

DESIGN AND QUALITATIVE ANALYSIS OF FLEXIBLE PAVEMENT BY USING WASTE MATERIAL

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Abstract– Every year several million tons industrial waste is produced by different industries which have a major problem of its safe, economical disposal. This paper investigates the performance of waste materials as an alternative of natural aggregates to be used in base, sub-base layer of flexible pavement. This paper also concern about improving the properties of bitumen by using modifier like rubber crumb. Steel slag and recycled aggregates are used in partial or full replacement of natural aggregates. Marshall's stability method is used to study the strength variations in bituminous mix with replacement of natural aggregates. This paper investigates the performance of flexible pavement with waste materials.

Key Words– Flexible pavement, VG-30 Bitumen, natural aggregate, Steel Slag aggregates, recycled concrete aggregates, Rubber Crumb, Marshall Stability Test etc.

1. INTRODUCTION

Flexible pavement is one of the important frameworks in advance countries. Due to increase in axel load and traffic intensity efficiency of road pavement has been reduced. The growth of various types of industries and population growth has resulted in enormous increase in production of various types of waste material ie steel waste, tyre, industrial waste, plastic waste, demolished concrete waste etc. Presently, steel slag produced from steel manufacturing industries isn't utilized and is dumped near the costly plants. Steel Slag can be used in replacement with natural aggregates due to its mechanical excellence in terms of its strength, skid and abrasion resistance compared to natural aggregate. Study was carried out to utilize the slag as an alternative of natural aggregates in road construction. Also crumb of waste tyre can be used to improve the binding properties of bitumen. Shredded tyre can be used to improve the soil strength and drainage properties of sub base. As sub base of flexible pavement takes lesser loads than base of pavement we can use recycled concrete waste in sub base in some percentage with natural aggregates. Natural materials are of limited availability and its quantities are declining rapidly creating an acute shortage. Re-utilization or recycling seems to be an attractive alternative and an important strategy for management of such waste materials. Aggregate form a major portion of the pavement structure and they form the prime material used in pavement construction. We are concerning to use this waste material in different layers of

flexible pavement in different ways and to improve its efficiency as compared to normal pavement.

2. OBJECTIVES

- Use of non degradable waste material.
- To check the properties of different aggregates by performing various test.
- Improving the properties of bitumen.
- Design of flexible pavement by marshall test.

3. MATERIAL AND METHODOLOGY

3.1 Natural aggregates

Natural aggregates were obtained from stone crusher plant located at khandat paali, chiplun. Test results for natural aggregates used is shown in table 1.

Table-1: Test results of natural aggregates

Table no -1

SR. NO	PROPERTIES	STANDERD VALUES	OBSERVED VALUES
1	Specific gravity	2.2 -2.85	2.74
2	Water Absorption	Max 2%	1.96%
3	Crushing Value	Max 30%	19.93%
4	Impact Value	Max 30%	12 %
5	Abrasion value	Max 40%	22.5%
6	Fineness modulus	2.2 – 3.2	3

3.2 Steel slag aggregates

In this study crushed steel slag (coarse, fine and filler) obtained from JSW Steel Ltd, Dolavi Pen, maharashtra was used to prepare the dense bituminous macadam mix specimens. The material needs to correspond to best performance parameter fulfilling the ideal conditions of mix

as specified in Ministry of Road Transport and Highways specifications in India. Test results for steel slag is shown in Table 2.



Fig 1: steel slag

Table-2: Test results of Steel Slag

Table no - 2

SR. NO	PROPERTIES	STANDERD VALUES	EXPERIMENTAL VALUES
1	Specific gravity	2.2 - 2.85	2.68
2	Water Absorption	Max 2%	6.5%
3	Crushing Value	Max 30%	31.47%
4	Impact Value	Max 20%	24.69%
5	Abrasion value	Max 40%	32%
6	Fineness modulus	2.2 - 3.2	2.8

3.3 Recycled concrete aggregates

In this work recycled concrete aggregates (RCA) was obtained from waste concrete testing cubes in civil dept of GIT campus. Cubes were crushed by using jaw crusher. Then aggregates obtained are washed and dried for 24 hours. Test results of RCA are shown in table 3.



Fig no 2: Recycled concrete aggregate

Table-3: Test results of recycled concrete aggregates

Table no -3

SR. NO	PROPERTIES	STANDERD VALUES	OBSERVED VALUES
1	Specific gravity	2.2 -2.85	2.8
2	Water Absorption	Max 2%	2.5%
3	Crushing Value	Max 30%	15.42%
4	Impact Value	Max 30%	9.33 %
5	Abrasion value	Max 40%	19%
6	Fineness modulus	2.2 - 3.2	2.8

3.4 Bitumen (VG-30)

VG 30 grade bitumen is obtained from HINDUSTAN PETROLIUM CORPORATION LIMITED, MUMBAI. This type of bitumen plays a very important role in the performance of bituminous mixes. For all studies conducted paving grade bitumen (VG 30) is used. To improve the properties of the bitumen the rubber crumb obtained from waste tyre is blended in it in different percentage i.e. 2%, 4%, 6% etc



Fig 3 : bitumen VG-30

Table 4: Represents various properties of Bitumen (VG-30)

Table no -4

SR.N O	NAME OF TEST	STANDARD VALUES	EXPERIMENTAL VALUES
1	Penetration test	5 - 7mm	5.33mm
2	Ductility test	Min 40mm	85.53mm
3	Softening point test	45 ⁰ C -59 ⁰ C	56 ⁰ C
4	Specific gravity	Min0.99	1.35
5	Viscosity ratio at 60	Max 4minute	3.55 minute

3.5 Rubber crumb

Rubber crumb is obtained by cutting waste tyre in pieces passing through 2.36 mm sieve and retained on 1.18mm sieve



Fig 4: rubber crumb

Table -6: Marshall test results

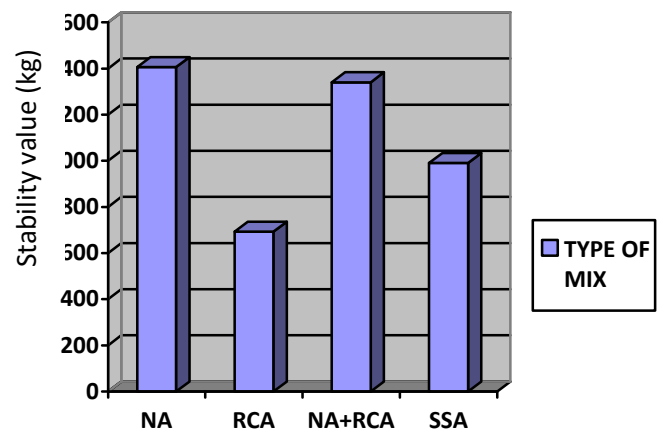
Table no - 6

TYPE OF AGG.	AVG. HEIGHT (cm)	% OF BITUMEN	MARSHALL STABILITY (Kg)	FLOW (mm)
Natural agg.	6.7	5.5	1268	3.4
	6.7	5.5	1536	2.9
	6.7	5.5	1424	3.1
Recycled concrete agg.	6.7	5.5	713	2
	6.7	5.5	634	1.58
	6.7	5.5	730	1.92
50% Natural agg.+ 50% Recycled agg.	6.7	5.5	1345	2.08
	6.7	5.5	1435	2.1
	6.7	5.5	1241	1.722
Steel slag agg.	6.7	5.5	962	1.8
	6.7	5.5	1020	2.4
	6.7	5.5	990	2.1

Table-5: Represents properties of bitumen (VG 30) with rubber crumb (%)

Table no - 5

% OF RUBBER CRUMB	EXPERIMENTAL VALUES OF BITUMEN		
	Penetration test (mm)	Ductility test (mm)	Softening point °C
0%	5.3	85.53	56 ⁰
2%	4.2	76	58 ⁰
4%	3.1	52	61 ⁰
6%	1.8	58	62.5 ⁰
8%	2.8	60	60 ⁰



3.6 Marshall stability test results and discussion

Marshall test were conducted on each type of aggregates plus VG-30 bitumen mix and steel slag aggregates plus rubber crumb modified bitumen mix.



Fig 5: Marshall test apparatus

Graph 1: Stability test

3. CONCLUSION

1. Impact value of steel slag is 9.33% , and crushing value is 15.42% therefore it can be used in highways as per IRC.
2. Impact value of recycled concrete aggregate is 24.69% and crushing value is 31.47%. RCA doesn't satisfy the requirements given by IRC,.
3. A property of bitumen improves with the addition of rubber crumb.
4. Marshall stability value of steel slag 990.6 kg and flow is 2.1mm, hence satisfies the requirements of IRC.

5. Marshall stability value of 100 % RCA is 692.33 kg and flow is 1.83mm, hence doesn't satisfies the requirements of IRC.
6. While stability value of 50% RCA plus 50% natural aggregates is 1340.3kg and flow is 1.96, hence satisfy all the requirements. therefore As the sub-base of flexible pavement takes lesser loads it can be used in 50% percentage replacement with natural aggregate.

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