value of waste glass to be used as aggregate substitute in sub-base course was found out to be 15%.
- Compression test carried out on RAP, it can be observed that initially the load carried by RAP pavement and standard pavement model is almost equal but with the increase in deflection the gap in load carried by the standard pavement model and RAP reinforced model increases. Though the load carried is less than the standard pavement, still it is sufficient to carry loads coming on pavement, so waste tyre can be used in pavement construction.
- Compression test carried out on RCM, it can be observed that initially the load carried by RCM pavement and standard pavement model is almost equal but with the increase in deflection the gap in load carried by the standard pavement model and RCM reinforced model increases slightly. Though the load carried is slightly less than the standard pavement, so RCM can be used in pavement construction.
- Compression test carried out on all waste materials together, it can be observed that with the increase in deflection there is a large increasing gap in load carried by the standard pavement model and reinforced model. Though the load carried is less than the standard pavement, still it is sufficient to carry loads coming on pavement, so reinforced model can be used in pavement construction where load coming to the pavement is less.
- From the above study it can be concluded that waste material can be used in the construction of road pavement effectively and efficiently. Though not for the expressway and national highways but it can be used for the construction of district roads and rural roads. This would lead in saving of a lot of materials and also solve the problem of waste disposal that the world is facing today to some extent.

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6. REFERENCES

1.Solid waste generation in India & their recycling potential in building materials" –By Asokan Pappu, Mohini Saxena, Shyam R. Asolekar.
2.Solid Waste Production - By. Tim Cassese.
3.Sustainable Solid Waste Management in India" - By Ranjith Kharvel Annepu, Advisor: Nickolas J. Themelis, Stanley-Thompson Professor Emeritus
4.Chesner WH, Petrarca RW (1988) The ecosphere recycling system and the use of glass as a construction aggregate material. Proc 1988 Conf Solid Waste Management and Materials Policy, Legis lative Commission on Solid Waste, New York, p 534
5.Federal Highway Administration and US Environmental Protection Agency (1993) Engineering and environmental aspects of recycling materials for highway construction, FHA-USEPA, Report No FHWA-RD-93–008,May 1993.Federal Highway Administration and US Environmental Protection Agency, Washington, DC, p 893
6. Hecht NL, Duvall DS (1975) Characterization and utilization of municipal and utility sludges and ashes: vol III: utility coal ash. National Environmental Research Center, US Environmental Protection Agency, Washington, DC, p 262
7. Kallas BF (1984) Flexible pavement mixture design using reclaimed asphalt concrete (FHWA/RD-84/088).Asphalt Institute, Lexington, KY, p 327
8.Yrjanson WA (1989) Recycling of Portland cement concrete pavements. National Cooperative Highway Research Program Synthesis of Highway Practice No 154,National Research Council, Washington, DC, p 729
9. Washington State Department of Trade and Economic Development (1993) Glass feedstock evaluation project, final report 056–45–23, 15:325
10.Recycling Solid Wastes as Road Construction Materials: An Environmentally Sustainable Approach" – By Tarek A. Kassim, Bernd R. T. Simoneit and Kenneth J.Williamson.
11.Schnormeier R (1992) Recycled tire rubber in asphalt. Presented at the 71st Annual Meeting of the Transportation Research Board, Washington, DC, p 537
12.Scrap Tire Management Council (1995) Scrap tire use/disposal study, 1995 update. Scrap Tire Management Council, Washington, DC, p 519