

Comparative Analysis of Glass Fiber and Steel Wool in Flexible Pavement

¹Shalini,²Mukesh Choudhary,³Himanshu Bhardwaj,⁴ Bharat Nagar

¹M.Tech Research Scholar,²Assistant Professor,³Assistant Professor,⁴Head of Department

¹Department of Civil Engineering Specialization in Transportation Engineering,

¹Jagannath University, Jaipur, Rajasthan, India

Abstract : India is a very big and the vast country having the huge network of roads , which contains the city roads , village roads and even the highways. With the state of time the road suffers from the wear and tear. The wear and tear may be due to the quality of material and water lodging due to rain or some other reasons. Thus the requirement arises to have road with the better quality and more strength which can withstand with such wear and tear.

Natural conditions joined with traffic burdens add to untimely disintegration of black-top solid pavements, lessening their quality and strength after some time. To improve it, fibers can be fused in the mixture. Also, electrically conductive fibers can be utilized for self-recuperating purposes. In this specific situation, the paper work will analyze influence of glass fiber and steel wool in adaptable pavement on the mechanical and physical properties of adaptable pavement. In the proposed work the bitumen is mixed with the glass wool and steel wool , the material is tested using the Marshalls test and the results which are obtained are quite significant and better than the previous researches.

IndexTerms – Road Construction, Glass Wool , Steel Wool.

I. INTRODUCTION

The issue of inadequately developed roads is for quite some time engraved in India, in the country regions as well as the issue concerns urban populace alike. Potholes, roads under development, inadequately cemented speed breakers and blue seepage framework on the roads are a reason for expanding mishaps, passings and medical issues in the nation and furthermore a wellspring of irritation, for example, during the ongoing tremendous congested driving conditions in Gurgaon, in the area of the Indian capital. As per the law, natives of India have a legitimate appropriate to very much kept up roads and any misfortune because of poor road foundation can be guaranteed. In any case, the privilege is being denied by the specialists as far back as its arrangement as potholes everywhere throughout the nation are a difficult reality.



Fig 1.1 Road Conditions in Delhi Area

New Delhi, Mumbai, Uttar Pradesh, Maharashtra, Madhya Pradesh, West Bengal and Bihar are among the most influenced urban areas or states where roads are in an express chaos, which brought about in excess of 10,000 passings in the nation a year ago. The administration does not organize fixes and city organizations guarantee to have a deficiency of enough assets for the fixes.

Indeed, even after different grievances and battles, when the administration neglected to see the issue, a craftsman in Bengaluru put fake crocodile in a pothole loaded up with water to draw the consideration of the experts. In Chennai as well, individuals took to take care of the issue. The occupants gathered cash and got the potholes fixed on Pudupakkam High road in the city this June. Different mishaps and even passings have been accounted for because of potholes, uneven speed breakers and roads under fix or under development in the previous years, and the numbers are regularly expanding. As of late, a multi year elderly person kicked the bucket in VasantKunj (South West Delhi) after his bike chanced upon a pothole. He tumbled off from his bicycle in view of the quick shock and after that a water tanker fighting against eminent loss squashed him to death.



Fig 1.2 Road Conditions in Kerela

The normal time for a road to begin wear is five years, after which it requires fixes. The low quality material utilized for development and now and again associated tricks could be unified with the reasons as the roads fall apart before the normal life expectancy. Water logging and substantial traffic prompts abuse of the roads that adds to the issue. The issue is uplifted during storm when the roads are loaded up with water because of the wasteful seepage framework. "Roads in VasantKunj are no not exactly a pool. Since water covers the whole length and width of the roads, potholes aren't obvious, that prompts rough rides and even crashes with different vehicles. It is hard to drive, particularly during the downpours," RohitChawla, an occupant of South West Delhi, told MIG. [1]

II. LITERATURE SURVEY

Mohammad M. Karimiet. al 2019, This investigation describes the mechanical, rheological, initiated warming, and incited recuperating conduct of black-top cement containing steel wool filaments (SWFs) as the conductive constituent. Actuated warming of black-top cement through the electromagnetic field is a novel technique to recuperate the harm instigated in black-top cement. Past investigations utilized high substance of the SWF as the conductive material to improve the affectability of the black-top cement to the electromagnetic radiations. Test tests directed in this examination (for example uniaxial quality, circuitous strain, semi-roundabout twisting tests) demonstrate that the expansion of 0.2 (wt)% SWF meets both the warming and mending necessities. The generally low measure of SWF brought about impressively less unfriendly consequences for the mechanical and rheological properties of black-top solid contrasting with higher rates of SWF (for example 1.5 (wt)% of SWF). Tests led on various example sizes of black-top cement uncover significant impacts of example measurement (volume) on the warming rate that ought to be considered in the assessment of black-top solid acceptance warming under electromagnetic power. Furthermore, it is demonstrated that utilizing 0.2 (wt)% SWF fundamentally decreases the impact of consumption on instigated warming of conductive black-top solid materials. Test results exhibit that the elasticity proportion (TSR) diminishes from 25% for 1.5% SWF to 7% for 0.2% SWF.

Shahrukh Kureshi1 et. al 2019, One of the creative strategy improvement in bitumen solid pavement is expansion of steel fiber (wool). Black-top cement is a self-recuperating concrete. In black-top cement, the steel fiber is collected to make it electrically conductive and material for acceptance warming. The reason for steel wool fiber included black-top cement for improve its quality and weakness attributes during flexibility. Splitting is one of the serious issue happen on the pavement and it is straightforwardly influenced to functionality, quality, life length, nature of adaptable pavement. At the point when limited quantity of breaks happens in the black-top solid pavement that time enlistment generator is utilized to warm the material to recuperate the splits through the high temperature. Throughout the mid year season on the off chance that the temperature is high, at that point there will be breaks begin shutting without anyone else. It might be additionally advanced misleadingly through enlistment warming or by microwave warming. Execution of black-top pavement should always be fixed to fulfill the need of the present transportation. This examination utilization of steel wool fiber include black-top cement to anticipate the black-top harm by the climate and burden traffic. This examination endeavors to know estimation of attributes. Three distinct measures of fiber were utilized: 0%, 0.3% and 0.5% by complete volume of blend with 9.5mm length and 8.89 to 12.7mm breadth was considered by leading marshal security test. The outcomes demonstrate that the utilization of steel wool fiber will influence attributes of blend black-top cement. As expansion of 0.3% steel wool fiber the solidness worth increment and further expansion of fiber 0.5% soundness decline and stream worth increment

Min-Jae Kimaet. al 2018, This examination plans to research the impact of carbon-based materials, i.e., carbon strands (CFs), carbon nano tubes (CNTs), and graphite nano filaments (GNFs), on the mechanical and self-mending properties of black-top cement. For this, 0.5% CF, CNT, and GNF, and 1.0% CF were joined, and plain black-top cement was additionally considered for correlation. Oneself recuperating ability of black-top cement was analyzed dependent on acceptance warming and was quantitatively assessed by looking at the flexural qualities of virgin and mended examples. Test outcomes demonstrated that including the carbon nano materials, i.e., CNTs and GNFs, was progressively successful in improving the Marshall soundness, backhanded elasticity, and dynamic steadiness, and diminishing the porosity, contrasted with including large scale CFs. Be that as it may, the flexural execution of black-top cement was all the more productively upgraded by adding the CFs in respect to CNTs and GNFs. Black-top solid examples that totally flopped under flexure were somewhat self-recuperated utilizing enlistment warming because of the fused carbon materials. The best mending ability, i.e., 40% recuperation of the first flexural quality, was acquired for the examples with 0.5% GNFs and CFs.

ShaherYaserFaridMatar 2017, As the advanced parkway transportation has fast, high traffic thickness and substantial burden, bituminous solid pavements are exposed to different kinds of trouble, for example, weakness splitting, rutting and raveling. Adjustment of the black-top fastener is one methodology taken to improve pavement execution. By and large, strands and polymers are two significant materials utilized for this reason. It is imagined that the expansion of glass filaments to black-top blends improves material quality and weakness attributes. In this exploration, Glass Fiber are utilized to research the potential prospects to improve black-top blend properties. Study points incorporate considering the impact of including various rates of Glass Fiber on the properties of black-top blend contrasting it and the neighborhood and universal prerequisites, other than distinguishing the ideal percent of Glass fiber to be included the hot blend black-top. Glass fiber (12mm) was added to the black-top blend. Marshal blend plan method was utilized, first to decide the Optimum Bitumen Content (OBC) and afterward further to test the changed blend properties. Altogether, (33) tests were readied, 12 tests were utilized to decide the OBC and the remaining were utilized to examine the impacts adding distinctive Glass fiber rates to black-top blend. The OBC was 5.4 % by the all out weight of black-top blend. Six extents of Glass fiber by the complete load of blend were tried (0.1, 0.2, 0.4, 0.6, 0.8 and 1%), other than testing of customary black-top blend. Tests incorporate the assurance of solidness, bulk thickness, stream and air voids. Results showed that Glass fiber can be helpfully utilized as a modifier for black-top blends to improve execution of some black-top blend properties. Glass fiber substance of 0.27 % by the complete load of blend is suggested as the ideal Glass fiber content.

III. OBJECTIVE

- The main objective of the study is to increase the strength of the road , in order to protect the road from the wear and tear with time.
- There are numerous manners by which potholes can be brought about by general mileage on the roads. This is on the grounds that over some stretch of time it is inescapable that general disintegration will occur because of heavier and quicker vehicles are unendingly acquainted with our roads.
- This will investigate a portion of the real causes and clarifications with respect to why this occurs..

IV. PREPARE YOUR PAPER BEFORE STYLING

The principle goal of this examination is to assess the properties of hot blend black-top changed by glass fiber. Procedure and techniques on how this examination is done will be clarified in detail. This part manages two subjects. To begin with, is to assess the utilized materials properties, for example, aggregates, bitumen steel fibre and glass fiber. Second, is to portray how trial work has been done to accomplish contemplate goals.

4.1 Laboratory Test Procedure

This investigation depends on research facility testing as the principle technique to accomplish contemplate objectives. All the testing is directed utilizing hardware and gadgets accessible in the labs. Lab tests are isolated into a few phases, which start with the properties assessment of the utilized materials: aggregates, bitumen, and glass fiber. Strainer investigation is completed for each aggregate kind to get the evaluating of aggregate sizes pursued by aggregates mixing to get wearing course degree bend used to get ready black-top blend.

From that point forward, Asphalt blends with various bitumen substance are arranged and marshal test is led to get ideal bitumen content. The estimation of the ideal bitumen is utilized to plan black-top blends adjusted with different rates of glass fiber. Marshal Test are used to assess the properties of these changed blends. At last, research center test outcomes are acquired and investigated.

4.2 Materials collection

4.2.1 Bitumen

Bitumen is otherwise called black-top. Some of the time it's called mineral tar. It is semi-strong type of oil and it is created from common store. It is chiefly utilized for road development where it is go about as paste for blending particles. It contains 87% carbon, 11% hydrogen and 2% oxygen. The shade of bitumen is Dark with slight rosy tinge. Basically there are 5 kinds of bitumen.

4.2.2 Glass Wool

Glass wool is a sort of stringy material produced using the softened glass crude materials or cullet. It comprises of two sorts: free wool and superfine wool. The fiber of the free wool is 50 ~ 150 mm long and 12 × 10⁻³ mm in distance across. On the other hand, the fiber of the superfine wool is a lot more slender in distance across, ordinarily under 4 × 10⁻³ mm. What's more, it is additionally called superfine glass wool.

The free wool can be utilized to make black-top reinforced glass cover and glass wool board. The superfine glass wool can be utilized to make regular superfine glass cover, glass wool board, antacid free superfine glass cover, hyperoxic silica superfine glass cover, and it is likewise used to save heat in the outside secured development and the pipelines.

4.2.3 Steel Wool

Steel wool, otherwise called iron wool, wire wool, steel wire or wire wipe, is a heap of fine and adaptable sharp-edged steel fibers. It was portrayed as another item in 1896 It is utilized as a grating in completing and fix work for finishing wood or metal articles, cleaning family unit cookware, cleaning windows, and sanding surfaces.[2]

Steel wool is produced using low-carbon steel in a procedure like introducing, where an overwhelming steel wire is pulled through a toothed bite the dust that evacuates flimsy, sharp, wire shavings.[2]

V. RESULTS AND DISCUSSION

After effects of research facility work had been acquired and examined so as to accomplish consider goals which incorporate contemplating the impact of including various rates of Glass Fiber on the mechanical properties of black-top blend and distinguish the ideal percent of Glass Fiber to be added to hot blend black-top.

Lab work results are exhibited in this section in three phases. To start with, taking care of the aftereffects of mixing aggregates to get black-top wearing course degree bend. Second stage, Marshal Test is done with various rates of bitumen which are (4, 5.0, 6.0 and 7.0%) and the outcomes are examined so as to acquire the ideal bitumen content (OBC).

In the wake of getting OBC, the accompanying advance is to think about the impact of including various rates of Glass Fiber and steel fiber on black-top blend properties which are (0%,0.25%,0.50%,0.75%,1.00%) by the heaviness of black-top blend. Marshal test results for adjusted black-top blends are broke down lastly the ideal Glass Fiber and steel fiber modifier substance is acquired.

5.1 Optimum bitumen content

Decide the ideal cover content for the blend configuration by taking normal estimation of the accompanying three bitumen substance discovered structure the diagrams got in the past advance.

- Binder substance relating to most extreme soundness
- Binder substance relating to most extreme bulk specific gravity ()
- Binder substance relating to the middle of planned points of confinement of percent air voids (in the absolute blend (for example 4%)

The solidness esteem, stream esteem, and are checked with Marshall blend plan specification outline given in Table underneath. Blends with extremely high security worth and low stream worth are not attractive as the pavements built with such blends are probably going to create breaks because of overwhelming moving burdens.

Table 1 Summary of Marshal Test results

BT (%)	SAMPLE NUMBER	STABILITY (KG)	FLOW(MM)	SA(g/cm ³)	Va (%)	VMA(%)	VFB(%)	Stiffness(KG/MM)
4%	1.1	1090.71	2.68	2.259	5.4	16.1	63.7	406.98
	1.2	1075.56	2.74	2.26	5.2	15.9	63.4	392.54
	1.3	1115.96	2.52	2.266	5.4	16	63.5	442.84
		1094.07	2.65	2.262	5.33	16	63.53	414.12
5%	2.1	1156.36	3.04	2.277	4.7	15.7	66.3	380.38
	2.2	1206.85	2.9	2.877	4.5	15.4	66	416.16
	2.3	1186.66	3.16	2.275	4.6	15.3	66.2	375.53
		1183.29	3.03	2.276	4.6	15.5	66.2	390.69
6%	3.1	1283.44	3.26	2.329	4.1	14.9	70.2	393.7
	3.2	1262.4	3.42	2.317	4	14.8	70.4	369.12
	3.3	1299.22	3.34	2.321	4	15	70.3	388.99
		1281.68	3.34	2.322	4.03	14.9	70.3	383.9366667
7%	4.1	1088.82	3.88	2.336	3.6	15.8	74.8	280.62
	4.2	1125.64	3.6	2.332	3.4	15.7	74.6	312.7
	4.3	1109.86	3.78	2.335	3.5	15.8	74.9	293.61
		1108.11	3.75	2.334	3.5	15.8	74.8	295.6433333

Stability – bitumen content relationship

Solidness is the most extreme burden required to create disappointment of the example when burden is connected at consistent rate 50 mm/min (Jendia, 2000). Figure (5.1) show the soundness results for various bitumen substance. Strength of black-top blend increments as the bitumen substance increment till it achieves the top at bitumen content 6% then it began to drop steadily at higher bitumen content.

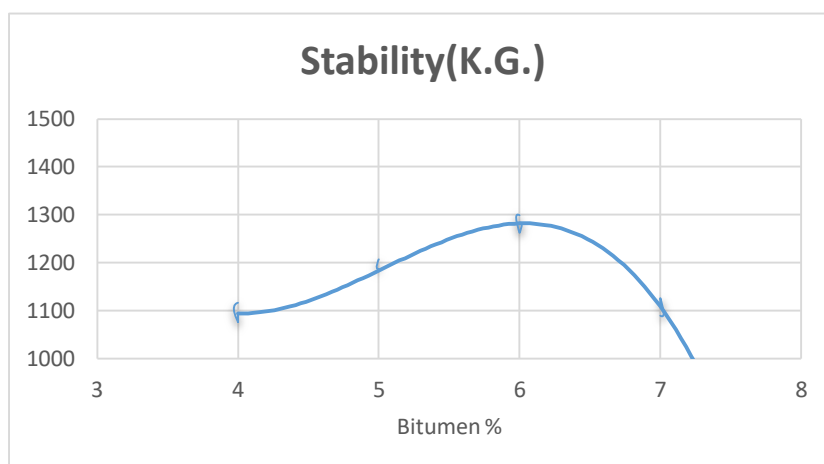


Fig 5.1 Stability vs. bitumen content

Flow bitumen content relationship

Stream is the aggregate sum of twisting which happens at most extreme burden (Jendia, 2000). Figure (4.2) show the Flow results for various bitumen substance. Stream of black-top blend increments as the bitumen substance increment till it achieves the top at the maximum bitumen content 7.0 %.

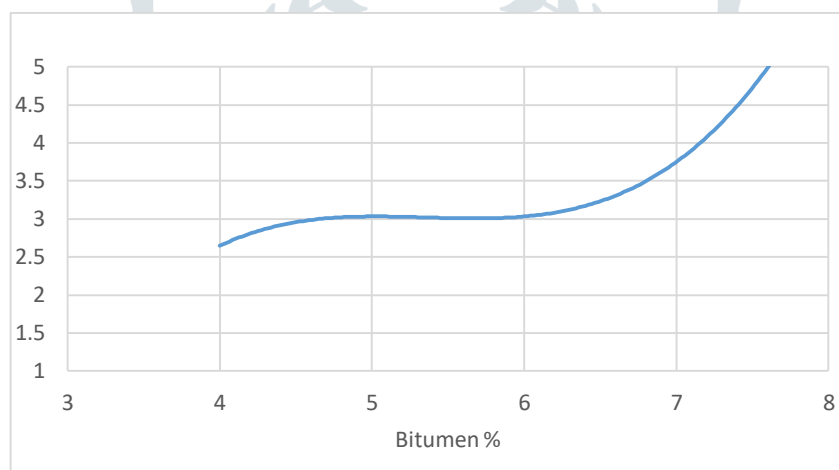


Fig (5.2): Flow vs. bitumen content

Effect of adding Glass Fiber on the mechanical properties of asphalt mix

Additional Material Used

The table 2 describes the additional material used.

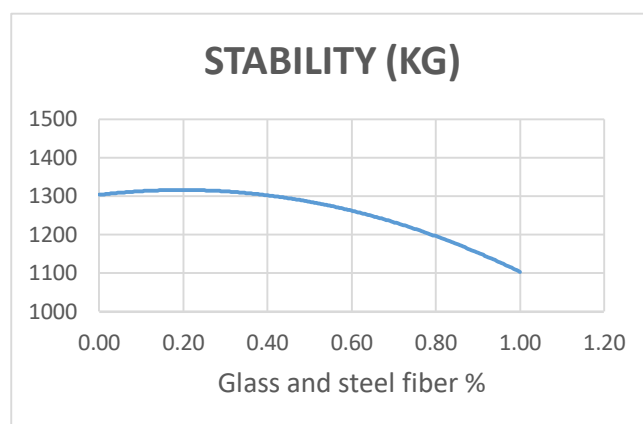
Table (4.2): Additional Material Used

	10mm	20mm	Dust	GW	SW	Bt
0%	284.4	420.8	432.2	0	0	72.6
0.25%	284.4	420.8	432.2	1.5	1.5	72.6
0.50%	284.4	420.8	432.2	3	3	72.6
0.75%	284.4	420.8	432.2	4.5	4.5	72.6
1.00%	284.4	420.8	432.2	6	6	72.6

Different examples were set up at OBC to assess the impact of including Glass Fiber and Wool Fiber to black-top blend tests by thinking about 5 extents of Glass Fiber (0.1, 0.25, 0.5, 0.75, and 1% by the heaviness of all out blend). Table (4.3) demonstrates the mechanical properties of black-top blend utilizing various rates of Glass Fiber (By weight of complete blend) at the OBC.

Stability – Glass Fiber and Steel Fiber content relationship

By and large, the strength of changed black-top blends is lower than the regular black-top blend (1728.7 kg). The most extreme steadiness worth is found about (1383.4 kg) at Glass Fiber and Steel fiber content around (0.25%). Figure (5.3) shows that the soundness of altered black-top blend diminishes as the Glass Fiber substance increments.



Fi (5.3): Asphalt mix Stability–Glass Fiber and Steel fiber content relationship

Flow – Glass Fiber and Steel Fiber content relationship

For the most part, the progression of adjusted black-top blend is higher than the ordinary black-top blend (2.7 mm). Figure (5.4) demonstrates that the stream increments persistently as the Glass Fiber and steel fiber modifier substance increment. The stream worth stretches out from (3.26 mm) till it achieve (3.92 mm) at Glass Fiber and steel fiber blend content (.25%).

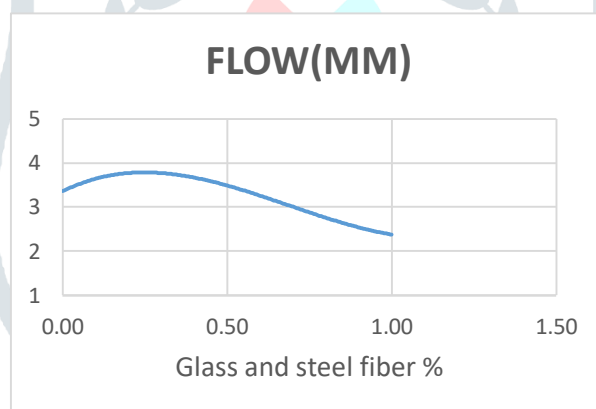


Figure (5.4): Asphalt mix flow–Glass Fiber and Steel Fiber content relationship

VI. CONCLUSION AND FUTURE WORK

6.1 Conclusions

- In light of test work results for Glass Fiber and Steel Wool adjusted black-top mixtures, the accompanying ends can be drawn:
- Glass Fiber and Steel Wool can be advantageously utilized as a modifier for black-top mixes for improved execution of black-top mix.
- The ideal measure of Glass Fiber and Steel Wool to be included as a modifier of black-top mix was observed to be (0.27 %) by the complete load of black-top mix.
- Asphalt mix altered with Glass Fiber and Steel Wool meets the neighborhood and global guidelines prerequisites.
- Asphalt mix altered with Glass Fiber and Steel Wool show higher stream an incentive as the Glass Fiber rate expanded. Be that as it may, the firmness of the changed mix diminished .

6.2 Recommendations

- It is prescribed to utilize Glass Fiber and Steel Wool content at 0.27% by the absolute load of black-top mix to improve execution of black-top mix.
- It is required to build up a nearby Palestinian specification for utilization of strands and modifiers in black-top mixes.

6.3 Future Studies

- Further inquires about are prescribed to consider the impact of including other Fiber types the black-top mechanical properties.
- Further inquires about are prescribed to lead this examination utilizing diverse bitumen rates and bitumen types.
- Further looks into are prescribed to lead this examination utilizing Super Pave Method as opposed to Marshall.
- The Superpave mix design method was designed to supplant the Hveem and Marshall methods. The volumetric investigation normal to the Hveem and Marshall methods gives the premise to the Superpave Mix Design method. The Superpave framework ties black-top folio and aggregate choice into the mix design procedure, and think about traffic and atmosphere too. The compaction gadgets from the Hveem and Marshall strategies have been supplanted by a gyratory compactor and the compaction exertion in mix design is attached to anticipated traffic.

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