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REVIEW ON: PARTIAL REPLACEMENT OF CEMENT IN CONCRETE PAVEMENT BY PHOSPHOGYPSUM

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Abstract: The rapid growth in creation activities leads to big shortage of traditional creation materials which includes cement, quality aggregate and coarse combination. Phosphogypsum is a byproduct of phosphate fertilizer flora and chemical industries. As its miles contaminated with the impurities that impair the strength improvement of calcined merchandise, it can be used as partial replacement of cement. The present paper deals with the experimental investigation on mechanical properties of in part cement replaced phosphogypsum concrete using 15%, 20%, 25% alternative with M25 grade concrete. The strength traits are studied via casting and testing specimens for 28 and 56 days. Cubes of 150mm x 150mm size, conventional concrete and take a look at changed into performed to have a look at the mechanical properties of concrete, such as compressive strength, and flexural strength. it's far proven that a part of ordinary Portland cement can be changed with phosphogypsum to expand a great and hardened concrete to attain financial system above 10% alternative of phosphogypsum in concrete leads to drastic reduction now not only in the compressive power, however additionally flexural.

Index Terms **- PhosphoGypsum, dihydrate (CaSO4.2H2O), Hemihydrate (CaSO4.5H2O), Triple super Phosphate**

1 INTRODUCTION

Phosphogypsum is a byproduct from the wet production technique of phosphoric acid (ammonium phosphate fertilizer) by using the motion of sulphuric acid at the rock phosphate. About 4 to 5 tons of phosphogypsum is generated in line with ton of phosphoric acid production the usage of moist system. Phosphoric acid is produced by using reacting phosphate ore (apatite) with sulphuric acid in step with the following response,in which X might also consist of OH, F, Cl, or Br.

Formula: - Ca5(PO4)3X + 5H2SO4+ 2H2O ė3H3PO4+ 5CaSO4. 2H2O + HX

Dumping of phosphogypsum into open land should have environmental and fitness issues. The stockpiled cloth dominated through calcium sulphate dehydrate (round 94-98% by way of wt.), additionally incorporates approximately 5-6% of impurities consisting of heavy metals, fluoride and radionuclides. These poisonous substances may be transported with the aid of wind over long distances. In consequence,it can contaminate soil and or groundwater. Targeted research are essential for you to fully understand the switch process of toxic substances into the adjoining environment and to assess their impact, however now not in the scope of this work.

Treated phosphogypsum can be used as an element of plaster. The maximum important and motivating use of phosphogypsum may be in the construction industry. In the manufacturing system of cement, phosphogypsum could be used as a replacement of herbal gypsum which performs the position of a fixed retarder, or to lessen the clinkerization temperature. Take a look at also conducted with weathered (stored in open air) phosphogypsum as a set retarder in Portland cement. In part refined boric acid and phosphogypsum mixture can be utilized in area of natural gypsum for Portland and Trass cements. It can be processed through wet sieving and washing process in the plant. The impurities of phosphate, fluoride, organic be counted and alkalies are decreased by means of tremendous quantity. The beneficiated phosphogypsum can be used as an additive in place of mineral gypsum within the manufacturing of Portland cement and Portland slag cement. Phosphogypsum-slag based combination changed into organized and examined for compressive, flexural and splitting tensile strength by way of the usage of in concrete. It was endorsed that the slag aggregate done properly as a coarse combination in cement concrete and must carry out satisfactorily in highway pavement system . within the manufacturing of building substances phosphogypsum changed into used as raw and calcined materials, but, the mechanical houses changed into located unsatisfactory . Heated phosphogypsum used as a binder,improved the compressive and flexure energy of the material. Phosphogypsum primarily based combination utilized in

curler Compacted Concrete (RCC) slabs gave proper end result for set retardation and drying shrinkage reimbursement. Observe on partial substitute of cement via numerous percent of phosphogypsum gave suitable end result with concrete specimens. Researches on the basic engineering houses of phosphogypsum-based totally concrete combos concluded that the unique houses of dihydrate phosphogypsum underneath compaction-consolidation can extensively make contributions to the compressive energy of concrete mixes.but, with better percentage of phosphogypsum,the energy of concrete combos is suffering from the moisture at the time of trying out. Better compressive electricity attained with calcined phosphogypsum. Study with as much as 40% cement substitute via phosphogypsum gave 10% degree optimum. Another study with each OPC and percent substitute in mortars determined reduced compressive electricity however extended flexural strength comparing with traditional mix. Phosphogypsum's presence in the cement has multiplied its initial power hastily. This power improvement was because of the formation of anhydrate at better temperatures. Self-compacting concrete mixes using 0-30p.cpercent alternative of cement also gave maximum flexural electricity with 10% phosphogypsum. Examine on the houses of each cement pastes and mortars the use of regular Portland cement, Limestone mixed cement and Slag cement gave compressive strengths at 7 and 28 days best up to eight% phosphogypsum substitute for all the three varieties of cements at wellknown mix share.those 3 forms of cement additionally met the limit of initial putting time and soundness requirements set via standards. Study advised amendment in concrete blend method to contain raw phosphogypsum as partial replacement in cement mortar and concrete.

In view of the traits of phosphogypsum and its attractive financial ability at the existing time there is a prodigious curiosity in the use of phosphogypsum as an opportunity uncooked material for many applications. Replacement of cement clinker with sure percent of phosphogypsum should supply fine results in mortar and concretealthough there is still debate in related literatures. This research particularly investigated the impact of phosphogypsum addition with cement clinker on the residences of paste, mortar and concrete. On this regard,each field situation and calcined phosphogypsum had been utilized in mortar and concrete on the alternative level of 15%, 20%, 25%.

1.1.Physical properties of phosphogypsum

Calcium sulfate can be either in dihydrate (CaSO4.2H2O) or hemihydrate (CaSO4.0.5H2O) shape relying on the response temperature used to supply phosphoric acid. Generally unfastened moisture content material between 25-30% exists in the gypsum cake after filtration. The generated hemihydrate form of phosphogypsum, within the presence of free water can rapidly convert to dehydrate form. Furthermore, if the system is left undisturbed it's going to set up into a distinctly difficult cemented mass. Di-hydrate is composed principally silt-size (<0.075mm) and appear as tender aggregates of crystals. It relies upon at the source of the phosphate rock and the reactor conditions.

1.2.Chemical properties of phosphogypsum

Phosphogypsum is composed especially calcium sulphate dehydrate with small amount of silica. The mineralogical composition of phosphate ore turned into described with the aid of various researchers and is dominated via fluorapatite, goethite and quartz, with minor amounts of Al-phosphates, anatase, magnetite, monazite and barite. X-ray Diffraction sample of received phosphogypsum indicates the material mainly composed of Gypsum.

1.3.Material property and specimen preparation

Regular Portland cement clinker, phosphogypsum, crushed sand and crushed stone was used to conduct the assessments in this research. The fineness modulus of sand became 2.7 which was washed and dried before use to avoid presence of dirt and clay particle. It became free from organic materials. Ordinary drinking water turned into used for paste,mortar and urban works.Phosphogypsum sample became amassed from triple superphosphate (TSP) complex, Chittagong, Bangladesh. The Industry has substantial production of phosphoric acid and sooner or later phosphogypsum. Category of pattern changed into organized the usage of phosphogypsum. One the use of uncooked phosphogypsum (determined in discipline circumstance after manufacturing) and the opposite turned into washed pattern. After washing the pattern turned into oven dried so as to get dry phosphogypsum.

1.4. Objectives

- Enhances the different properties of concrete viz, compressive strength, flexural Strength, water absorption, moisture content, compatibility,surfacefinish ability and Workability.
- Advantageous disposal of industrial waste.
- Solve the problems of environmental pollution.
- As PG is having low value of specific gravity, the density of material is decreased by utilizing Phosphogypsum.

1.5. Literature Review

1) Investigation of a durable gypsum binder for Building material (1992)

The strength of the gypsum binder increases with increasing Curing period. However, the Strength development at 27°C is more pronounced in the binder based on granulated slag than the binder based on fly ash. With the increase in curing temperature from 27°C to 60°C, the Compressive strength of the gypsum binder is reduced. The level of fall in strength was lower for binder Based on fly ash than for binder based on granulated slag.

2) Effect of Phosphogypsum on the Properties of Portland cement (2016)

TSP complex at Chittagong is the main source of phosphogypsum production in Bangladesh. The industry occasionally sales the product at low price but mainly use for landfilling. 5-10% Addition of phosphogypsum with Portland cement clinker gave promising results while tested various fresh and hardened properties of cement paste, mortar and concrete. The raw field Sample was processed by washing and subsequent drying. In general, the processing of Phosphogypsum gave better performance in all media.

3) An Experimental Study on Partial Replacement of Cement by Various Percentages of Phosphogypsm in Cement Concrete (2019)

Compressive nature of cement for 10% substitution of Bond thru way of phosphogypsum (Mix3) at 28days Mitigating duration, splendid is nine.12% more whilst Separated and regularRobust combination (Mix1) and 90days exquisite is 7.29 % greater while separated and Preferred robust mixture (Mix1)

4) Comparative Study of Phosphogypsum and Phosphogypsum plus Flyash Mix Concrete

The workability of phosphogypsum mix concrete decreases with increase in percentage Replacement with Cement. The workability of phosphogypsum plus fly ash mix concrete is comparatively higher than phosphogypsum Mix concrete.The maximum compressive strength of phosphogypsum mix concrete is achieved at 8% replacement of phosphogypsum with Cement

5) Studies on Strength and Durability Properties of Concrete with Partial Replacement of Cement in Phosphogypsum P.Ramesh, K.Pandi (2020)

The experimental test results shows that the Phasphogypsum in blended concrete had significantly Higher Compressive strength, split tensile strength, flexural strength and lower water absorption Properties compare to that of the Concrete without phasphogypsum. It is determined that the Cement could be advantageously replaced with phasphogypsum Up to maximum limit of 15%.

6) Effects of partial replacement of cement with phosphor gypsum on strength characteristics Of concrete (2017)

An industrial waste phosphogypsum impairs the strength development of calcined product and hence it can be used in construction industry for preparation of concrete to achieve the economy. Addition of Phosphogypsum to concrete affects the strength characteristics of concrete. Based on The experimental investigations conclude as follows.

7) Some aspects of the durability of a phosphogypsum-lime-fly ash binder (1995)

Cementitious binder cured at 50°C shows low porosity and better water resistance than binder Cured at 27°C. As compared to the cementitious binder cured at 27°C the binder cured at 50°C shows a much lower Fall in strength and weight loss with increase in temperature and alternate Wetting and drying cycles. The cementitious binder cured at 50°C shows no fall in strength and Weight loss from the pristine values with increase in temperature (27” to 50°C) and heating and cooling cycles.

8) Parcel replacement of fine aggregate and cement in concrete pavement by Phosphogypsum

The gradation of particles in the PG and NS are nearly analogous. Due to the resemblance in the Gradation of the particles of the PG, it is concluded that PG, it is concluded that PG can be utilized for the replacement of the natural sand. Moisture content of natural sand (NS) is found in the range from 1.36-1.68 and that of PG is in the range from 11.43-12.82.

9) Investigation on Utilization of Phosphogypsum as a Partial Replacement of Cement in Concrete (2019)

Industrial wastes such as phosphogypsum contribute to the development of concrete strength and can therefore be used in the construction industry for the production of concrete with partial cement Replacement, which is a valuable component for economical concrete. Phosphogypsum in ordinary Portland cement mixtures often slows down the setting time, but is not involved in the production of unsound cement paste.

10) Study on Replacement of Phosphogypsume in conventional cement S.Venkatasubbaiah, Sri.V.K.Visweswararao M.Tech Student, Department of Civil Engineering, G Pulla Reddy Engineering College, Kurnool (2017)

By replacements cement in concrete by phosphogypsum, reduces the consumption of cement.Compressive strength at 28 days increases by 19.92% and 56 days increases by 18.44% with Optimum value of 10% replacement of phosphogypsum. Split tensile strength at 28 days increases by 16.28% and 56 days increases by16.88% with optimum value of 10% replacement of Phosphogypsum. Flexural strength at 28 days increases by 26.6% and 56 days increases by17.92% with optimum value of 10% Replacement of phosphogypsum.

1.6. **Methodology**

1) Casting: - Cube samples measuring 150mm x 150mm x 150mm are fabricated. The concrete mixture is formulated by substituting a portion of the cement with PhosphoGypsum at different proportions, namely 15%, 20%, and 25%.

2) Curing: - The curing process is implemented on the concrete samples to attain the desired characteristics suitable for their intended application. This is achieved through the provision of adequate moisture, temperature, and duration.

3) Testing: - The compressive strength test is the prevalent method used to evaluate the hardened concrete and is performed using either Universal Testing Machines (UTM) or Compression Testing Machines (CTM). The test specimens utilized have dimensions of 150mm x 150mm x 150mm.

1.8 **Conclusion**

1) After examining the existing literature regarding the utilization of Self-Contained Breathing Apparatus (SCBA) in concrete, the following deductions can be made:

2) Substituting cement in concrete with phosphogypsum results in a reduction in cement consumption.

3) Experimental findings conducted in laboratories demonstrate that mixtures of phosphogypsum stabilized with Portland cement can effectively serve as materials for road base and subbase construction.

4) In certain instances, the use of phosphogypsum leads to an increased setting time of cement.

5) Empirical investigations indicate that incorporating phosphogypsum into concrete affects the concrete's durability and strength characteristics.

6) The performance of stabilized phosphogypsum mixtures is significantly influenced by the type and quantity of Portland cement employed.

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