Global Journal of Engineering Science and Research Management

A PARTIAL REPLACEMENT IN NATURAL AGGREGATE TO RECYCLED HIGHWAY AGGREGATE

Ehsan Ali[*1] Yogendra Kushwaha[2]
Dept. of Civil Engineering, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed University), Allahabad-211007, India
*Correspondence Author: **Ehsan Ali**

Keywords: Recycled aggregate, maximum dry density, moisture content, California bearing ratio, granular sub base.

Abstract

Crushed or ordered inert particles obtained from the materials that are used in road are known as recycled aggregates. The objective of this research is, to conclude and relate the maximum dry density, optimum moisture content and California Bearing Ratio (CBR) of Granular Sub Base (GSB) and Wet Mix Macadam (WMM) by means of different percentages of recycled aggregates. This study was carried out by using CBR for total of 5 batches of mixes prepared in which 0, 20, 30, 40, 50 and 60% are replaceable to that of fresh aggregate by recycled aggregate at optimum moisture contents. The maximum dry density of recycled aggregate was up to 30% and replacement level was about 0.02 g/cc. The CBR of recycled aggregate was up to 30% and replacement level was about 1.5%. The reduction of strength causes due to lower strength of recycled aggregate as in compare of the fresh aggregate.

Introduction

In developing countries, it is indispensable to develop an economical construction material with ecological benefits by using the complementary aggregate material. Construction industries in India are generating approximately 13-14 million ton wastes yearly. These wastes are generated due to any construction/destruction action as construction/destruction of roads, bridges and fly over, subway and recreation of old subways etc. Technology information Forecasting and Assessment Council (TIFAC) had specially made a techno-market survey on 'Utilization of waste from construction industry' by use of recycled construction material and technology in development of urban infrastructure. The center of attention of this study was to accumulate the present information of the Indian construction industry and possible utilization of the recycling materials from construction and destruction wastes. This survey was focused on building and road construction section. In this survey, it is found that approximately 60 to70% of construction industries/companies were not aware of the recycling and rest of 30 to 40% were not even aware of recycling possibilities. It is known that natural capital are appropriate for several product and have a wide marketing region where as recycled materials such as aggregates have restricted product mixes or uses and have controlled marketing region.

As per Limbachiya et al. (2000), sorting and cleaning of recycled aggregate are done by two methods; first one is dry separation process in which removal of lighter particles by blowing air from the recycling material. A lot of dust formation is only the drawback of this method. Second method is wet separation process in which removal of low density contaminants by the water jets or float-sink tank and produces very clean aggregate. As per Limbachiya et al. (2000), fresh aggregate has higher relative density and more water absorption capacity where as in recycled aggregate has lower relative density and less water absorption capacity. This results; strength of fresh aggregate was not affected even if up to 30% of coarse recycled aggregate was used as replacement of fresh aggregate. As per Mandal et al. (2002); when a certain amount of recycled aggregate is replaced, a bit decreased in compressive strength was noted. It was concluded that properties and characteristics of recycled aggregate had enough deficient in respect of fresh aggregate. Due to large bang in construction trade, scarcity of aggregates becomes a big setback of twelve five-year plan in infrastructure region and this problem may be increase exponentially in present and in future. Consequently, recycling from waste materials is a noble idea to reuse in constructive way. Considering the beyond particulars in analysis, the aim of this investigation is to establish and evaluate the maximum dry density, optimum moisture content and California Bearing Ratio (CBR) of Granular Sub Base (GSB) and Wet Mix Macadam (WMM) by using different percentages of recycled aggregates.

Materials and methods

Material and methods: stone aggregate was used in this study. The properties of aggregate was as per IS-383 (Fineness modulus = 2.78; Specific gravity = 2.67). Specified grading as per Ministry of Road Transport and Highways (MORTH) was maintained during the experiment. Recycled stone aggregate for experiment was taken from Patna to Gya State Highway of Bihar State which is beneath up-gradation. Recycled aggregate was sieved and the fraction of passing aggregate from sieve was used in experiments. Value of LOS angle abrasion was approximately 38.5% whereas in base courses like water mix macadam and bituminous macadam as per IS: 2386 (part-4) up to 50% is allowed; value of aggregate impact was approximately 28.69% whereas as per IS: 2386 (part-4) or IS: 5640 the maximum permissible value is 35% for bitumen macadam and 39% for wet mix macadam and hence all is within permissible limit. For different mix (variable % of recycled aggregate) the maximum dry density for GSB and WMM were found at optimal moisture content as per method mention in IS: 2720 (Part-8)-1987. Condition of the materials

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highly affects the value of CBR during experiment. Remolded specimens were used during experiment. Experiments were conducted as per IS: 2720 (part-16)-1987. The physical condition of natural aggregate and recycled aggregate is shown in Fig. 1 and 2.

Fig. 1. The physical view of natural aggregate.

The aim of this experimental study is to conclude and evaluate the maximum dry density, optimum moisture content and California Bearing Ratio (CBR) of Granular Sub Base (GSB) and Wet Mix Macadam (WMM) by using different percentages of recycled aggregates. This experimental study was conceded by means of modified proctor CBR for given 5 batches of mixes in which 0, 20, 30, 40, 50 and 60% replaced by recycled aggregate that of fresh aggregate at optimal moisture contents. A relative study of mix design GSB and WMM by means of job mix formula at different mixes is mentioned in Table 1.

The maximum dry density of recycled aggregate matrix up to 30% replacement level is about 0.02 g/cc which is more than that of referral mix by natural aggregate (Fig. 3). When replacement level is about 1.5% the CBR of recycled aggregate matrix up to 30% which is less than the referral mix by natural aggregate (Fig. 4). The reduction of strength causes due to lower strength of recycled aggregate as in compare of the fresh aggregate.

Fig. 2. The physical view of recycled aggregate.

Table 1. Maximum dry density and California Bearing Ratio of mix at different level.

Replacement level of recycled aggregate (%)	Granular Sub Base (GSB)		Wet Mix Macadam (WMM)	
	Max. dry density (g/cc)	California Bearing Ratio (%)	Max. dry density (g/cc)	California Bearing Ratio (%)
0	2.33	33.2	2.36	38.2
20	2.30	30.3	2.34	34.3
30	2.28	28.7	2.33	32.2
40	2.32	32.6	2.35	37.7
50	2.28	27.2	2.32	30.3
60	2.22	26.3	2.29	28.2

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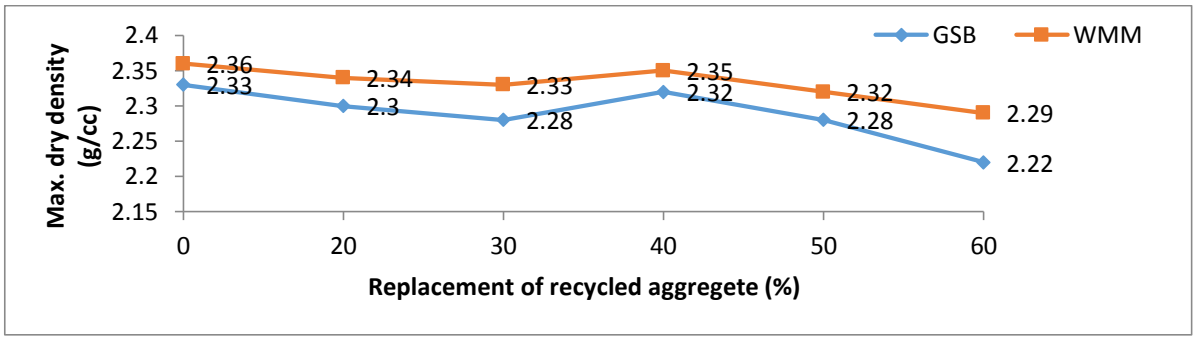

Fig. 3. Maximum dry density of mix at different level.

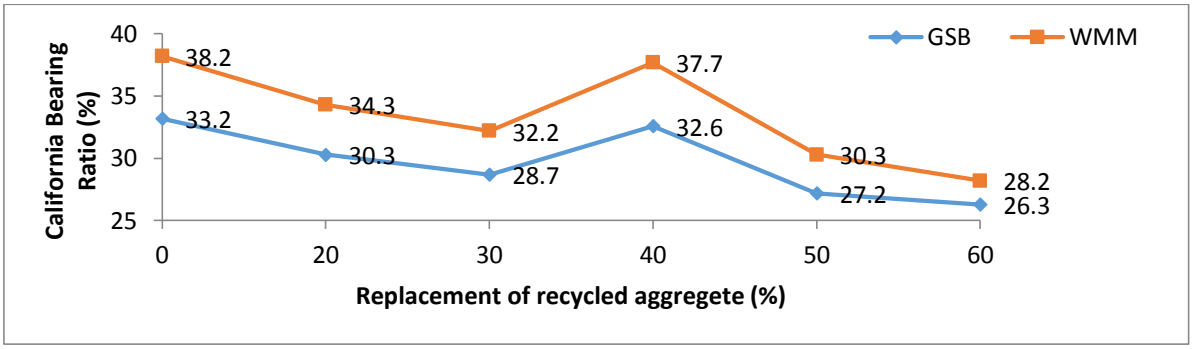

Fig. 4. California Bearing Ratio of mix at different level.

Conclusion

- It is very economical to use recycled aggregate in construction of road as in GSB and WMM and on the other hand it is eco-friendly as in manner to diminish mining pollution.
- Recycling of aggregate at the same place where demolition of project is done might be very economical at very low cost of transporting of material and less land is required to dispose of demolition waste. This study might be extensive in subsequent directions:
- By using of recycled aggregate with other mixes such as Bituminous Macadam etc; working ability and changing in characteristics might be studied.
- Effect of heat and rub on recycled aggregate obtained through 'heating and rubbing method' might be integrated in the further studies.

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