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Effect of Partial Replacement and Sizes of Palm Kernel Shells on Asphalt Concrete

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Abstract: Rising development activity in urban areas has basis for declining of raw materials used in construction activities. The palm oil industries often dumped palm kernel shells as waste products after the extraction of palm oil. It has been huge environmental problem due to this disposal of waste generated from palm oil industries. Present study is focused on partial replacement of coarse aggregate with Palm Kernel Shell (PKS) in Asphalt concrete. Laboratory test were carried out on aggregates, PKS and bitumen to study their properties. Softening point and Penetration value test were performed to measure consistency of bitumen. Tests on aggregates and PKS were carried out in two phases. In Phase I, physical tests such as bulk density, abrasion value, specific gravity, water absorption were conducted. In Phase II, Marshal Stability and flow value test were carried out by partial replacement of aggregate with Crushed Palm kernel shell (CPKS) in varying percentages of 5 %, 10 % and 40% and in different sizes of 10-15mm, 5-10mm, 5-15mm. The results for marshal stability tests were 15.14KN, 18.81KN, 22.97KN and flow value test were 4mm, 7mm, 12mm. Result of normal mould with 0% of CPKS replacement was 13.9KN and flow value 3.9mm. Standards set by Ministry of Road Transport Highways (MoRTH) for marshal stability test should be more than 8.2KN and maximum flow value should be 4 KN. The specific gravity of aggregates was found to be 2.51 and for CPKS 1.55. The Recommended result of specific gravity used in road construction should be less than 2.8. These test results revealed that CPKS can be used as a suitable material as partial replacement for aggregate in asphaltic concrete up to 5% of size 10-15mm for rural roads of low traffic.

Key Words: Palm Kernel Shell, Coarse and Fine aggregates, Bitumen, Marshall Stability Test.

I. INTRODUCTION

One of the most important tasks for society nowadays is conservation of environment. The basic requirement of every construction activities are materials such as concrete, steel, brick, stone, glass, clay, mud, wood, and so on. However, the cement concrete is considered to be principal construction material used in construction industries. For the suitability of concrete due to changing environment should be adopted in such a way that it can conserve resources, protect the environment, economize and lead to proper consumption of energy. To achieve this, major significance must be set for the use of wastes and by products in cement and concrete for new constructions. The aggregates can be recycled and utilize promisingly as 75 percentage of concrete is made of aggregates. Large quantities of demolished concrete are available at different construction sites, which are now posing a serious problem of disposal in urban areas. Such concrete can be easily reused as aggregates and used in concrete. As the problem of disposing these waste materials became a big environmental issue, the proper utilization of these materials again in construction activities will be a great relief to the society. Some of the significant elements in this respect are the reduction of the exhaustion of energy and natural raw materials, systematic consumption and use of waste materials to a great extent. Development activities have been taken up even in India for proving its feasibility, economic viability and cost effectiveness for the use of waste materials in all the construction activities. Asphaltic concrete is derived from mixture of course and fine aggregates, stone, dust, mineral filler and binders usually bitumen. The mixture is done so that products formed after mixing should not contain too much bitumen. If the % of bitumen is more this will lead friction less surface. If percentage (%) of aggregate is uneven this will lead to separation of aggregates from the surface. The major advantage of asphaltic concrete surface is easy to construct and repair. In the course of design and construction of road pavement, factors such as materials, durability, strength and economy should be considered. The demand for conventional flexible pavement has increase in construction activities in road sector. However, the road paving industry is intent in utilizing alternative and sustainable materials that satisfy replacement and performance of road pavement. The material used as alternative should be sustainable properly with bitumen and have comparatively low cost when used in pavement construction. For the substitute of materials to be considered sustainable, they must be technically economically and environmentally viable.

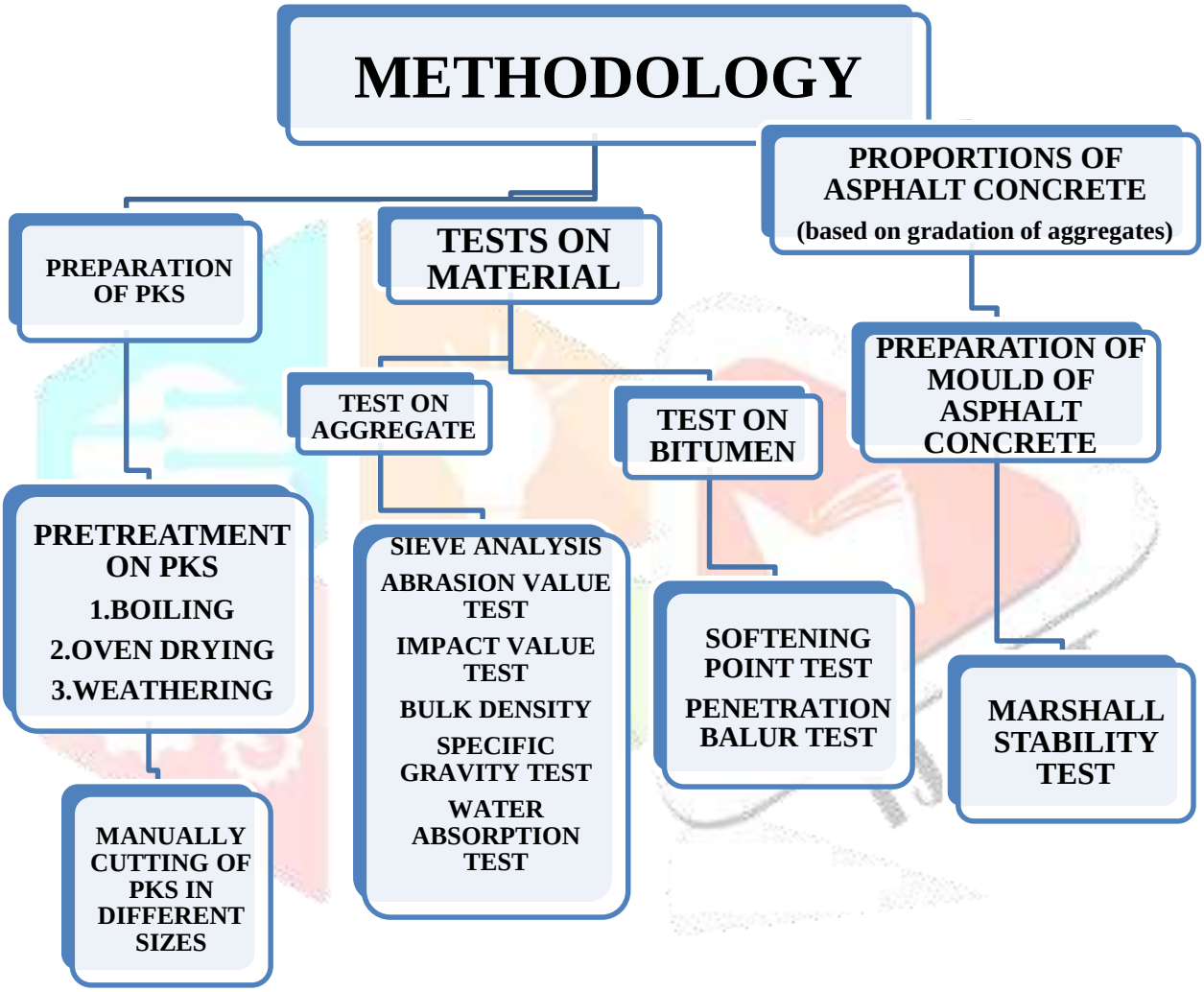
Palm oil industry generates large quantity of wastes whose disposal is tough responsibility. PKS can be used as replacement of coarse aggregate in asphalt concrete & can be utilized as raw material for road construction. Palm kernel shell is derived from oil palm tree an economically valuable tree which is mainly used for the production of palm oil. The palm oil shell is light in weight and found to be economical. Palm kernel shell is the left-out material after crushing in the oil mill. Press fibre and shell generated by the palm oil are traditionally used as solid fuels for steam boilers. To make the efficient use of locally available materials, this study was performed to study

the effect by replacing coarse aggregates and fine aggregates from asphalt concrete by palm kernel shell varying in mix ratios and proportion of aggregates on strength, stability and flow from marshal stability test and To determine optimum quantity (%) of PKS can be replaced in asphalt concrete

2. MATERIAL AND METHODS:

Sourcing of materials:

The material used in asphalt concrete such as fine aggregate and coarse aggregate, Stone dust (0-5mm), crushed stone size ranges of (5-10mm) and size (10-15mm) were obtained from local market of Kharghar, Navi Mumbai. The palm kernel shell was obtained from local market of Uran village. The bitumen was obtained from college laboratory of SCOE Kharghar.



2.1 Tests performed on material in accordance to the standard specifications as below:

Table 1: Standard results

Test	Requirement	Test method
Grain size analysis	Max. 5% passing 0.075 micron	IS 2386 Part I
Los Angeles Abrasion Value	Max. 40%	IS 2386 Part IV
Aggregate Impact Value	Max. 30%	IS 2386 Part IV
Specific gravity	2.8	IS 2386 PART III
Water absorption	Max. 8%	IS 2386 Part III
Bulk density test	MIN 1120 Kg/M^3	IS 2386 Part III
Penetration test	80/100	IS 1201
Softening point test	80/100	IS 1203-1978

Table 1 displays standard results as per Indian Standard Code. The properties of both aggregates and Palm Kernel Shell was verified with standard results. Results showed that both the material were satisfying standard requirements.

2.2 Properties of material

Table 2: Properties of material used in asphalt concrete

Sr. no.	Test	PKS	Fine aggregate	Coarse aggregate	bitumen
1	Sieve analysis (FM)	4.7	3.506	4.5	-
2	Specific gravity	1.55	2.51	2.51	-
3	Water absorption	22.22%	6.06%	8.62%	-
4	Bulk density	616.123kg/m^3	1712 kg/m^3	2194.22 kg/m^3	-
5	Abrasion value	6.48%	-	35.2%	-
6	Impact value	9.98%	-	10.58%	-
7	Penetration	-	-	-	76mm
8	Softening point	-	-	-	93*c

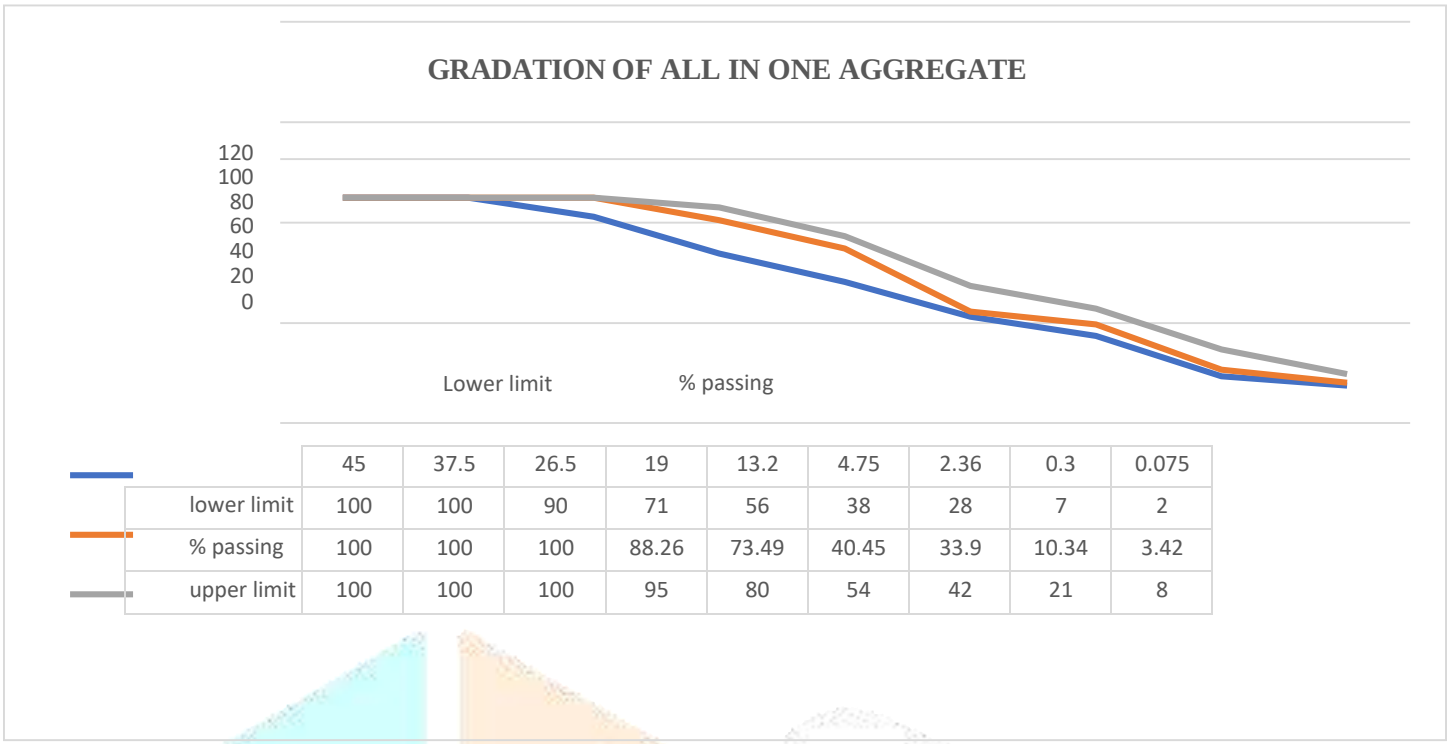
Table 2 displays the test performed on aggregates, PKS and bitumen to check the properties of material. All the test was performed according to standard procedure given in Indian Standard Code (Table 1) thus all the results were within the permissible limit.

3. TESTS & RESULTS:

Sieve analysis

Sieve analysis is test performed to assess the particle size distribution of material (also called gradation). Test were performed according to IS 2386 Part I. Sieve analysis is considered to be most important factor of this research because on the basis of this test percentage of partial replacement of palm kernel shell (PKS) with aggregates is mainly decided.

The results of sieve analysis of all in one aggregate which contains fine aggregate and coarse aggregate in the test sample is shown in graph.

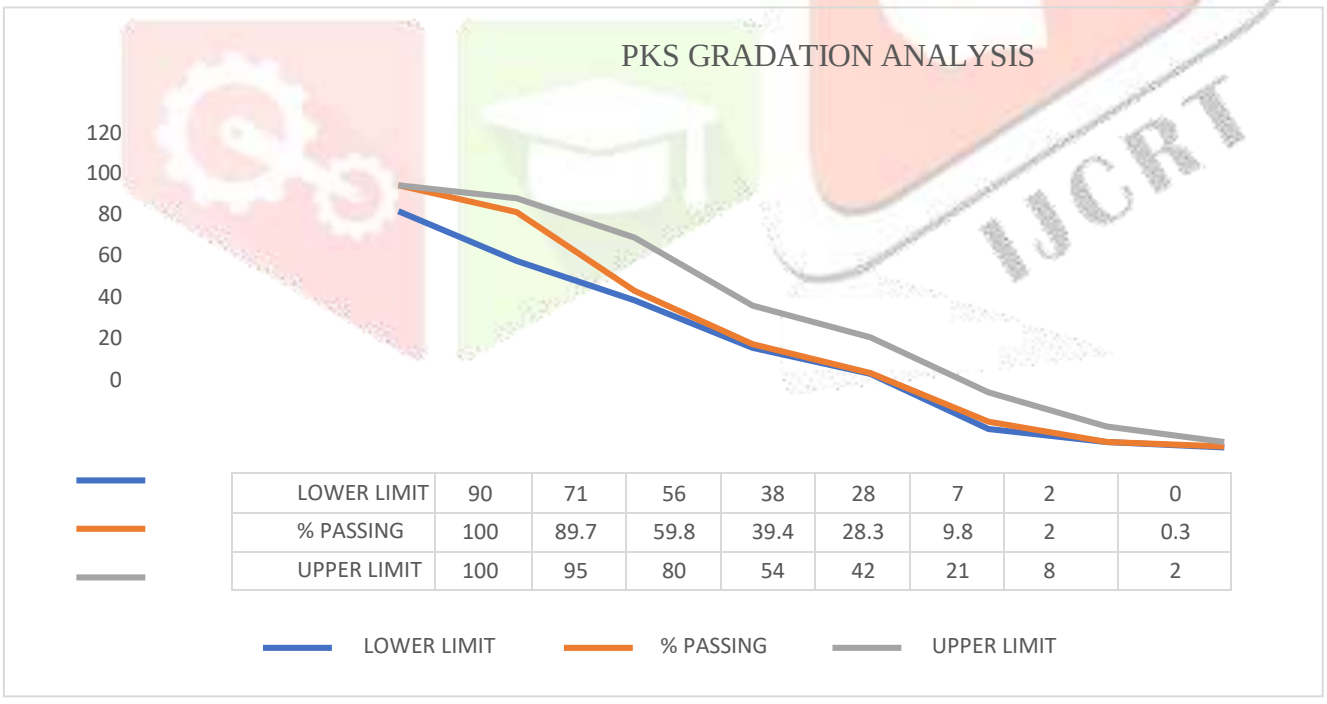


	45	37.5	26.5	19	13.2	4.75	2.36	0.3	0.075
lower limit	100	100	90	71	56	38	28	7	2
% passing	100	100	100	88.26	73.49	40.45	33.9	10.34	3.42
upper limit	100	100	100	95	80	54	42	21	8

Figure 1: Gradation of all in one aggregate

Figure 1 displays the all in one gradation as per Ministry of Road Transport and Highway (MoRTH). The upper and lower limit are given in MoRTH. Percentage of passing of aggregates should be such that it should lie within both limits.

SIEVE ANALYSIS GRADATION (PKS)



LOWER LIMIT	90	71	56	38	28	7	2	0
% PASSING	100	89.7	59.8	39.4	28.3	9.8	2	0.3
UPPER LIMIT	100	95	80	54	42	21	8	2

Figure 2: Gradation of PKS

Figure 2 shows gradation carried out for Palm Kernel Shell. The result of sieve analysis of pks which shows it is fairly graded.

Figure 3: sieve analysis of pks & aggregates

4 Marshall Stability Mould Procedure:

Figure 4.1: Mixing of Asphalt Concrete With PKS

Figure 4.2: Asphalt Concrete Compaction

Figure 4.3: Asphalt Concrete mould after Compaction. (Kept in mould for 24 hour)

Figure 4.4: Water Bath Machine (At 60 ^{0}C±1% of set point for 30 min.)

Figure 4.5: Marshall Stability Testing.

5 MARSHALL TEST RESULTS & ANALYSIS

The Marshall Stability test results are given below of various proportion of aggregate in different sizes replaced with PKS.

SAMPLE NO.	PKS % WITH DIFFERENT SIZES	PROPERTIES		REMARKS
		Stability (KN)	Flow (mm)	
1	0% of pks normal	13.9	3.9	Not satisfactory
2	(10% PKS = 10-15mm)	18.81	7	Not satisfactory
3	(10% PKS = 5-10mm)	15	5	Not satisfactory
4	(5% PKS = 10-15 MM)	15.14	4	satisfactory
5	(40% PKS = 5-15 mm)	22.97	12	Not satisfactory
SPECIFICATION		Not less than 8.2	2 to 4mm	

Table 3: Properties of Marshall Stability mould at various % of PKS

Table 3 displays partial replacement of pks in Asphalt Concrete of various sizes and results of Marshall Stability. The maximum permissible limit of stability should not be less than 8.2 KN and flow value should be between 2mm to 4mm as per MoRTH.

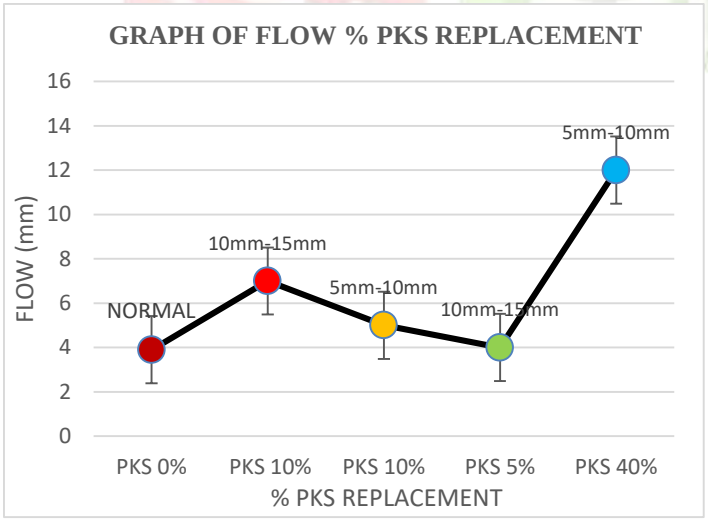


Figure 5

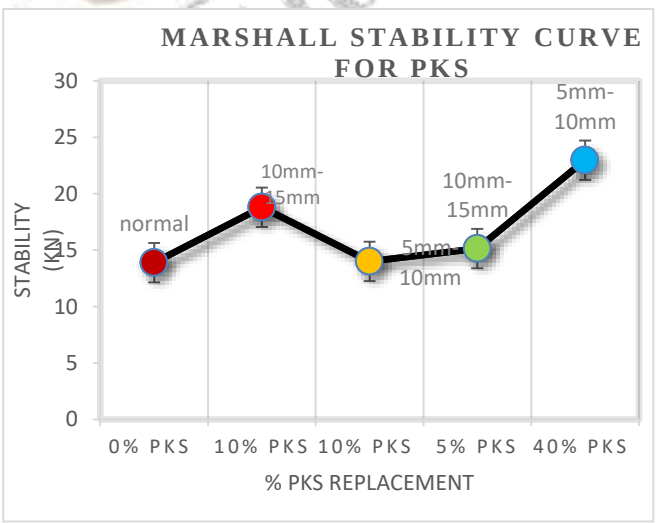


Fig 5 and 6 shows the graph of flow value and stability. Both the graphs were plotted with various replacement of PKS

6. CONCLUSION

It is concluded that PKS can be a viable source of aggregate for partial replacement in asphalt concrete from the results obtained in this experiment, all flow values of marshal stability tests exceed their limit except 10-15mm size of PKS 5%. In addition, the results of the tests showed that the marshal stability value decreased as the percentage of crushed palm kernel increases which implies the reduction in the strength of the asphaltic concrete. Hence the effective optimum quantity of palm kernel shell replacement with aggregates is 10-15mm and 5% replacement in binder course. It is suitable for rural roads with light traffic.

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