An Experimental Study on Replacement of Crushed Aggregates with Non-Conventional Material in Sub-Base Layer in Pavement

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Abstract— Road transportation contributes to the economic, industrial, social and cultural development of a country. India now has the second largest road network in the world. The extensive road construction programme by the Government of India has resulted in a high development process in the road industry. In this study I will focus on To check the usability of different non-conventional materials as partial replacement of crushed aggregates in pavement granular sub-base. To compare the strength with and without replacement of non-conventional materials in granular sub base. To perform cost calculation with and without use of non-conventional materials in granular sub base.

Keywords: Crushed Aggregates, Pavement, Non-Conventional Material

I. INTRODUCTION

Now-a-days the depletion of natural resources has been a major issue in the construction sector from which the road segment cannot be excluded. Because of the extensive road construction processes the aggregate demand is so huge that lots of blasting, quarrying, crushing and transportation activities are consuming a lot of energies, but also the aggregate materials are depleting fast and are in short supply.

On the other hand, industrial wastes, by-products and locally available unused materials which are considered as non-conventional materials are causing environmental and dumping problems, but can have a potential for their application in road constructions.

II. OBJECTIVE OF THE STUDY

1) To check the usability of different non-conventional materials as partial replacement of crushed aggregates in pavement granular sub-base
2) To compare the strength with and without replacement of non-conventional materials in granular sub base
3) To perform cost calculation with and without use of non-conventional materials in granular sub base

III. MATERIALS TO BE USE IN STUDY

Low fuel content coal rejected from power plant: All over India the coal from coal mines, which is supplied to the thermal power plants for electricity production, contains both coal and stones.

The material which contains less than 40% fuel (pure coal) content is rejected because its containment of less coal percent and when it is feed in the machinery it causes harm to the machinery.

A. Over Burnt Brick Bats:

Bricks may be natural mud (laterite) blocks cut to sizes or artificial manufactured in clamps and kilns. Artificial bricks shall be well-burnt so that their crushing strength is not less than 30N/mm². Under burnt bricks shall not be used to make brick aggregate.

B. Waste Phosphate Rock Aggregate from Fertilizer Units:

Phosphate rock is grinded for production of phosphoric acid for production of phosphor based fertilizers.

River bad material: River bed material is extracted from the bed of the rivers. This consists of large proportions of sand with combination of silt and gravel

Physical properties of rejected coal aggregate

Property	Value
Textural form	Nodular, Granular
Color	Black
Specific gravity	2.68
Soundness	7%
Water absorption	1.78%
Impact value	28%

IV. LITERATURE REVIEW

Yash Pandey conducted studies to check the usability of low fuel content coal rejected from power plant as partial replacement of crushed aggregates in granular sub base.

Souvik roy& Aman patidar conducted their study to check the usability of over burnt brick bats as partial replacement of coarse aggregates in pavement subbase. In

North-Eastern region of India, there is an acute scarcity of stone aggregates. Therefore the road engineers are always in search of an optional material as aggregate which can replace the regularly used material. The purpose of this work was to evaluate the utilization of locally available over-burnt brick aggregates in base course layer.

Vineethraj Math, Rajat Vaidya, Veeresh Karikatti. Substantial improvement in the technology of traffic and its load carrying capacity to satisfy the current demand, there is need of stable pavement structure but for sustaining the traffic load and to optimum usage for material for economic construction. There is a need of design which (particularly) exhibit optimum thickness of different layer in flexible pavement considering the stability of all the layers separately.

V. EXPERIMENTAL METHODOLOGY

Experiments to be performed:
The tests required to be performed are as below:-

1) Sieve analysis
2) Specific gravity and water absorption test
3) Aggregate impact test
4) Los Angeles abrasion test
5) Shape test
6) Permeability test
7) CBR test

VI. RESULTS & ANALYSIS

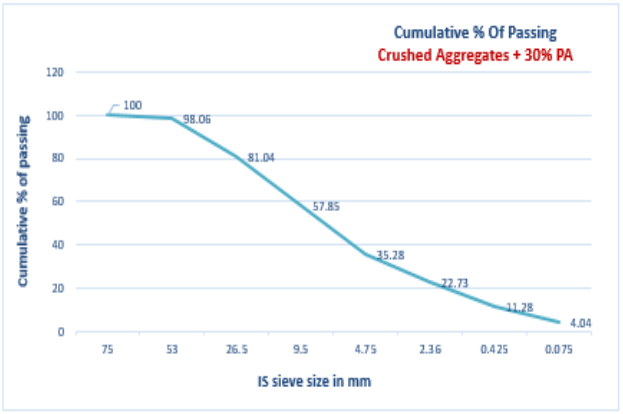
A. *Results & Analysis:*

Sr. No.	Proportion Mix Design
1	100 % Crushed aggregate
2	90% A + 10% RCA
3	80% A + 20% RCA
4	70% A + 30% RCA
5	90% A + 10% PA
6	80% A + 20% PA
7	70% A + 30% PA

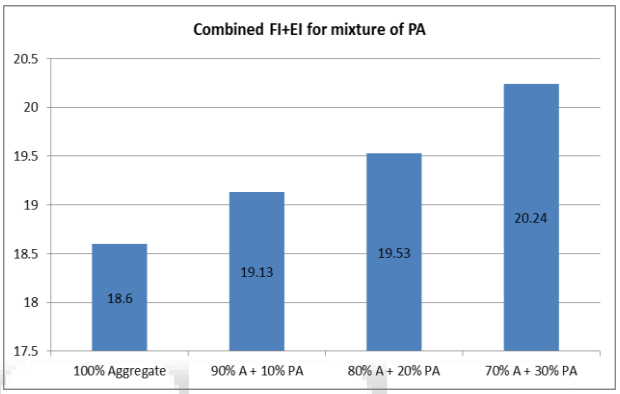
Table 1: Proportion Mix Design

IS sieve size in mm	Cumulative % of passing			
	crushed aggregates	+ 10% RCA	+ 20% RCA	+ 30% RCA
75	100	100	100	100
53	98.18	97.75	97.58	97.63
26.5	81.1	80.25	80.15	80
9.5	57.96	56.83	56.58	56.5
4.75	35.52	33.8	33.5	33.36
2.36	23.03	21.04	20.65	20.34
0.425	11.22	10.2	10.52	10.24
0.075	4.07	2.99	4.04	3.43

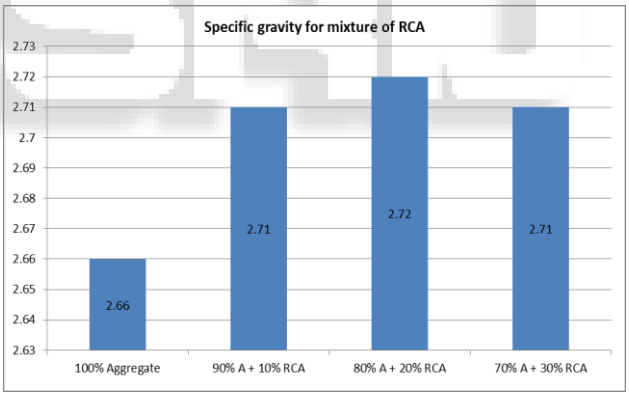
Table 2: Gradation Analysis of Crushed Aggregates



Graph 4.7: Gradation analysis of crushed aggregates + 30% PA



Graph 1: FI+EI Results for 100% aggregates and Mix with PA



Graph2: Results of Specific Gravity with 100% aggregates and Mix RCA

Test	Proportion	Permeability (m/day)	MORTH Specification
Permeability test	100 % Crushed aggregate	4.73	3 m/day Minimum
	90% A + 10% RCA	3.19	
	80% A + 20% RCA	3.03	
	70% A + 30% RCA	2.61	
	90% A + 10% PA	3.14	
	80% A + 20% PA	2.81	
	70% A + 30% PA	2.47	

Table3: Results of Permeability test for various mix proportions

Test	Proportion	CBR Value (%)	MORTH Specification
CBR Test	100 % Crushed aggregate	32.76	30 % Minimum
	90% A + 10% RCA	31.94	
	80% A + 20% RCA	30.97	
	70% A + 30% RCA	28.61	
	90% A + 10% PA	33.19	
	80% A + 20% PA	34.67	
	70% A + 30% PA	35.12	

Table 4: Results of CBR test for various mix proportions

VII. FINDINGS FROM THE STUDY

1) GSB-I grading has been chosen for present study purpose. Results of gradation for crushed aggregate, RCA & PA are within permissible limit
2) Coal is having high porosity than crushed aggregate. Hence water absorption is more with addition of coal aggregate. There is no major change in specific gravity observed for RCA & PA
3) With increasing replacement percentage of coal aggregate impact value and abrasion value increasing but with increasing replacement percentage of coal aggregate impact value and abrasion value decreasing.
4) As per MORTH 5th revision value of CBR for subgrade material should be 30% minimum. It is not achieved with increasing coal replacement but with increasing phosphate aggregate the value of CBR increasing
5) As GSB-I grading is for strength purpose it is having low permeability value. But for all the proportions the minimum permeability value had been achieved.
6) Phosphate aggregate are more suitable than rejected coal aggregate.

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