

Experimental Study on Replacement of Sand by Quarry Dust and Partial Replacement of Cement by Fly Ash and Natural Admixture (Guar Powder).

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ABSTRACT

Sand is one of the constituents used in the production of concrete, become expensive and also a scarce material. In view of this, there is a need to identify suitable alternative material from industrial waste in place of river sand. The utilization of quarry dust which is a waste material as been accepted as building material in many countries for the past three decades. Recycling involves processing used materials into new products in order to control to waste of potentially use full materials reduce the consumption of fresh raw materials, reduce energy usage, reduce air and water pollution by reducing the need for conventional waste disposal. Concrete traditionally consists of cement fine aggregate coarse aggregate and water. Guar cum, also called guaran, is a galactomannan polysaccharide extracted from guar beans that has thickening and stabilizing properties useful in food, feed and industrial application. The guar seeds are mechanically dehusked hydrated milled and screened according to application. It is typically produced as a free-flowing, off-white powder. The guar been is principally grown in India, Pakistan, the United States, Australia, and Africa. India is the largest producer accounting for nearly 80% of world production. In India, Rajasthan, Gujarat, and Haryana are the main producing regions. The US has produced 4,600 to 14,000 tonnes of guar over the last five years. Texas acreage since 1999 has fluctuated from about 7,000 to 50,000 acres. The world production for guar gum and its derivatives is about 1.0 million tonnes. Non-food guar gum accounts for about 40% of the total demand.

Keywords:

Admixtures, guar gum, hydtation, polysaccharide, guar derivatives super plasticzers,

1.INTRODUCTION

Concrete plays a very important role in the construction industry. It is widely used in the worldwide due to the its durability versatility and low cost for a concrete mix fine aggregate is an essential component of the concrete and the most commonly used fine aggregates id the river sand. The demand of natural sand in the field of construction is increasing day by day due to extensive use of concrete the price was increasing which resulting a huge reduction in the sources of sand. Natural river sand takes a million of years to form and it is not replenished able. Because of its limited supply and excessive cost of transportation from natural source therefore, it becomes more necessary to find alternative sources of fine aggregates to minimize river sand extraction. Dispersing admixtures such as super plasticizers are commonly used in the formulation of ready mixed concrete. High or ultra-high performance cementitious materials self-compacting concrete. These admixtures can dramatically reduce the workability. In addition to guar gum's effects on viscosity its high ability to flow or deform gives it favorable rheological properties. It forms breakable gets when cross-linked with boron. It is used in various multi-phase formulations for hydraulic fracturing in some as an emulsifier because it helps prevent oil droplets from coalescing and in others as a stabilizer to help prevent solid particles from settling and/or separating.

2. MATESIALS USED

2.1 QUARRY DUST

Quarry dust is a fine -grained, waste-like material produced from the crushing of rock during quarrying operations, acting as a fine aggregate for concrete and other construction applications, including building

blocks and roads. It serves as an eco-friendly substitute for river sand, which is facing unsustainable demand and environmental degradation from mining. While its use can enhance concrete strength and texture, it can also increase water demand and potentially reduce strength if not properly incorporated.

Fine aggregate for concrete: can replace a portion of natural sand in concrete mixes.

Building blocks and tiles: used as a raw material for these products.

Road development: Incorporated into materials for road construction.

Masonry and filler: Can be used as a sand substitute in mortar and to fill gaps between bricks.

Table-1: showing the physical properties of quarry dust and natural sand

Property	Quarry Rock dust%	Natural Sand%
Specific gravity	2.59	2.69
Bulk relative Density(kg/m ³)	1700	1550
Absorption (%)	1.29	Nil
Moisture Content (%)	Nil	1.50
Fine particles Less than 0.075mm (%)	14	06
Sieve analysis	Zone III	Zone III

Table-2: Typical Chemical Composition of quarry rock dust and nature fine aggregate

Constituents	Quarry rock dust (%)	Natural sand (%)
SiO ₂	62.48	80.78
Al ₂ O ₃	18.72	10.52
Fe ₂ O ₃	06.52	01.75
CaO	04.83	03.21
MgO	02.56	00.77
Na ₂ O	Nil	01.37
K ₂ O	03.18	01.23
TiO ₂	01.21	Nil
Loss on ignition	00.48	00.37

Application of quarry dust in construction industry:

- Building materials
- Plastering
- Road Construction
- Foundation engineering

2.2 COARSE AGGREGATE

Aggregate is building and construction materials used for mixing with cement, bitumen lime, gypsum, or other adhesive to form concrete or mortar. The aggregate gives volume, stability, resistance to wear or erosion, and other desired physical properties to the finished product. For this experiment, 20 mm size of aggregate is used.



Fig -1: Picture for Fine Aggregat

2.3 Cement

Ordinary Portland cement of Grade-43 are used



Fig -2: Showing the Cement Bag used in the Experiment

2.4 Test on cement

The field test has been conducted through which we know the quality, of cement at site. It gives some ideas on touch, color and feel and other tests.

1. Color test: - The color of the cement was uniform, grey in color.

2. Presence of lumps: - The cement is free from hard lumps.

3. Initial and final setting time test

4. Fineness test

2.5 FLYASH

Fly ash is a fine powdery byproduct of burning of coal in thermal power plants, collected from exhaust gases. It is a pozzolanic material rich in silica, alumina and iron oxides, which is can be used to replace a portion of Portland cement products.

Classifications of flu ash as class C, and class F.

2.6 Water

Water is fundamental in construction for mixing materials like mortar and concrete, for curing newly set concrete, for dust control quality of the water is crucial, as contaminants like oil, salts, and acids can negatively impact the strength and durability of the building materials. Ordinary portable water was used in the overall investigation as well as for curing the concrete specimens when it touched and rub.

2.7 Mineral products

The investigations were carried on water-cement system, The cement used for this study was an ordinary Portland cement, referenced as CEM I 42.5 R (CEMEX) according to the European standard EN197-1. The chemical composition was determined X- ray fluorescence spectroscopy and the resulting clinker composition according to the modified Bogue calculation according to Taylor is gives in table 3.

Table-3: Oxide composition (%weight) of the investigated cement determined Investigated cement determined by XRF and clinker phase composition according to the modified Bogue calculate.

Chemical composition (%wt)				Phase composition (%wt)	
Oxide s	XRF	Oxide s	XR F	Phase s	XRD (Rietveld)
CaO	62,80	Na ₂ O	0,28	C ₃ S	61,8
SiO ₂	20,56	K ₂ O	0,95	C ₂ S	20,5
Al ₂ O ₃	4,36	TiO ₂	0,2	C ₃ A	6,2
Fe ₂ O ₃	2,27	SO ₃	3,45	C ₄ AF	7,7
MgO	2,14	LOI	2,40		

2.8 Organic admixtures (Guar powder)

Chemically, guar gum is an exo-polysaccharide composed of the sugar's galactose and mannose. The backbone is a linear chain of 1,4-linked mannose residues to which galactose residues are 1,6-linked at every second mannose, forming short side-branches. Guar gum has the ability to withstand temperatures of 80 °C (176 °F) for five minutes.

Guar gum powder standards are:

HS-CODE- 130 232 30

CAS No.- 9000-30-0

EEC No.- E 412

BT No.- 1302 3290

EINECS No. -232-536-8

IMCO CODE- Harmless

2.9 Solubility and viscosity

Guar gum is more soluble than locust bean gum due to its extra galactose branch points. Unlike locust bean gum, it is not self-gelling. Either borax or calcium can cross-link guar gum, causing it is not affected by ionic strength or pH, but will degrade at extreme pH and temperature (e.g., pH 3 at 50 °C). It remains stable in solution over pH range 5-7. Strong acids cause hydrolysis, and loss of viscosity and alkalis in strong

concentration also tend to reduce viscosity. It is insoluble in most hydrocarbon solvents. The viscosity attained is dependent on time, temperature, concentration, pH, rate of agitation and particle size of the powdered gum used. The lower the temperature, the lower the rate at which viscosity increases, and the lower the final viscosity. Above 80^{0C}, the final viscosity is slightly reduced. Finer guar powders swell more rapidly than larger particle size coarse powdered gum.

Guar gum shows a clear low shear plateau on the flow curve and is strongly shear-thinning. The rheology of guar gum is typical for a random coil polymer. It does not show the very high low shear plateau viscosities seen with more rigid polymer chains such as xanthan gum. It is very thixotropic above 1% concentration, but below 0.3%, the thixotropy is slight. Guar gum shows viscosity synergy with xanthan gum. Guar gum and micellar casein mixtures can be slightly thixotropic if a biphasic system forms.

3. EXPERIMENTAL PROGRAMME

3.1 Workability of concrete

Concrete workability is the ease with which fresh concrete can be mixed, transported, placed, and compacted without losing its homogeneity, ensuring a high-quality, structurally sound outcome with a good surface finish. It is influenced by water content, mix proportion, and aggregate characteristics and is measured using tests like the slump test, compaction factor test, and flow table test.



Fig -3: Sample of concrete mix for Slump Test

3.2 Compressive strength test

The freshly mixed concrete was filled in the mould of size 150mm X 150mm X150mm and then cube was kept for curing. Testing of hardened cube was carried out in 7 days and 28 days respectively. Using compression testing machine. The sample of cube was kept between the hardened steel bearing plates on a compression and load was applied.



Fig -4: Sample of cubes



Fig- 5: Compression testing Machine

2.4 preparation of concrete mixes

Mix proportions are done for the following ways

Table -4: Mix proportions

S.NO	MIXES	PROPORTIONS
1	MIX-1	5% Quarry dust, gum & 5% fly ash, gum
2	MIX-2	10% Quarry dust, gum & 10% fly ash, gum
3	MIX-3	20% Quarry dust, gum & 20% fly ash, gum
4	MIX-4	25% Quarry dust, gum & 25% fly ash, gum
5	MIX-5	30% Quarry dust, gum & 30% fly ash, gum

Sand: Dust: Guar gum, fly ash % mixes	SPLIT TENSILE STRENGTH (N/mm ²)	
	7 DAYS	28 DAYS
5%	1.53	2.22
10%	1.60	2.49
20%	1.92	2.42
25%	1.83	2.96
30%	1.64	2.46

3.COMPRESSIVE STRENGTH RESULTS

Table -5: Compressive Strength in MPa

Sand: Dust: Guar gum, fly ash % mixes	7 DAYS	28 DAYS
5%	16.55	20.30
10%	17.60	22.35
20%	19.10	24.65
25%	15.80	20.45
30%	13.50	17.80

Compression Graph for compressive strength test

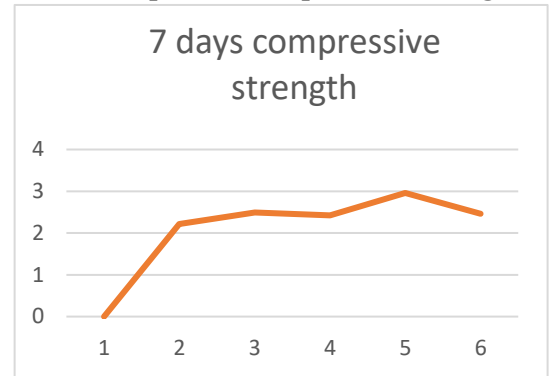


Fig -6: Compressive Strength Comparison Chart At 7 Days

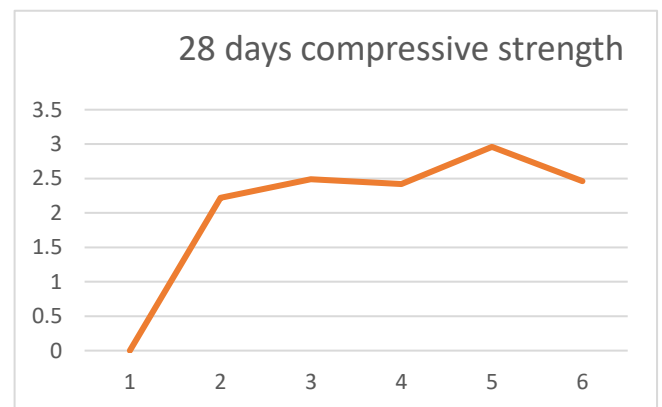


Fig -7: Compressive Strength comparison Chart At 28 Days

4.SPLIT TENSILE STRENGTH RESULTS

Table-6: Split Tensile Strength test

Compression Graph for split tensile strength test

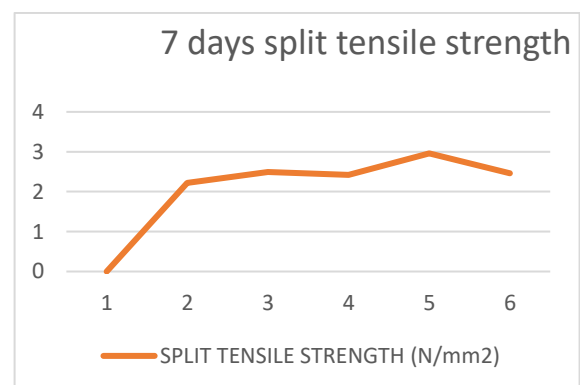


Fig -8: SPLIT TENSILE STRENGTH CHART AT 7 DAYS

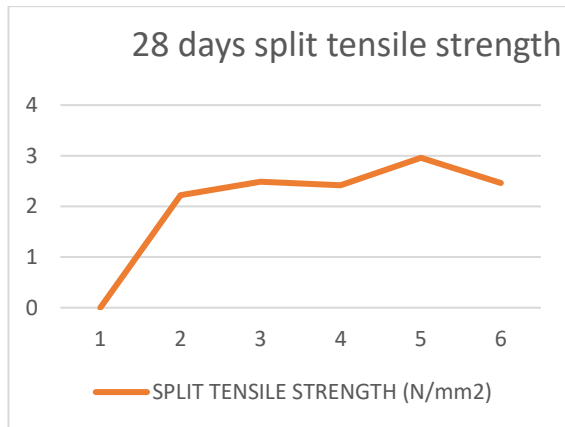


Fig -9: SPLIT TENSILE STRENGTH CHART AT 28 DAYS

5.RESULT AND DISCUSSION

According to the results and discussion the following conclusion is found

1. From following studies and results we found that the quarry Waste as a fine aggregate replacing of cement by fly ash and Quar gum relatively good as compared to river sand.
2. The various properties of used Quarry dust and fly ash such as aggregate crushing value, pH value, flakiness index and soundness give the significant effects to the strength and durability of concrete.
3. The concrete mix of dust as partial replaced to sand, and partial replacement of cement by fly ash and Quar gum results a reduction in the compressive strength.
4. But the reduction in the compressive strength of the quarry dust concrete was compensated by the inclusion of mineral admixtures into the concrete mix.
5. In the presence of fly ash, quarry dust can be a suitable partial replacement material to sand to produce concretes with fair ranges of compressive strength
6. The results also highlight that the combination of the both kind of dust and admixtures lead to a slightly shorter setting time compared to nominal mix.

5.REFERENCE

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