FLEXIBLE PAVEMENT USING COCONUT SHELL AND COIR FIBRE

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Abstract : This paper study about the of utilization coconut shell and coir fibre in road construction. Coconut shell and coconut fibre can be effectively used in highway industry. Some researches showed that coconut fibre can increase the stability, skid resistance and resilient modulus while coconut shell will improve the indirect tensile strength and creep behavior of the modified asphalt pavement. This paper explains about the suitability of adding varying percentage of coconut shell such as 5%,10%, 15%, 20% and fibre such as 0.5 %,1%, 1.5% ,2%. The result shows that the mix with 21.5 replacement shows the better result.

IndexTerms: Coconut Shell, coconut fibre, skid resistance, waste material, asphalt pavement -

I. INTRODUCTION

Coconut shell is one of the major pollutant that contributes to the nation's pollution problem. It is a produced as waste product from agriculture The various waste materials that used to improve the quality of bituminous mix are ash, scrap tire, iron and steel slag, fly ash and plastic waste. Coconut shell (CS) and coconut fibre (CF) as shown in Fig. 1 are known as new waste materials that used in construction of pavement. The coconut shell has good weather resistant thus it can be used as construction materials. Also, it has no economic value and its dispose process is costly and will cause environmental problem.

Fig.1 Coconut shell and Coconut fibre.

3. CHARACTERISTIC PROPERTIES OF COCONUT SHELL AND COCONUT FIBRE :

(a) COCONUT SHELL (CS):

The coconut shell contains 33.61% cellulose, 36.51% lignin, 29.27% pentosans and 0.61% ash . CS has low ash content but high volatile matter, 65-75%3. But coconut fibre has the lowest cellulose content, 36 - 43% but with twice amount of lignin (41- 45%) compared to jute and sisal which makes it has greater resistance and hardness. CF will act as stabilizing agent when added into the asphalt mix around 180°C. The water absorption of the CS is higher than normal aggregate, which is 24% compared to 0.5. CS is also more resistance against impact, crushing and abrasion compared to others conventional crushed granite aggregate. It can be used to mix with asphalt mixture directly for the experiment except water absorption test. This is because coconut shell has high water absorption capability and not suitable to use for mixing without treatment.

(b) COCONUT FIBRE (CF):

Coconut fibre has many advantages when react with asphalt mixture as it can reduce bleeding of the binder and advancing the macro texture of the coating. It can help to reform the mechanical properties and improve surface drainage .Coconut fibre enable the use of discontinuous of grain size, which can increase the content of binder, hence the aggregates will coat with thicker film. This can reduce the oxidation of asphalt mixtures, moisture penetration and separation. Coconut fibre has outstanding moisture absorption because the irregular of crack in the cross section surface provides unique structure. This structure also results in better air permeability and moisture conductivity. In addition, the unique structure of the CF will improve the moisture susceptibility, viscoelasticity and rutting resistance as well as ameliorate low temperature anti-cracking properties, durability, material toughness, fatigue life and lowering reflective cracking of asphalt concrete mixtures and pavements.

4. **METHODOLOGY**

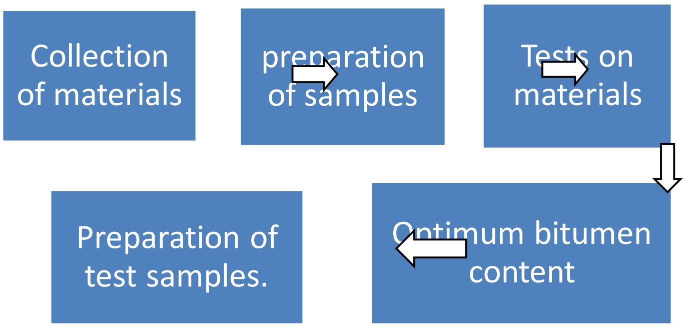

fig. 2 Methodolgy

5. MATERIALS AND METHODS:

5.1. AGGREGATES

Aggregates is a collective term for the mineral materials such as sand, gravel and crushed stones that will be used with a binding medium to form compound materials. They should be strong and durable; and also possess proper shape and size. Aggregates are tested for strength, toughness, hardness, shape and impact. Aggregates can either be natural or manufactured. The size of aggregates used from 19-20 mm-4-6mm. The test results are computed as follows

- **Table 1. Tests On Aggregate**

Aggregates	Test	Experimental Value	Standard Values
Coarse Aggregate	Impact strength	20.2%	20-30%
	Crushing strength	24.5%	30%
	Flakiness index.	29.9%	25-30%
	Elongation index	15.56%	10-20%
	Water absorption	0.54%	1%

5.2. BITUMEN BINDER

The bitumen acts as a binder of the aggregate that provides the structural strength and texture of the road surface. It makes up about 5 to 6 percent of the total bitumen mixture. It is available in various grades, for higher traffic roads, 60/70 found to be suitable. The properties of bitumen are analyzed by performing various tests

Table 2 Test On Bitumen

Test	Experimental Values	Standard Values
Specific Gravity	1.07	0.97-1.02
Penetration	215mm	100-200mm
Ductility	47cm	10-50cm

5.3. MIX DESIGN:

Marshall Method of mix design has been adopted in this work. Accordingly aggregates with the grading 1 of IRC 29-1988 and bitumen having properties described in the tables have been used. The objective of bituminous paving mix design is to form an economical blend of aggregates and bitumen. Several trial aggregate-bitumen binder blends have been used, each of different binder content. By evaluating each trial blend's performance, optimum bitumen binder content is obtained. The first step in sample preparation is to estimate OBC. Trial blend bitumen contents are then determined from this estimate.

5.4.DETERMINATION OF OPTIMUM BITUMEN CONTENT:

DESCRIPTION	S1	S2	S3
% of bitumen content(%)	5	5.5	6
Initial weight(g)	1219.5	1320.2	1347
Weight in water (g)	687	717	721.5
Weight in air (g)	1224	1263.4	1269.9
Stability(KN)	21.2	34.9	30.1
Flow(mm)	2.56	3.66	4.9
Unit weight (g/cc)	2.46	2.54	2.56
% Of air voids with bitumen (%)	4.5	3.4	2.9
Voids filled in bitumen (%)	61.53	83.87	82.52

The average value of the properties are determined for each mix with different bitumen content and the following graphical plots are prepared:

- Binder content versus corrected Marshall stability
- Binder content versus Marshall flow
- Binder content versus unit weight
- Binder content versus percentage of void in the total mix
- Binder content versus voids filled with bitumen

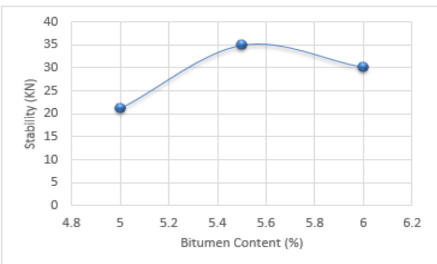

FIG. 3 STABILITY CURVE

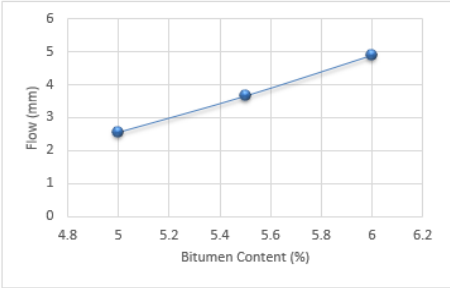

Fig.4 Flow Curve

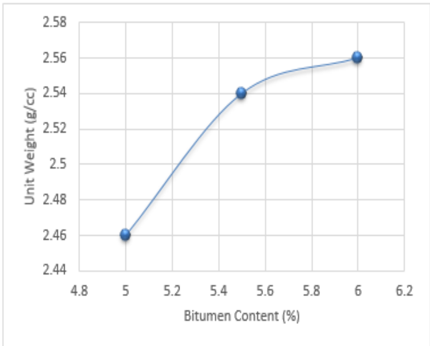

FIG.5 UNIT WEIGHT CURVE

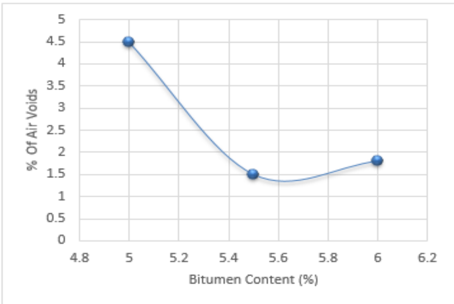

Fig.6 Percent Air Voids Curve

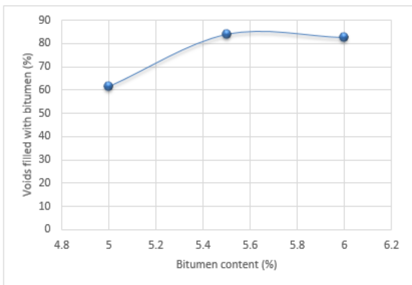

FIG.7 VOIDS FILLED WITH BITUMEN CURVE

The optimum bitumen content for the mix design is found by taking the average value of the following three bitumen contents found from the graphs of the test results.

- Bitumen content corresponding to maximum stability
- Bitumen content corresponding to maximum unit weight
- Bitumen content corresponding to the median of designed limits of percent air voids in total mix.

From the above results the optimum bitumen content found desirable is 5.5% for the mix design as it lies in the range given in IRC 29-1988. Hence 5.5% bitumen content is used to make the moulds with the partial replacement of the coarse aggregate with CS and CFs.The procedure is followed same as mentioned above. The aggregate dust is replaced with 5% ,10%, 15%, 20% ..of coconut shell and 0.75%, 1%, 1.25%, 1.5%.. of coir fibre respectively.

5.5 DETERMINATION OF OPTIMUM CS AND CF CONTENT:

Description	S1	S2	S3	S4	S5	S6
Stability(KN)	17.26	17.81	19.27	21.11	20.74	20.64
Flow(mm)	2.11	2.46	3.45	3.51	2.87	3.08
Unit weight(g/cc)	2.431	2.459	2.506	2.549	2.479	2.477
% of voids in total mix	5.4	5.1	4.6	3.9	4.1	4.9
Voids filled with bitumen (%)	65.81	66.1	71.96	84.04	75.72	68.46

5.6 MARSHALL STABILITY AND FLOW

Marshall stability of a test specimen is the maximum load required to produce failure when the specimen is preheated to a prescribed temperature placed in a special test head and the load is applied at a constant strain (5 cm per minute).

While the stability test is in progress, dial gauge is used to measure the vertical deformation of the specimen. The deformation at the failure point expressed in units of 0.25 mm is called the Marshall Flow Value of the specimen.The following graph gives the value of optimum values of CS and CF.

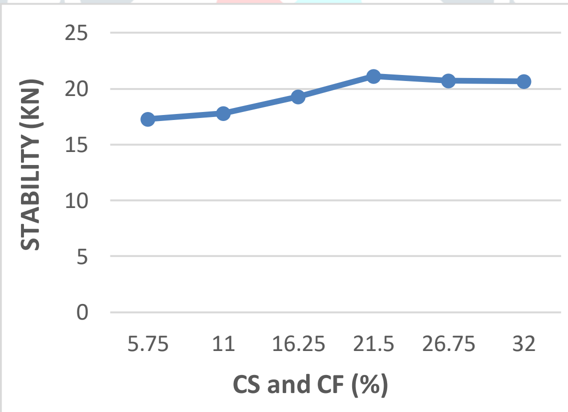

FIG.8 VARIATION OF STABILITY WITH DIFFERENT CS AND CF

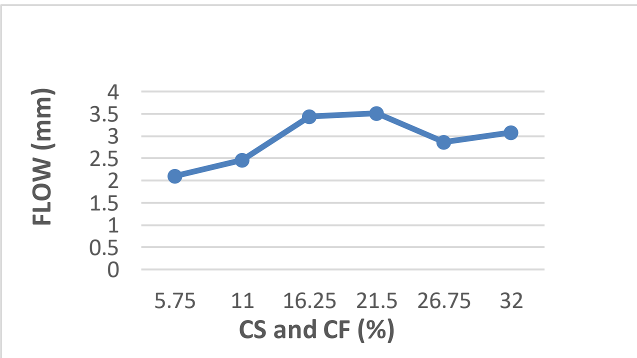

Fig.9 Variation of flow

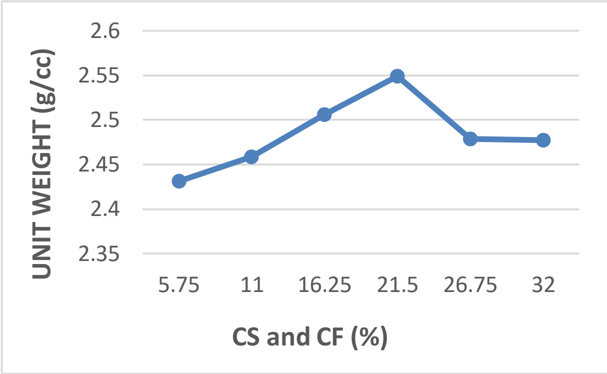

Fig. 10 **Variation of Unit weight**

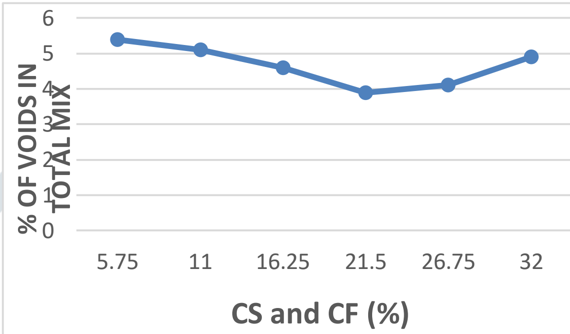

Fig.9 Variation of voids in total mix

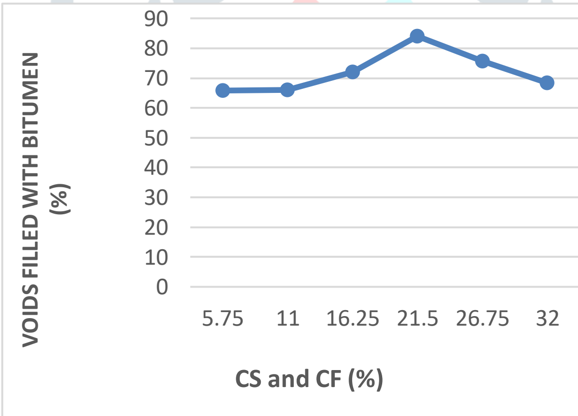

Fig.9 Variation of voids Filled with Bitumen

CONCLUSION:

Based on the experimental investigations carried out the following conclusions are arrived

- ✓ Based on Marshall stability, the stability of all the specimens is above the given range. Although, CS and CF replacement at 21.5% gives the highest stability. And from Marshall Flow, all the specimens are also within the given range.
- ✓ Based on the percent air voids present in the specimens, all the specimens were under the specified range. But the least voids were found in 21.5% CS and CF content. It makes it more suitable as it prevents cracking, plastic flow and bitumen bleeding.
- ✓ The unit weight obtained at 21.5% is most suitable in the flexible pavement construction.

Based on the above points, the replacement of coarse aggregate with 21.5% CS and CF dust is most suitable in the construction of low to medium traffic roads

REFERENCES

[1] .Jyothi M., Patel sheikh. Monikkah A. 'Partial Replacement of Coarse Aggregates Using Cockle Seashells in Flexible Pavement', International Journal of Creative Research Thoughts pp 25-30

[2] Olugbenga , Oyedepo,Lekan Makanju Olanitori & Ebenezer Omoniyi Olukanni (2015), "Partial replacement of Palm Kernal Shell for aggregates in asphaltic concrete",International Conference on Advances in Civil Engineering,pp.4-5.

[3] ..K.Kiruthiha,G.Loshini,M.Thivya(2015),"Experiment of Strengthening of Flexible Pavement using Egg Shell as a Filler", International Journal of Engineering Trends and Technology (IJETT) ,pp.5- 7

[4] Indian Roads Congress 29-1988 Specification of Bituminous concrete for Road pavement, Indian Road Congress, New Delhi Joseph and John (2012) ,"Properties of Soy Fatty Acids (SFA) as sustainable modifier for asphalt binders",ICE- Construction Materials Conference,pp.6-7.

[5] Tay Lay Tinga, Ramadhansyah Putra Jaya, Norhidayah Abdul Hassan, Haryati Yaacob and Dewi Sri Jayant (2016), "Review of utilization coconut shell in road construction", Indian Journal of Science and Technology ,PP.5-6