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# An Experimental Study on Effects of Quarry Dust as Partial Replacement of sand in Paver Blocks

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**ABSTRACT:** The drastic decrease in the sources of natural river sand has result in the demand to find substitute material to natural river sand as fine aggregate in the production of Paver Blocks. Quarry dust is a waste product produced during the preparation of coarse aggregate as per requirements shape and size in quarry. This investigation work is an attempt to utilize quarry dust as a Partial replacement of sand in Paver block. Utilize of quarry dust, decrease the price and safe disposal of waste material is achieved. The experimental investigations work is carried out by replacing sand with quarry dust in various percentage as 0%, 25%, 50%, 75%, 100%. The effect of using quarry dust as natural sand replacement on physical properties such as compressive strength, density and durability properties like water absorption are carried out.

**KEYWORDS:** Quarry Dust, Compressive Strength, Density and Water Absorption.

## I. INTRODUCTION

Natural sand is a non-renewable resource of environment. Nowadays, there is an drastic increase in demand of natural sand for construction works. Researches were being conducted to develop some alternative materials to natural sand. Utilization of quarry dust from industrial waste is showing advantages in field of construction industry as an alternate to natural river sand. Concrete is the almost all generally used material in the construction field due to its adaptability, durability and flexible. Fine aggregate is an most fundamental component of concrete. The fine aggregate and coarse aggregates generally occupy 65 % of the concrete mix and therefore, strongly influence the hardened properties, durability proportions, and economy. It is therefore, consequential to get quality aggregate at field site. In concrete almost all gravel or crushed stone and river sand is utilised as coarse and fine aggregate respectively. Natural river sand takes millions of years to arise and it is not replenish able. Due of its shortage in supply and excessive price for transportation from natural sources, Price of natural sand high and its continuous supply cannot be achieved. By the large reduction of these natural sources also created environment problems. The Government has banned river sand mining due to environmental problems arise near major, minor rivers. Therefore, it becomes necessary to find out the possibilities for similar sources to minimize river sand utilization. So, the investigation work is required to found out similar material that should be eco- friendly and affordable and in this work the utility of quarry dust has obtained an promising factor in the preparation of concrete. On account of this, to reduce disposal of quarry dust, investigations work have carried out to produce affordable concrete by replacing of fine aggregate by quarry dust.

### Paver Blocks :

Concrete Paver blocks made fast development in the construction industry and have almost become a preferable choice for pavements. Paver blocks are made up of concrete. Pavers are also known as “Interlocking concrete block Pavement”. Paver block is a hard, non reinforced, not casted on site and utilized for pave work. By alternating the physical properties, it can be utilized in surface course of pave work. Nowadays concrete paver blocks are widely used in footpaths, garden, bus stops, road and other in construction places. Concrete paver block can resist heavy stress of earth quakes and slight ground erosion by flexing.

### Quarry Dust:-

It is defined as deposit, waste material, left during the processing of rocks at crushing plant at a quarry. It is also called as gravel dust, stone dust, quarry waste or rock dust. When rock is crushed and sized in a quarry, the main aim has to produce coarse graded aggregates of different sizes and shape for road construction materials to achieve the certain specifications as per required standards. Quarries are set up to manufacture coarse aggregate, but as a part of production process crushed aggregate is also produces by product called quarry dust.



## II. LITERATURE REVIEW

**Shweta Sinha, Preeti Soni (2017)** have got known about workability. By substitute of quarry dust as fine aggregate the workability have increased and at 50 % replacement the compressive strength have achieved high strength.

**Jeyaprabha et. al. (2016)**, in investigation work she have found that the implementation of granite dust in concrete the strength have increased it is due to the presence of micro-fines particles in granite dust which dense the concrete influence in strength.

**Chandan Mandal and Dr. S.S. Goliya (2019)** they came to know that as density increases the compressive strength also increases and at 40 % replacement compressive strength have maximum strength. In this the workability have quite decreased.

**Cordeiro et. al. (2016)** have observed that the substitution of natural sand by quarry dust the water absorption have reduced as the percentage of replacement increased.

**Vijayalakshmi et. al. (2013)** have observed in there investigation work that the compressive strength have increased at early days it is due to the presence of C3A content have increased hydration process result in increase in strength at early days.

## III. OBJECTIVES OF STUDY

1. The utility of the quarry dust as replacement of fine aggregate, reduces the environmental waste product as well as providing an economic value for the waste material.
2. Also to alter the durability, ductility of engineering materials by partial replacement of fine aggregate.
3. To learn the mechanical and physical properties of waste aggregate by conducting experimental investigation.
4. To know the percentage utilize feasibility for the paver block.

## IV. EXPERIMENTAL RESULTS

Experimental Investigation work discussed. Physical properties of cement, natural sand, coarse aggregate and quarry dust. Workability, density of paver block, Compression strength test and water absorption test were done for 0%, 25%, 50%, 75%, and 100% replacement of fine aggregate.

### 4.1 Properties of Raw Materials:

#### 4.1.1 Cement:

43 Grade Cement (OPC 43), manufactured by UltraTech Cement, is utilised for preparation of all mixes. The cement is uniform in colour and no lumps in it. Physical properties of cement are given in Table 4.1.

**TABLE 4.1 : Physical Properties of Cement of 43 Grade**

Physical Requirement	Result	Specification according to IS 8112:1989
Standard Consistency (%)	30.4	-
Setting period (minutes)		
Initial Setting Time	140	30 Minimum.
Final Setting Time	230	600 Maximum.
Fineness	1.6	10.0 Maximum
Soundness	0.8	10.0 Maximum
Specific Gravity	3.07	-

#### 4.1.2 Coarse Aggregate:

A 12mm nominal size aggregate is utilized as coarse aggregate concrete. Coarse aggregate is tropically gathered and conformed to Indian Standard Specifications given in BIS 383:1970. Different physical properties are given in below Table 4.2

**TABLE 4.2 : Physical Properties of Coarse Aggregate**

Physical Property	Test Result
	12mm Nominal Size Aggregate
Specific Gravity	2.65
Water Absorption (%)	0.27%
Fineness Modulus	2.35
Bulk Density (kg/m <sup>3</sup> )	1590
Moisture Content	Nil

**4.1.3 Fine Aggregate:**

Typically procured natural sand was used in the experimental program and it was conformed to Indian Standard Specifications given in BIS 383:1970. Different properties of river sand and quarry dust are given in the below Table 4.3.

**TABLE 4.3: Physical Properties of Fine Aggregates**

Physical Property.	Natural Sand	Quarry Dust
Specific Gravity	2.63	2.22
Water Absorption (%)	1.75%	2.9%
Bulk Density (kg/m <sup>3</sup> )	1430	1490
Fineness Modulus	3.05	3
Silt Content (%)	0.5	5.3
Grading Zone	Zone II	Zone II
Moisture Content	Nil	Nil

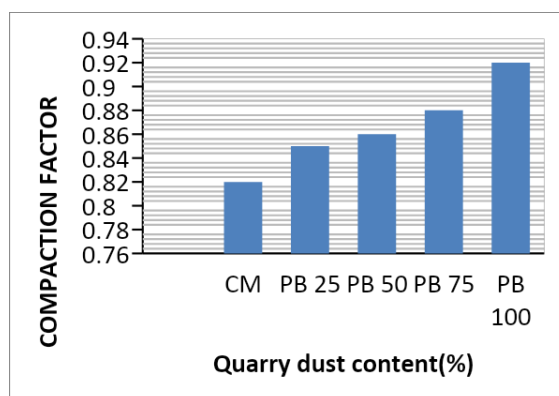
**4.2 Fresh Properties of Concrete:****4.2.1 Workability:**

Compaction Factor Test is utilised find the workability of all Mix to know the intent of quarry dust as a substitute of sand on workability of paver block concrete and the observations is given in below Table 4.4.

**TABLE 4.4 : Compaction factor Test Results of Fresh Concrete Mixes**

Mix Designation	COMPACTION FACTOR
CM	0.82
PB 25	0.85
PB 50	0.86
PB 75	0.88
PB 100	0.92

Observations of workability of all concrete mixes as slump in mm are graphically represented in Figure 4.1.

**Figure 4.1 :Workability of fresh Concrete**

### 5.3 Hardened Properties of Concrete:

#### 5.3.1 Density of Concrete:

Density of concrete, based upon the 1-day weight of the square paver block of 250mm×250mm×70mm at the time of demoulding after 24 hours of casting, observations of density of concrete with implementation quarry dust are given in Figure 4.2

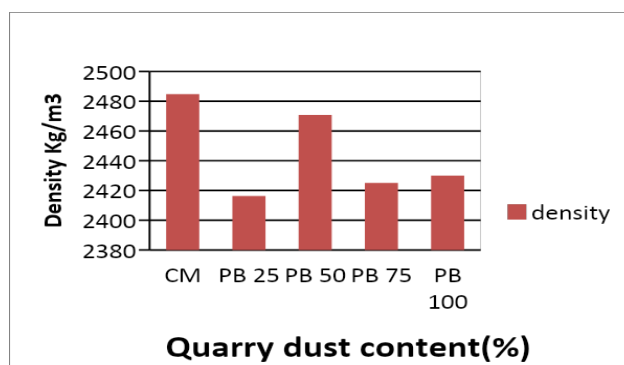


Figure 4.2. : 1-day Density of paver block

#### 4.3.2 Compressive Strength:

The Compressive strength of paver block is evaluated at age of 7 and 28 days and different observations are given in Table 4.5.

TABLE 4.5 : Compressive Strength Test Results of Concrete Mixes

Mix Designation	Compressive Strength (MPa)			
	7 days		28 days	
	Individual	Average	Individual	Average
CM	31.68	31.04	68.8	64.42
	32		64	
	29.44		60.48	
PB 25	28.8	29.87	56.32	48.21
	31.2		49.92	
	29.6		38.4	
PB 50	28	29.39	55.04	56.74
	30.4		58.88	
	29.76		56.32	
PB 75	24	22.67	24	55.25
	26.4		26.4	
	17.6		17.6	
PB 100	25.6	23.79	49.92	50.77
	21.76		44.8	
	24		57.6	

Graphical representation of compressive strength results of all concrete mixes at 7 and 28 days given in Figure 4.3.



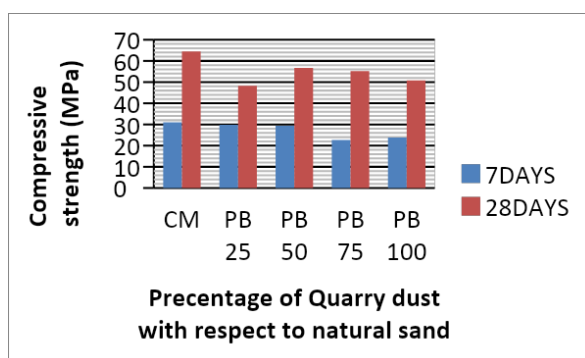


Figure 4.3 : Compressive Strength of Paver block.

#### 4.4 Durability Properties of Paver block:

##### 4.4.1 Water Absorption:

Water Absorption test has been done as per IS: 15658:2006.

TABLE 4.6 : Water Absorption of Concrete Mixes at Different Ages

Mix Designation	Water Absorption (%)		
	24 hours	7 days	28 days
	Average	Average	Average
CM	5.16	4.54	4.10
PB 25	5.33	4.89	3.38
PB 50	6.53	4.32	3.80
PB 75	7.10	4.93	3.68

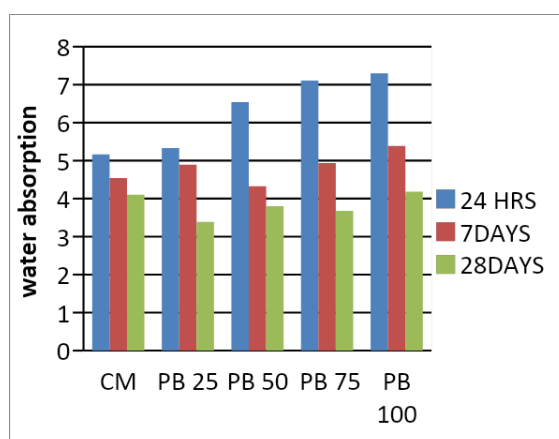


Figure 4.4 : Water Absorption of Paver block concrete.

## V. CONCLUSION

1. Paver block concrete workability is raised as the replacement rate of quarry dust is increased with respect to natural sand. The micro-fineness present in quarry dust particles increased the water usage of concrete but consequently



resulted in increase in workability. However, As per IS 15658-2006 and SP 63-2004 workability should be below 25 mm slump, 0.8 compaction factor which is permissible.

2. Utility of quarry dust in concrete have reduced the density of paver block. Density of concrete mix with 50% sand replacement level was maximum. The paver block density is reduced due to the specific gravity of quarry dust which is quite less than natural sand .

3. The implementation of quarry dust in Paver block Concrete have yield the compressive strength. As required target strength is 33Mpa we have obtained up to 50Mpa which is permissible. The yield in compressive strength of paver block is attributed to increase in density of paver block with the inclusion of quarry dust and better conditions for hydration of cement in the presence of quarry dust micro-fines.

4. Paver block water absorption should be with in 7 percent according to IS15658-2006. At 7days and 28 days the water absorption have decrease below 7 percent and but at 24 hour water absorption is quite more ,But it is much be lesser than 10% as per IS: 2185.1. 2005 water absorption.

5. M 30 grade designed paver block are used only for non traffic, but use of quarry dust the compressive strength increases,so this block can be use in heavy traffic also as per IS 15658-2006. it can be also used for fillers beside paver block.

Hence,the implementation of quarry dust can over come the problems arised in environment due to scarcity of river sand,also reduces illegal mining plants and all reduce the use of manufactured sand.

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