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Research Paper on Feasibility of Bitumen and Concrete Blend in Construction of Roads

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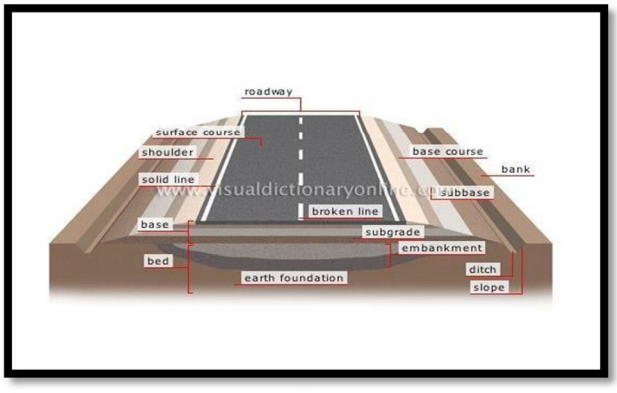
Abstract: ***A pavement or a road which is smooth, free of any potholes and cracks, easy to maintain and very quick to repair is the most ideal type of a road. But, with the construction of bitumen or concrete roads we don'tsee that happening, the present roads which are generally constructed using bitumen or concrete has shown many defects in them like cracks, potholes during every rainy season, frequency and difficulty in maintenance, and very difficult to repair them in quick time. So to overcome this situation every year, this project aims at constructing apavement or a road which is jointless which will minimize lots of defects, minimize potholes, a road which does not require frequent repairs and which is easy to maintain. All the above remedies could be possible if we blend bitumen and concrete together to concrete a road. This project aims at checking the feasibility (to what extent it can be done) of constructing this mix road which is a blend between bitumen and concrete by testing its various parameters. For creating a strong bond between bitumen and concrete, various materials, combination of materials and their different proportions were used. After experimenting and several trials and error methods later, a strong bond between bitumen and concrete was created by using combination of materials and their different proportions. The strength to withstand the load of vehicles was achieved after adding differentadmixtures into it. Once, the fundamental parameters were fulfilled, it was time to perform different tests on its specimen. The results of tests like flexural, split tensile, compressive and water penetration were all satisfactory.Thus, feasibility check for constructing this mix road was successful.***

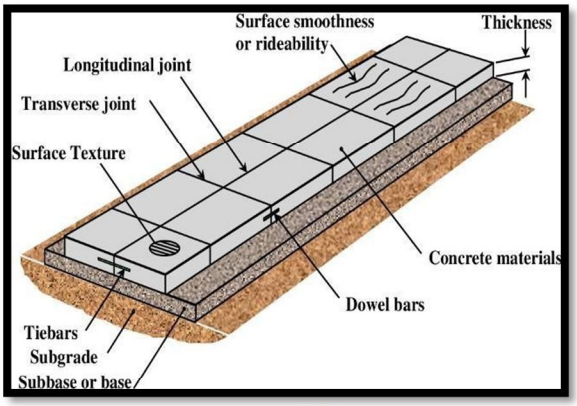
Keywords: vg-40 bitumen, Compressive Strength, Flexural strength, Split Tensile strength, water penetration depth

I. INTRODUCTION

The road pavement is the layered structure located directly above the subgrade, and beneath the subgrade, and beneath the wearing surface which transmits the applied vehicle loads to the sub-grade and underlying soil. Basedon design considerations there are two types of pavements i.e., flexible pavement and rigid pavement. Flexible pavement has very low flexural strength and is flexible in its structural action under vehicle loads. In this pavement, the wheel load stresses are transferred from grain to grain to the lower layers. The wheel load is distributed over a wider area, and the stress is also decreased with the depth. Flexible pavements are constructed in many layers using bituminous materials like asphalt. The top layer is supposed to sustain maximum compressive stress whereas the lower layers will experience lesser magnitude of stress. pavements have a great amount of flexural strength or flexural rigidity. In this pavement the load is distributed by the slab action, and thepavement acts an elastic plate. Rigid pavements are constructed by using Portland cement concrete (PCC). The pavement materials are placed either directly on the prepared sub-grade or on a single layer of granular or stabilized surface.



(1a.)



(1b.)

Fig 1a., 1b.: Schematic diagram of a Flexible and Rigid concrete pavement

II. LITERATURE REVIEW

Jocelyn lvel et al. (2020) has performed midpoint analysis for asphalt revealed that the creation of asphalt cementposed the highest impact on each category. The endpoint analyses were compared for both products. Overall, bothprocesses had similar results for the human health and ecosystems categories; however, asphalt was marginally higher for both. Asphalt had exceeded concrete in the resource impact category by 100 mpt.**[1]** Arjita biswas et al. (2020) has concluded that the substitution of bitumen with waste plastic (8% in this study) will indirectly saveon costly bitumen which in turn will make these roads further beneficial**.[2]** Daniela L. Vega A et al. (2020) has performed Life cycle assessment of hot mix asphalt with recycled concrete aggregates for road pavements construction. The impact categories OD,

HHP and GW are particularly affected by changes in the value of the moisture content of the RCA**.[3]** Peyman babashamsi et al. (2016) has commented the Use of LCCA must be carried out appropriately and data utilized must be from existing records that are accurate in terms of initial costs, salvage value, rehabilitation timing and costs.**[4]** Hamidreza Abbasianjahromi (2019**)** has evaluated the regression method has better performance than the time series model and the second, the implementation of concrete pavement has less economic risks in Iranianfreeways and highways The pavement is one of the most important components of roads since it directly contacts with the vehicles**.[5]** Peyman babashamsi, (2016) has performed the precise estimation of pavement performance, traffic for more than 30 years in the future and future costs by analysts determines the reliability of LCCA results**.[6**] Surajo Abubakar Wada(2016) has evaluated rate of deterioration of bituminous pavement increases rapidly when water is retained in the void spaces of the bituminous pavement layers**.** . Aging and oxidation of bituminous binder also lead to the deterioration of the bituminous surfacing **[7]** Vivek Pagey, 2015 hasinvestigated how CBR values cause uneven settlement of the different pavement layers causes rutting and undulations on the top surface of the pavement**.[8]** Jayant Damodar Supe (2014) has evaluated that By applying more advanced and sophisticated treatment process the usage of RCA in concrete mixture can be found to have strength in close proximity to that of natural aggregate and can be used effectively as a full value component of new concrete**..[9**] O.o alao"Current(2013)has investigated on the durability, and structural soundness of rigid pavements can be achieved if it is properly designed. Similarly, strict adherence to precise construction practices cannot be over-emphasized**.[10]**Praveen kumar(2010) has evaluated that if the temperature ofbitumen/bituminous mixes is not maintained properly, then it leads to pavement failure. Over heating of bitumenreduces the binding property of bitumen. Proper pavement preservation techniques, guidelines and policy should be implemented in implementing any highway design and construction project.

III.PROBLEM STATEMENT

In India, mostly in rural areas bitumen roads are generally preferred, whereas in metropolitan cities concrete roads are preferred. Bitumen roads are heavily affected because of rainfall resulting in potholes which increases the percentage of accidents and regular maintenance, therefore is not a sustainable method of road construction. In concrete roads, though it lasts a long-time repairing is a bigger chore, holes or cracks can't be simply patched instead, entire slabs must be replaced the cost of concrete roads are also higher than that of asphalt, both in installation and repair.

IV.SCOPE OF WORK

In this project work we made an effort to bind bitumen and concrete in road construction so that we can get the advantages of both the materials and also minimize or eliminate the disadvantages of both materials, therefore resulting in a sustainable and efficient road. This mixed road (blend of bitumen and concrete) is expected to be ajointless road where the repairing and maintenance will be minimum and quick and easy.

V. EXPERIMENTAL INVESTIGATION

A. Bond between Concrete and Bitumen

Using aggregates of size 12.5 mm, it was mixed with bitumen grade Vg 30 in the presence of constant heat under a stove fuel. Constant heating is required to keep the bitumen in the semi-fluid form so as to mix it uniformly with the aggregates. After uniformly blending bitumen with the aggregates, this mixture was put in a cube mouldof size 150 x 150 x 150 mm and allowed it to set completely in the mould for 2-3 days. After setting in, a grout mixture was made which contains different materials which served different purposes. The grout mixture contained cement, GGBS, micro silica, sprayset hblm q cda 1435, cebex 100, auramix 300 and water. This groutwas poured into the cube and beam mould using the marsh cone which will allow the grout to flow uniformly and with a constant speed. After the grout was poured uniformly throughout the mould it was kept for setting for 2-3days. After the setting period was complete the mould was opened to get the solid specimen.

The specimen was kept in curing for 7 days. After the curing period compressive load test was performed on the specimens.
Specifications:
Bitumen grade: VG 30 Aggregate size:12.5 mm
Grout mix: Cement, GGBS, Micro Silica, Sprayset hblm q cda 1435, cebex 100, auramix 300 and water.Rectangular cube mould size: 150 mm x 150 mm x 150 mm.
Proportions: Total mix: 5000 gm, Cement: 75 % of total mix, Bitumen: 1.5 % of total mix, GGBS: 25 % of totalmix, Water: 30 % of total mix Micro-silica: 10 % of total mix, Sprayset: +120 ml Auramix 300: +14 ml

Table 1: Compressive strength

Cubeno	Bitumen in gm	Total wt. of aggregatesin gm (12.5mm)	Grout	Average compressive strength (kN/m^2)
1.	1.5 % - 75 gm	5000	Cement, GGBS, micro silica, Sprayset hblm q cda 1435, cebex 100, auramix 300 and water.	397
2.	1.5 % - 75 gm	5000		
3.	1.5 % - 75 gm	5000		

B. Beam Flexural Strength Test

Concrete is quite strong in compression and comparatively weak in tension. Hence in most of the design of concrete structures, its tensile strength is completely ignored. However, at certain situation like, water retaining and pre-stressed concrete structure, the tensile strength of concrete is an essential requirement and the study of tensile strength carries the importance. Tensile cracking may occur due to shrinking, corrosion of steel in concrete, temperature gradient etc. Tensile strength of concrete is closely related to its compressive strength but there is no simple proportional relation between the two. A direct application of pure tensile stress is difficult. An indirect way is adopted by measuring the flexural strength of beam. The theoretical maximum street reached at bottom fiber is known as modulus of rupture. The flexural tensile strength of concreteis related to its compressive strength in IS: 456-2000, by a formula for = 0.7I√fok

Table 2: Flexural strength of beam specimen

Sr no.	Age	Size of specimens (mm)			Load	Flexuralstrength	Avg flexural strength
	(Day)	Spanlength	Width	Thickness	(KN)	(N/mm^2)	(N/mm^2)
1.	28	600	150.25	151.82	13.680	2.37	3.34
2.	28	600	150.28	151.65	21.240	3.69	
3.	28	600	150.20	150.78	22.620	3.97	

C. Water Permeability

The method determines the depth of penetration of water under pressure in hardened concrete that has been water cured. Water is applied under pressure tothe surface of hardened concrete. The specimen shall then be split and the depth of penetration of the water front is recorded and measured.

Table 3: Water penetration depth

Srno.	Dimension of specimen		Age of specimen	Maximum water penetration depth	Avg depth ofpenetration
	Diameter	Length			
	(mm)	(mm)	(DAYS)	(mm)	(mm)
1.	149.5	160.2	28	104.05	100.05
2.	150.16	160.5	28	72.31	
3.	149.5	161.9	28	123.80	

D. Split Tensile Strength

The tensile strength of concrete can be obtained indirectly compressing the concretecylinder (kept in horizontal position) between the platens of the compressive testing machine. The knowledge of strength of concrete is required for the tensile design of structural concrete elements subjected to transverse shear, torsion, shrinkage etc. The tensile strength is also useful in design of prestressed concrete structures, concrete rods etc. Since the test cylinder splits vertically into two halves, this test is known as splitting test.

Table 4: Split tensile strength

Srno.	Dimension of specimens		Age of specimen	Load	Splittingtensile strength	Averagesplitting tensile strength
	DIAMETER	LENGTH				
	(mm)	(mm)	(DAYS)	(KN)	(N/mm^2)	(N/mm^2)
1.	150.0	161.0	28	42.00	1.11	1.13
2.	150.0	161.1	28	40.40	1.06	
3	150.0	162.0	28	46.50	1.22	

E. Compressive Strength

Compressive strength of Concrete can be defined as the ability of material or structure to carry the loads on it without any crack or deflection**.** A material under compressive load tends to reduce the size, while in tension**,** size elongates.

Table 5: Compressive strength

Cube number	Weight (kg)	Peak load (kN)	Peak stress(MPA)	Average compressive strength (MPA)
1.	8.332	306.5	13.6	13.65
2.	8.135	376	16.733	
3.	8.141	291.9	12.9	
4.	8.082	291.9	12.9	
5.	8.141	288.1	12.8	
6.	8.209	294.6	13	

VI. RESULT AND DISCUSSIONS

A. Flexural Strength

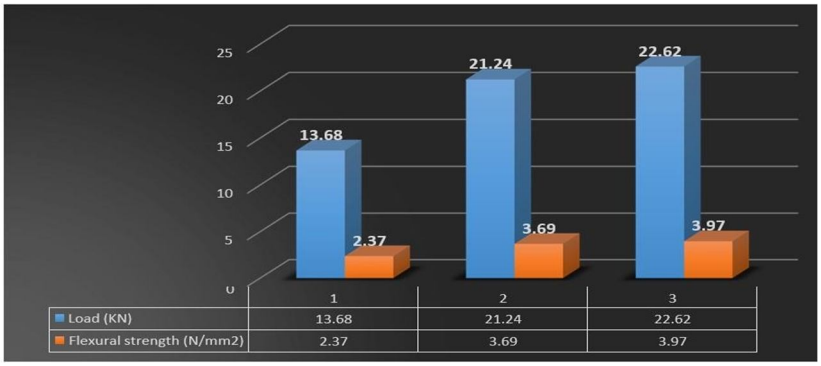


Fig 3: Flexural Strength

Discussion

- The average flexural strength is 3.34 MPa.
- The peak load and flexural strength for all specimen showed similar variations.
- The results were satisfactory and hence the test was successful.

B. Splitting Tensile Strength

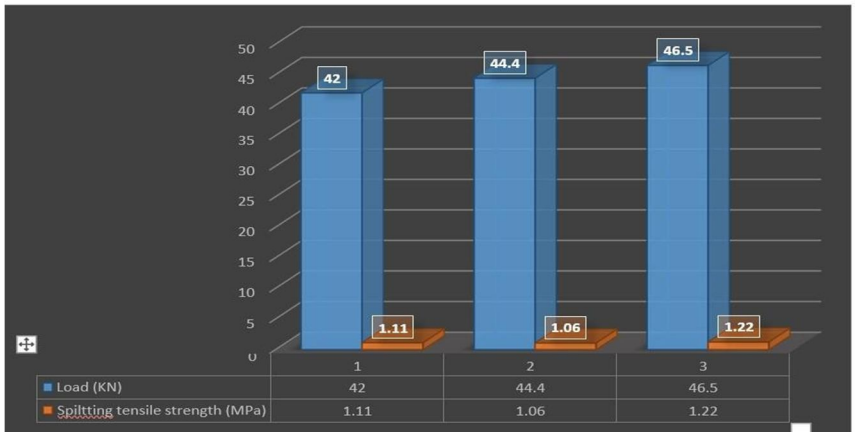


Fig 4 : Splitting tensile strength

Discussion

- From graph, the avg. splitting tensile strength is 1.13 MPa.

C. Compressive Strength

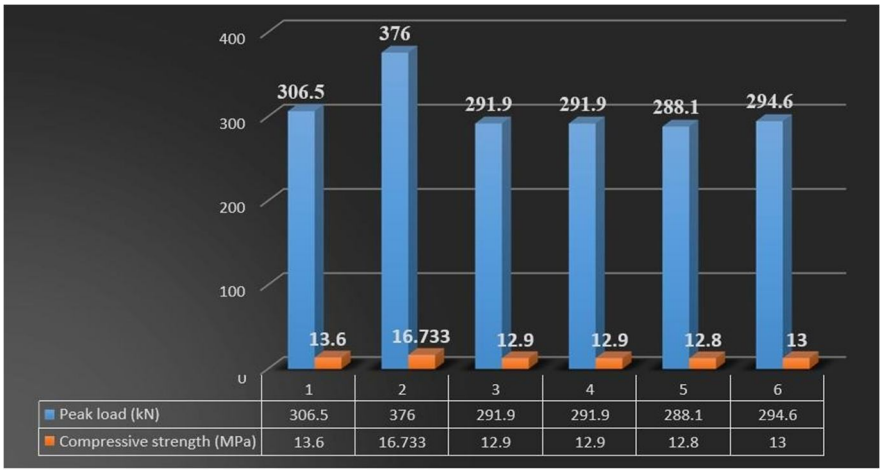


Fig 5 : Splitting Compressive strength

Discussion

- From Graph, the avg. compressive strength comes out to be 13.65 MPa.
- For all the specimens the ultimate load and peak stress showed similar variation except for the secondspecimen.
- Hence, the compression test was successful and the results were satisfactory

VII. CONCLUSION

The perfect proportions of bitumen, aggregates and grout was identified after no. trial and error method**.**

1) This trail was successful as all the parameters for strength and bonding were achieved.
2) The bonding between bitumen and concrete was achieved after performing many trails.
3) Avg. flexural strength value of a beam specimen is 3.34 MPa.
4) Avg. water penetration depth of a specimen of a cylinder is 100.05 mm which is justified for the mixed road.
5) Avg. splitting tensile strength is 1.13 MPa.
6) Avg. compressive strength of a cube is 13.65 MPa.

Hence, for checking the feasibility of a road to be constructed from a blend of concrete and bitumen, the parameters likebonding, flexural strength, water penetration depth, splitting tensile strength, compressive strength are satisfactory.

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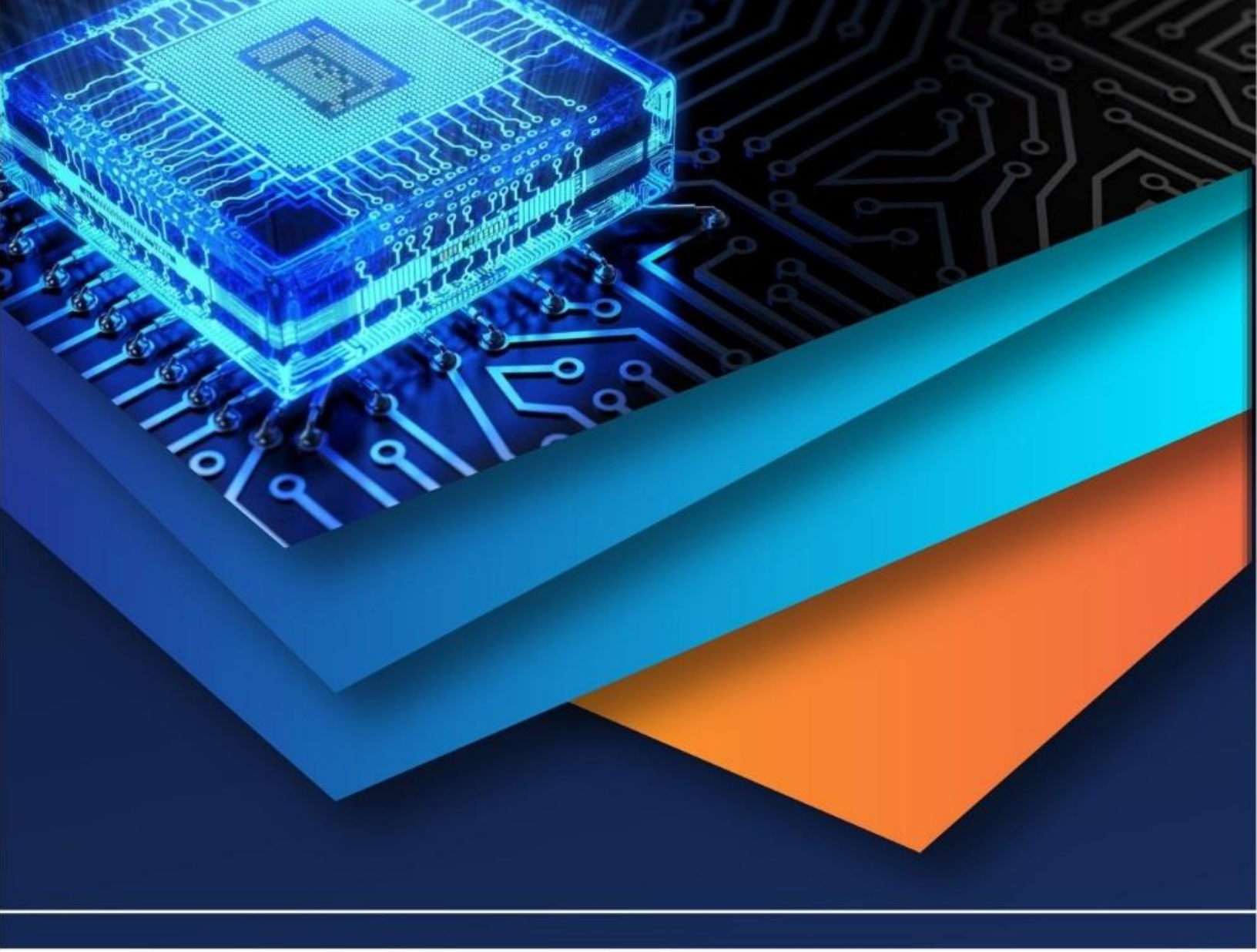

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