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A REVIEW PAPER ON EXPERIMENTAL STUDY ON OPTIMIZATION OF PHOSPHOGYPSUM IN CONCRETE

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ABSTRACT

The utilization of supplementary cementation materials is well accepted, since it leads to several possible improvements in the concrete composites, as well as the overall economy. Phosphogypsum is contaminated with the impurities that impair the strength development of calcined product. The concept of study is an effort to quantify the strength of phosphogypsum at various replacement levels with cement and evaluate its efficiencies in concrete. Cement with phosphogypsum replacement has emerged as a major alternative to conventional concrete and has rapidly drawn the concrete industry attention due to its cement savings, energy savings, savings cost, environmental and socio-economic benefits. In this review paper, different properties of concrete are studied. Also, more focus is given to study of optimum percentage of phosphogypsum. It is observed that use of phosphogypsum is beneficial for improving the properties of concrete. This paper will be useful for the future investigation on the utilization of phosphogypsum as a construction material.

Keywords:Compression strength,Flexural strength, Phosphogypsum, partial replacement.

I.INTRODUCTION

Concrete is one of the most widely used construction materials in the world today. It is a heavily used material in urban development, meeting the requirements of codes of practices by means of strength and durable structures. With the advancement of technology and increased field applications of concrete and mortars the strength, workability, durability and other characteristics of ordinary concrete is continuously undergoing modifications to make it more suitable in any situation. Hence the growth in infrastructure sector leads to scarcity cement because of which cost of cement increased incrementally.The production of phosphoric acid from natural phosphate rock by means of the wet process give rise to an industrial byproduct named phosphogypsum. World phosphogypsum generation is estimated to be around 100-280 millions tones per year. About 5 tones of PG are generated for every tone of phosphoric acid produced. Phosphogypsum can be obtained from Rashtriya Chemical and Fertilizers (RCF), Chembur plant in Maharashtra state, India. Phosphogypsum is mainly composed of gypsum but also contains a high. Level impurities such as phosphate, fluorides, heavy metals and other trace elements.Chemical composition of phosphogypsum are CaO 31.2%,SiO2 3.92%,SO3 42.3%,R2O3 3.6%,MgO 0.49% and phosphates 18.49%. Phosphogypsum is disposed off without any treatment

usually by dumping in large stockpiles occupies considerable land areas and causes serious environmental damages.

II. MATERIAL

Phosphogypsum is generated from filtration process in phosphoric acid plants where insoluble gypsum (and other material) are separated from the product i.e. phosphoric acid as efficiently as possible. Depending on the source of rock phosphate about 4.5 -5 Tonnes (dry basis) of phosphogypsum (by-product phosphogypsum) is generated per ton of phosphoric acid (as P2O5) recovered. The quality & quantum of phosphogypsum generation depends upon the quality of the phosphate rock, process route used to produce phosphoric acid, calcium sulphate generated either in di-hydrate (CaSO4.2H2O) or the hemi-hydrate (CaSO4.1/2 H2O) form. Phosphogypsum generation in the Country is about 11 Million Tonnes per annum (based on the assumption that 5 Tonnes of phosphogypsum generated per ton of phosphoric acid production). The industry-wise production of phosphoric acid scenario in the country as per the information provided is compiled and given in Table 2.1

Phosphogypsum is a gray coloured, damp, fine grained powder, silt or silty-sand material with a maximum size ranges between 0.5 mm (No. 40 sieve) and 1.0 mm (No. 20 sieve) and the majority of the particles (50-75 %) are finer than 0.075 mm (No. 200 sieve). The specific gravity of phosphogypsum ranges from 2.3 to 2.6. The maximum dry bulk density is likely to range from 1470 to 1670 kg/m3 (92 to 104 lb/ft3), based on Standard Proctor Compaction.

Year	Phosphoric acid production	Estimated Phosphogypsum generation
2000-01	1042.4	4690.8
2001-02	1134.7	5106.15
2002-03	1085.6	4885.2
2003-04	990.1	4455.45
2004-05	1242.5	5591.25
2005-06	1067.8	4805.1
2006-07	1331.8	5993.1
2007-08(p)	1206.5	5429.25
2008-09(p)	1201.7	5407.65
2009-10(p)	1160	5407.65
2010-11(p)	1544.6	5220
2011-12(p)	1740.4	6950.7
2012-13(p)	1394.7	6276.15

III. LITERATURE REVIEW

T. Siva Sankar Reddy[1]: This paper deals with the experimental investigation on compressive tensile and flexural strength characteristics of partially cement replaced phosphogypsum concrete using 0%, 10%, 20% replacement with different water binder ratio 0.40, 0.45, 0.50. The strength characteristics are studied by casting and testing a cube for 7, 28 days. It is shown that the part of Portland cement can be replaced with phosphogypsum to develop well and harden concrete to achieve economy. Experimental investigation shows that on replacement of cement by phosphogypsum by 10% gives compressive strength 49.3 N/mm2 at 28th day of curing .Author found that the compressive strength at 7th day increased significantly around 20% at water binder ratio 0.5 and marginally around 10% increase of the water binder ratio. The split tensile strength at 28th day increased marginally around 3 to 10 % at different water binder ratio.

NadarGhafoori and Wen F. chang[2]: In this paper experimental investigations states that, standard proctor value of dry density of phosphogypsum is 14.52 KN/m3 for compressive strength 1789.50Kpa and split tensile strength was found 165.40Kpa and for modified proctor test dry density of phosphogypsum was 15.17KN/m3. whereas compaction strength was found 2452.8 Kpa and split tensile strength was 227.40 Kpa and hence test results indicates that phosphogypsum is highly compressible material and its strength improves by increasing compaction energy and hence it is comparable to the compressive strength of good quality concrete. Experimental study also states that, the 28th day compressive strength of all compacted samples have shown considerable compressive strength considering the percentage level of cement in mixture, strength above 20.67 and 31.00 Mpa can be readily obtained by using 7.5% and 10% cement content respectively. The use of limited amount of phosphogypsum (20-25%) by weight of total solid appears to be beneficial for strength characteristics of phosphogypsum concrete.Test results obtained from strength versus time diagram indicates that the concrete mixture containing phosphogypsum continue to gain strength with curing age, if proper curing condition is provided.

IV. USE OF FLORIDA PHOSPHOGYPSUM IN CONSTRUCTION[3]:

In this paper it is found that U.S. bureau of mines has conducted research to identify and develop high volume uses of phosphogypsum. Bureau plays an important role to promote the efficient use of minerals and mineral process waste.Mixture of Phosphogypsum with cement, cement kiln dust, silica powder and calcium chloride were also investigated. A series of tests were performed on mixtures with fly ash, lime ratio of 3:1,5:1,10:1, each containing 20 to 80 % Phosphogypsum. Another series of tests were run on mixture containing 35% phosphogypsum 0 to 25 % lime and remaining fly ash and compressive strength were determined on each specimen after curing for 7, 28 and at 23 delicious and 95% relative humidity. Compressive strength of mixtures with 3:1 fly ash lime ratio are found increased with lime and with decrease in percentage of phosphogypsum.

Mahesh A Bagade and S.R.Satone[4]: In this paper, it is found that an industrial waste like phosphogypsum impairs the strength development of calcified products and hence it can be used in construction industry for to achieve economy.The mixture in which cement replaced with 5%of phosphogypsum having almost same

standards of normal consistency. In this paper it is observed that, author had replaced cement in concrete in 0% ,5%,10%, 15% by phosphogypsum, for mix design M25 grade concrete and he found that compressive strength at 28th day of curing it was 25.51,28.59,30.15 and 21.35 N/mm2 respectively. Hence, it is observed that at 5% to 10% replacement of cement by phosphogypsum compressive strength of concrete increases where as above 10% replacement compressive strength is affected. For 35% phosphogypsum, 16.25% lime and 60% fly ash compressive strength were found at 28th day of curing is 2100 psi and for 20% phosphogypsum, 20% lime, 60% fly ash compressive strength were found 2360 psi. For 20% phosphogypsum 13.33%lime and 66.67% fly ash compressive strength were found 2980 psi.However, in this paper, it is found that tests were performed to determine, if the phosphogypsum could be used to replace sand in cement mortar if, phosphogypsum were produce strong, hard material with cement kiln dust or with silica powder when 65% phosphogypsum, 24% kiln dust and 11% water produce compressive strength 420 psi at 28th day of curing. Also 65% phosphogypsum 24% type two cement and 11% water produce 1590 psi compressive strength.

S.S.Bhadauria, Rajiv Gandhi, Rajesh B. Thakare[5]: The mixture in which cement replaced with 5% phosphogypsum having almost same standards or normal consistency than that of plain cement. The author had cast specimen with concrete mixes mentioned and cured for 28 days in the laboratory on completion of curing period and specimen were taken out and tested for compressive strength. Concrete mix For M20 grade compressive strength was 19.00N/mm² at 28th day of curing for 5% replacement and for 15% replacement it was 14.00N/mm².for mix design M25 for 5% replacement compressive strength was found 26.40N/mm2 at 28th day of curing while for 20% replacement compressive strength was 13.00N/mm2.Hence there is constant increase in compressive strength of concrete containing five percent of phosphogypsum as compared to conventional concrete. Further increase in phosphogypsum content causes decrease in compressive strength, but rate is slow as compared with previous mix.

MAHESH A. BAGADE, S. R. SATONE(JULY 2012)[6] : Cement replaced with phosphogypsum concrete using 10% , 15%, 20% with replace water binder ratio of 0.40.The part ordinary Portland cement can be replace with phosphogypsum to develop good and hardened concrete to achieve economy. Phosphogypsum in ordinary Portland cement mixes considerably retards setting time but does not contribute to produce unsound cement paste. The compressive strength of phosphogypsum cement concrete with 5% and 10% are improve it indicates phosphogypsum concrete used in mass concrete work.

S. DEEPAK, C. RAMESH(MARCH 2016)[7] : In this paper the effect of replacing 10%, 20%, replacement of cement by phosphogypsum at two different water cement ratio (0.4 and 0.5) on strength characteristic namely split tensile strength and flexural test of beam goes increasing 28 days.

KODURU.SRINIVASALU(MARCH 2017)[8] : This paper deals with experimental investigation on durability characteristic of hardened concrete, compressive strength. The study aims to determine the optimum amount of phosphogypsum can give maximum strength of concrete. The experiment consist of testing concrete using 0%, 2.5%, 5%, 7.5%, 10% replacement of phosphogypsum for M20, M25, M30 grade of concrete. It is observed that cement can be replaced by phosphogypsum to develop too good and hardened concrete to achieve economy.

V.CONCLUSION

1. After studying all these papers it is observed that, phosphogypsum can be used as a cement replacing material in the concrete. Mostly cases, phosphogypsum is replaced with cement in range of 0-30%.
2. It is found that, 10-15% replacement is optimum for compressive strength of concrete.
3. In some of the cases it is observed that, setting time of cement is increased due to use of phosphogypsum.
4. This paper will help to new researchers and user how and where the waste phosphogypsum can be used as building and construction material in glance.
5. Split tensile strength has its maximum value at 10% replacement of cement with phosphogypsum with different cement water ratio.
6. Based on experimental investigation to addition phosphogypsum in concrete affects durability strength characteristic of concrete.

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