Experimental Investigation of Bituminous Concrete By The Addition of Egg Shell, Coir Fibre And Plastic Waste

Mohammed Anwar[1], Devika Dinesh[2], Sona S B[3], Fathima Azad[4]
[1,2,3,4] Dept of Civil Engineering, Musaliar college of Engineering, Chirayinkeezhu, Kerala, India

Abstract- *Road construction plays an important role in maintaining a sustainable development as it intersects with various environmental factors. This study focuses on improving the properties of bitumen through the addition of additives such as egg shell, coir fiber and plastic waste. Given the sustainability concerns, innovative practices are widely adopted. additives are incorporated through the combination of two and three different additives. Testes such as Softening point test, ductility test, Penetration test and Marshall stability and flow test are conducted.*

Keyword: coir fiber, plastic waste, egg shell, bitumen, softening point test, ductility test, penetration test, Marshall stability and flow test

I. INTRODUCTION

The modern world faces various challenges in meeting infrastructure demands while safeguarding sustainability. Construction industry plays a vital role in maintaining sustainable development. The integration of innovative construction methods into bituminous pavement strives to balance the challenges of climate change and resource depletion in the sphere of infrastructure development.

Plastic waste can enhance the pavement's durability. Coir fiber offers reinforcement properties and improve crack resistance. Eggshells rich in calcium carbonate can help to stabilize the bitumen mixture and increase its resistance.

The experimental investigation of bituminous concrete incorporating the three additives holds significant position for advancing sustainable road construction practices. This study demonstrated the importance of enhancing bituminous concrete properties through the addition off egg shell coir fibre and plastic waste. The result shows the potential for using these waste materials for more sustainable and resilient road construction materials.

II. LITERATURE REVIEW

Prof. Shashikant S. Manekari, et al., (2020) studied the use of plastic waste in the construction of bituminous pavement. The optimum plastic to be coated in the aggregate is 8% of the bitumen. The bitumen content is reduced up to 8% by replacing with plastic. The use of the innovative technology increases the road life as well as improve environment and also create a source of income.

M. Jyothi, et al., (2021) based on the experimental investigations carried out the following conclusions are arrived based on Marshall Stability, the stability of all the specimen is above given range. CS and CF content replacement at 21.5% gives the highest stability.it makes it more suitable as it prevents cracking, plastic flow and bitumen bleeding.

Sneha Elangban, et al., (2021) studied the use of eggshell as a filler material. Eggshell can be a partial replacement of concrete. The construction cost reduces leading to more innovative green pavement. The application of such pavement can bring great changes in the country like India because most of the eggshells are burned.

Ramit Thakur, et al., (2017) stability value of bituminous concrete is start increasing up to 0.4% and then start decreasing slightly. The flow of bituminous concrete is start decreasing up to 0.2% and then again start increasing. Percentage of air voids with the addition of coir fibre id decreased. The key to effective performance of flexible pavements is to understand the causes of failures and the action needed for correction.

III. MATERIALS AND METHODOLOGY

3.1 MATERIALS USED

3.1.1 Bitumen 60/70

Bitumen is a viscous, sticky and black material obtained from the distillation of crude oil. bitumen 60/70 is commonly used in road construction and asphalt paving due to its relatively soft consistency, which makes it suitable for mixing with aggregate to form bituminous concrete.

Table 1: physical properties of bitumen

SI no	Properties	Result
1	Softening point	40°
2	Ductility	53cm
3	penetration	67mm
4	Specific gravity	1.10

3.1.2 Coarse aggregate

Aggregates passing through IS 20 mm sieve are used. Crushed stone is generally used as coarse aggregate.

Table 2: Physical properties of coarse aggregate

SI no	Properties	Result
1	Specific gravity	2.81
2	Bulk density	1.69 g/cc
3	Porosity	39.75%

3.1.3 Coir fibre

Coir fibre, derived from coconut husks is used as a filler in bitumen to enhance the properties of asphalt mixes. When incorporated into bituminous mixtures, coir fibre acts a reinforcing agent, improving the tensile strength and crack resistance of the pavement.

Fig 3.1: Coir fibre

3.1.4 Eggshell powder

Eggshell powder is used as a filler in bitumen to improve the properties of asphalt mixes. Eggshell powder acts a stabilizing agent when added to bitumen. It can reduce rutting and moisture damage in asphalt pavements.

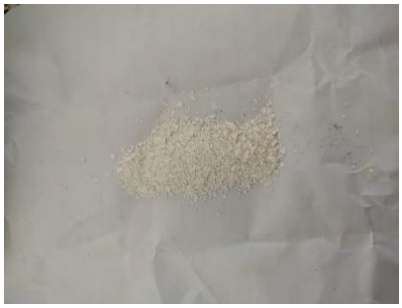


Fig 3.2: Eggshell powder

3.1.5 Plastic waste

Plastic waste is used as a filler in bitumen to increase the adhesive properties of asphalt mixes. Shredded plastic waste function as a modifier and improves flexibility, durability and provide resistance to cracking. Use of plastic waste as filler material also covers the concerns of sustainable environment.

Fig 3.3 waste plastic

3.2 METHODOLOGY

3.2.1 Experimental progress

The filler materials such as coir fibre, eggshell and plastic waste has been collected from various sources. The collected materials are cleaned and sorted. The coir fibres are chopped into small pieces and is allowed to pass through 4.75mm and 2.36mm sieve. The coir fibre retained in 2.36 are taken. The eggshell is made into powdered form. The plastic waste is made into shredded form and is allowed to pass through 2.36mm and 600µm sieve. The particles retained in 600 µm is used.

The collected filler materials are added into the bitumen with a combination of two and three. The filler items are added to the bitumen at a temperature between 140 to 160 degrees Celsius and mixed thoroughly.

3.2.2 Preparation of specimen

In the initial phase bitumen is mixed with a combination of two additives at a varying percentage of 2%, 4%, 6% and 8%.

Following that additional batches of bitumen are mixed with a combination of three additives at proportions of 2%, 4%, 6% and 8%.

3.2.3 Test for bitumen

Softening point test

Softening point of bitumen is determined by ring & ball apparatus. bitumen is placed in the apparatus where they undergo testing to determine its softening point. The temperature at which the bitumen becomes soft enough to allow the ball to sink is noted.

Ductility test

Ductility is the property of bitumen to stretch. The bitumen samples are taken in the briquette mould and is placed in the ductility machine. The distance at which the specimen stretches until it breaks is noted.

Penetration test

Penetration test determines the consistency of bitumen. The standard needle is allowed to fall in the prepared bitumen mix. The depth at which the needle penetrates is noted.

Marshall stability and flow test

Marshall stability test determine the strength and stability of asphalt concrete mixture. The compacted cylindrical specimen of the mixture is subjected to a compressive load at a certain rate and temperature. The maximum load at which the specimen withstands before it fails or deforms is recorded.

IV. RESULTS

4.1 Softening point test

Table 3: Softening point result

SL NO.	PERCENTAGE OF ADDING TWO ADDITIVES (PLASTIC AND COIR FIBRE)	RESULTS (℃)
1	0%	40
2	2%	41
3	4%	42.6
4	6%	43.4
5	8%	43

Table 4: Softening point result

SL NO.	PERCENTAGE OF ADDING THREE ADDITIVES	RESULTS (℃)
1	0%	40
2	2%	43.4
3	4%	45
4	6%	47.4
5	8%	47

4.2 Ductility test

Table 7: Ductility results

SL NO.	PERCENTAGE OF ADDING TWO ADDITIVES (COIR FIBRE AND PLASTIC)	RESULTS (cm)
1	0%	55
2	2%	56
3	4%	57.5
4	6%	57.9
5	8%	57

Table 8: Ductility results

SL NO.	PERCENTAGE OF ADDING THREE ADDITIVES	RESULTS (cm)
1	0%	55
2	2%	58.7
3	4%	62.4
4	6%	66.5
5	8%	66

4.3 Penetration test

Table 10: Penetration result

SL NO.	PERCENTAGE OF ADDING TWO ADDITIVES (COIR FIBRE AND PLASTIC)	RESULTS (mm)
1	0%	62
2	2%	61
3	4%	59
4	6%	57
5	8%	58

Table 11: Penetration result

SL NO.	PERCENTAGE OF ADDING THREE ADDITIVES	RESULTS (mm)
1	0%	62
2	2%	60
3	4%	58
4	6%	55
5	8%	57

4.4 Marshall stability and flow test

Table 12: Result of three additives

BITUMEN CONTENT	5%			
% OF ADDITIVES	2	4	6	8
STABILITY (KN)	21.32	22.58	23.66	22.76
FLOW(mm)	2.55	2.25	2.14	2.07

Table 13 : Result of three additives

BITUMEN CONTENT	5.5%			
% OF ADDITIVES	2	4	6	8
STABILITY (KN)	23.52	25.62	31.65	29.87
FLOW(mm)	3.15	2.78	2.65	2.22

Table 14: Result of three additives

BITUMEN CONTENT	6%			
% OF ADDITIVES	2	4	6	8
STABILITY (KN)	24.32	24.45	32.65	30.14
FLOW(mm)	3.5	3.2	3.12	3.06

Fig 4.1: Bitumen content vs Stability

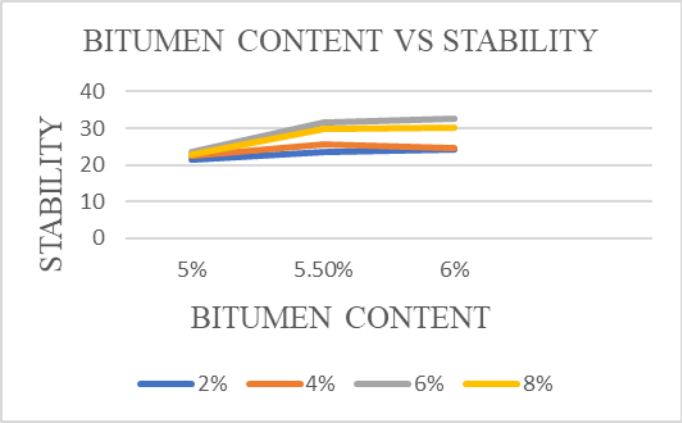


Fig 4.2: Bitumen vs Flow rate

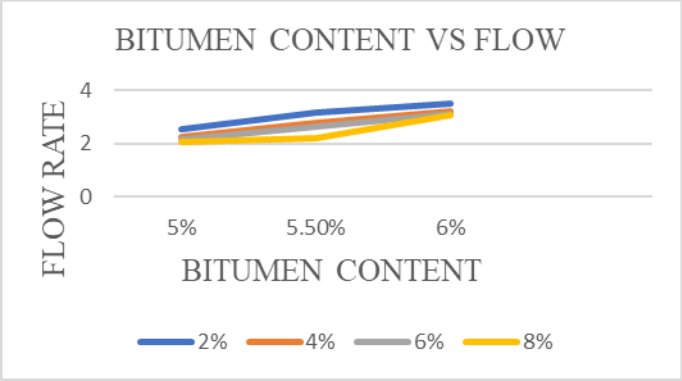


Table 15: Result of two additives

BITUMEN CONTENT	5%			
% OF ADDITIVES	2	4	6	8
STABILITY (KN)	21.22	22.34	23.05	22.81
FLOW(mm)	2.32	2.24	2.11	2.06

Table 16: Result of two additives

BITUMEN CONTENT	5.5%			
% OF ADDITIVES	2	4	6	8
STABILITY (KN)	22.45	22.95	23.51	23.12
FLOW(mm)	2.55	2.4	2.27	2.19

Table 17: Result of two additives

BITUMEN CONTENT	6%			
% OF ADDITIVES	2	4	6	8
STABILITY (KN)	22.87	23.11	25.64	23.7
FLOW(mm)	2.62	2.5	2.39	2.22

Fig 4.3 : Bitumen content vs Stability

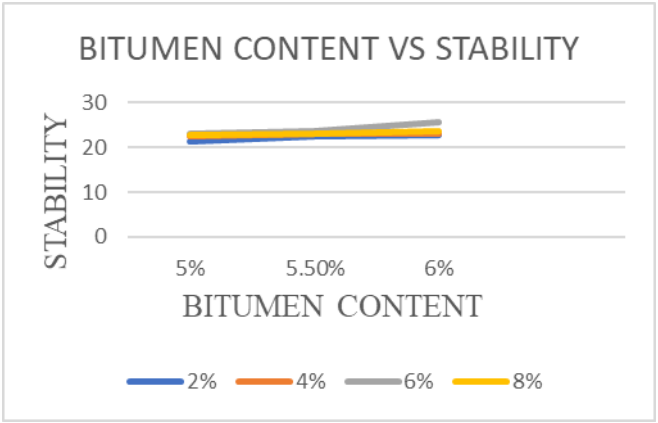
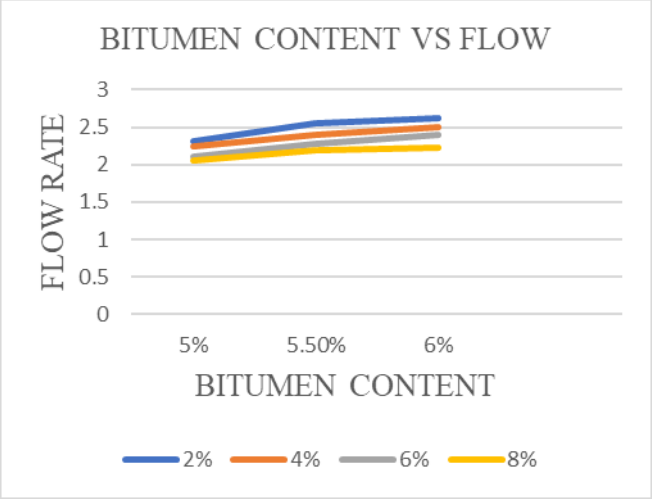


Fig 4.4 : Bitumen content vs Flow rate



V. CONCLUSION

In this paper, we conducted a study on bitumen by adding coir fibre, plastic waste and eggshell as additives at proportions of 2%, 4%, 6% and 8%. Tests such as Marshall Stability and flow, penetration, ductility and softening point, which determine the quality of bitumen were conducted. The result shows that the bitumen exhibited better ductility and softening point at the addition of 6% additives.

Marshall stability increases proportionally with the percentage of additives. The penetration value was found to increase after the addition of 8% additives, indicating a softening of the bitumen.

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