The Waste Characteristics of Demolition Construction Rigid Pavement as Aggregate's Alternative on Road Pavement

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Abstract. The existence of road building projects will produce a waste, including the concrete waste, which will crash into landfill capacity. The construction waste has been utilized as a raw resource for recycling construction materials, definitely as aggregates. It is vital to do research on the use of construction waste as an alternative to road paving materials because the development of roads obviously demands a lot of aggregate material. This study takes a look at the physical properties of aggregates by combining a natural aggregate with a concrete waste from road construction materials in 50:50 ratios. The test results indicate that the combination of a waste and a natural aggregate is physically engaged the requirements, so that it is necessary to add the additional testing of other physical attributes.

Keywords: Pavement · Recycled Aggregate · Waste Construction Materials

1 Introduction

One over third of the materials volume in landfills are cause of construction and demolition. One of the construction projects that always increase is a highway facility, including rigid and flexible pavements. Highways role as a crucial part in the development of an area to support the efficient land transportation, therefore, it required a comfortable, safe, and efficient road pavement [1].

The appearance of the rest construction materials (construction waste) is inherent in construction operations. The term "residual material" refers to extra construction or work-related materials that are scattered or damaged and cannot be used again in accordance with their intended use [2]. The rest of the remaining building materials caused by some factors, likes design, material procurement, material handling, and other execution elements [3]. The remaining content has crash into the increasing waste volume and the extremely limit a landfills.

The utilizing of solid waste from industry and household waste, the use of those and recycled materials for residual concrete materials in pavement mixtures not only contributes to reduce the environment pollution but also minimize the use of natural resources materials, whose availability is limited. Waste recycling as a component of road paving

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has been attempted all around the world with varied degrees of success. While many nations are still in the drafting stage, many have created rules, regulations, recommendations, and restrictions that permit their respective transportation departments to use waste that is readily available locally [4].

The most popular method for recycling aggregates in the most straightforward and affordable rigid pavements is to replace as much cement concrete mixtures with natural aggregates as possible; this has little impact on the hardened concrete's performance characteristics [5]. Concrete refuse from construction projects may be recycled. Recycled Aggregate Concrete (RAC) is created from concrete waste. On flexible pavements, recycled aggregate concrete (RAC) can be used to replace natural aggregates, however a replacement rate of 40% is advised for best results.

RAP, recycled concrete aggregates (RAC), construction waste, and pavement removal from already-existing concrete pavements are all permitted for use as base soil and base materials in highway construction by the Florida Department of Transportation. According to its evaluation, the state permissive specification permits the contractor to employ a certain percentage of recycled material [6]. The Texas Department of Transportation also permits a 20% usage rate for RAP and RCA in basic building and basic land construction. This state department advises that materials for a project come from the same stockpile, with gradations, and that stocks should adhere to the state's harmless recycled materials rules, with a maximum percentage loss from filing of 5% [7]. India is also making progress when it comes to using recycled materials to build walkways. Metal bricks and concrete that has been broken up may be used as a granular base material, according to the Ministry of Transportation and Highways. Recycled materials must require with recommendations for physical aggregates and gradations that are equivalent to those of pure aggregates [8].

Asphalt Concrete Binder Course (AC-BC) Mixture High Quality Concrete Waste Utilization Study. This study substituted fine aggregates for coarse aggregates in AC-BC mixtures with asphalt contents of 5%, 5,5%, 6%, 6.5%, and 7% using high-quality concrete waste with fc' 42, fc' 47, and fc' 50. The results of this study show, among other things, that fc' 50 concrete waste of 1969.4 kg at a 6% asphalt content has the highest stability value against an ac-BC mixture with coarse aggregate concrete waste. They also show that fc' 50 with a 7% asphalt content has the best quality of the three variations of concrete waste and has a Marshall parameter value that is similar to Marshall testing with natural stone aggregates [9]. Marshall stability analysis is also applied to the dense bituminous macadam (DBM) coatings of flexible pavements that can reduce environmental pollution using construction waste, demolition debris, and recycled materials [10].

Waste from building and demolition activities is used in research titled Construction and Demolition Waste as an Alternative of Rigid Pavement Material: A Review which recycled into construction materials [11]. This waste can be used to little traffic roads by substituting natural aggregates at 25, 35, 50, and 75%. The results of volumetric testing showed that the robust modulus of the mixture can be decreased by increasing the amount of natural aggregate substitution, particularly when the composition of 75% performs poorly [12]. The similar outcomes also happened when RCA was used as an alternative to traditional aggregates. According to the study, partial replacement of RCA produces results that are comparable, and its use in the field should be promoted [13].

Road pavement is composed of 90–95 percent aggregate, however the ongoing use of aggregates in significant amounts would undoubtedly result in environmental issues near the mining region, thus the material must be readily available[14]. Utilizing concrete waste from the construction of roads, in particular, can be used to improve materials. Despite all these negative effects, road building must continue since it is crucial to a country's growth. In order to maintain structural integrity while decreasing the consumption of natural resources and landfill pressure, it is crucial to look for resources that might offer a sustainable aspect. Utilizing waste products created nearby is a huge step in the right direction [15].

In this study, we take a look at the physical properties of aggregates by combining a natural aggregates and aggregates waste from road construction materials. Specific gravity, absorption, sludge content, aggregate roughness, and aggregate wear are examples of these physical characteristic.

2 Materials and Research Techniques

The materials were from rigid pavements waste, that is a concrete from the KM.277 Pematang Panggang Kayu Agung toll road in Ogan Komering Ilir (OKI), South Sumatra, was employed in this research. Aggregates with sizes of 30 mm, 20 mm, and 10 mm are created from the waste material.

The following steps are used to prepare rest of concrete from rigid pavement construction so that it can serve as an aggregate:

1) Cutting of damaged, hard pavements.
2) Concrete separation from reinforcement.
3) Concrete waste from rigid pavement construction is converted into aggregate by being processed through the use of a stone crusher tool.
4) Using an excavator tool, the material is loaded into the breaking bucket.
5) In the breakaway bucket, the material is reduced in size.
6) The materials is moved along the conveyor in the direction of the bucket and mixer.
7) The concrete will be reduced to smaller sizes by the stone crusher tool, Aggregates with sizes of 30 mm, 20 mm, and 10 mm (Figs. 1, 2, and 3).

Waste concrete materials are processed into aggregates of sizes 30 mm, 20 mm and 10 mm before being mixed with natural aggregates in a 50:50 ratios (natural aggregates: waste concrete materials). Following that, tests were conducted on physical properties such specific gravity and absorption, coarse aggregate hardness with Rudolf vessels, and wear with Los Angeles tools. Physical testing standards for coarse aggregates in materials for road paving are shown in Tables 1 and 2.

Fig. 1. Location where concrete waste materials from road construction was picked up

Fig. 2. Sample of a piece rigid pavement which be used

Fig. 3. The result of processing a concrete waste material from road construction

Table 1. Physical property normative reference testing of materials

No.	Exam Name	Method
1	Specific Gravity and Absorption of Coarse Aggregates	SNI 1969:2016
2	Hardness of Rough Aggregates Using Rudolf Vessels	SII 0079-75
3	Los Angeles Test	SNI 2417:2008

Table 2. Offering coarse aggregates

Testing			Test Techniques	Value
Maintaining aggregate formations in opposition to solutions		Sodium sulfate	SNI 3407:2008	Max.12%
		Magnesium sulfate		Max. 6%
Abrasion with Los Angeles Engines	Mixed Ac Modification and SMA	100 spins	SNI 2417:2008	Max. 6%
		500 spins		Max.30%
	All other types of graded paved mixtures	100 spins		Max. 8%
		500 spins		Max. 40%
Attachment of the aggregate to asphalt			SNI 2439:2011	Min. 95%
Grains Break on Coarse Aggregates		Sma	SNI 7619:2012	100/90*
		Other		‘95/90**
Flat and Oblong Particles		Sma	SNI 8287:2016 Comparison 1:5	Max. 5%
		Other		Max.10%
Material Passed Sieve No. 200			SNI ASTM C117:2012	Max.1%

3 Research of Results

Based on the results of the tests, it can be concluded that the physical properties of the aggregate made from concrete waste road building materials fall within the range of acceptable values for each type of test. Table 3 shows the results of testing for each characteristic, where the standard values for the specific gravity of ssd aggregate 10 mm and aggregate absorption rate 30 mm were out of range. The rigid pavement aggregates made from waste often have different physical properties when compared to natural aggregates. Low compressive strength values, low elasticity modulus, and rapid shrinkage make it difficult to use scrap concrete [16]. The mixing of natural aggregates is done in order to see whether or not the prospective physical qualities of the road building concrete material waste are still in standard values. The results of testing these physical properties are shown in Table 4, with the exception of water absorption, which still does not reach the acceptable requirements for SSD specific gravity, sludge content, aggregate

hardness, and Los Angeles test. This indicates that the use of waste concrete from road building and natural aggregates together is physically probable to meet the standards, it is necessary to add the additional testing of other physical attributes to complete the information.

Table 3. The physical properties of discarded concrete material used as aggregates

Exam Name	Unit	Concrete Waste Material			Aggregates from Nature for *Rigid Pavement*	Normative Values
		Aggregate 30 mm	Aggregate 20 mm	Aggregate 10 mm		
Specific gravity of SSD	gr/cc	2.53	2.263	2.682	2.640	2.5–7,7
Water Absorption	%	3.15	1.196	0.76	1.538	1–3
Sludge Volume	%	0.55	0.13	0.91	0.5025	<1
Hardness of Rough Aggregates Using Rudolf Vessels	%	1.25	1.25	1.25	–	<30
Los Angeles Test	%	28.57	28.57	28.57	20.24	<30

Table 4. The properties of mixing natural aggregates with waste concrete material aggregates

Test Name	Unit	50% aggregate waste 30mm + 50% natural aggregate	50% aggregate waste 20mm + 50% natural aggregate	50% aggregate waste 10mm + 50% natural aggregate	Natural Aggregates for *Rigid Pavement*	Standard Values
Specific gravity of SSD	gr/cc	2.414	2.372	2.531	2.640	2.5–7,7
Water Absorption	%	4.12	3.85	4.12	1.538	1–3
Sludge Volume	%	0.58	0.56	0.53	0.5025	<1

(*continued*)

Table 4. (*continued*)

Test Name	Unit	50% aggregate waste 30mm + 50% natural aggregate	50% aggregate waste 20mm + 50% natural aggregate	50% aggregate waste 10mm + 50% natural aggregate	Natural Aggregates for *Rigid Pavement*	Standard Values
Hardness of Rough Aggregates Using Rudolf Vessels	%	1.44	1.44	1.44	–	<30
Los Angeles Test	%	27.83	27.83	27.83	20.24	<30

4 Conclusions

According to test results for the material's physical properties, only water absorption continues to fall short of the standards, but the specific gravity of SSD, sludge content, aggregate hardness, and wear are all required. This indicates that the use of concrete waste from road building and natural aggregates together is physically probable to meet the standards, it is necessary to add the additional testing of other physical attributes to complete the information.

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