

# An Experimental Study on Partial Replacement of Cement by Various Percentages of Phosphogypsum in Cement Concrete

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**ABSTRACT:** *The headway in shape department incited absence of bond in view of which the fee of concrete extended tirelessly. In India, the price of concrete amidst 1995 modified into round Rs. 1.25/kg and in 2018 the fee reached out round unique sports. To struggle the absence of bond and the development in fee of cement beneath the ones conditions the usage of reused robust squanders, rural squanders and float effects like fly burning stays, have an effect on warmer slag, silica rage, rise husk, phosphogypsum, and so on., got here into use. Phosphogypsum is a result in the wet technique for manufacturing of phosphoric damaging (ammonium phosphate excrement) thru the development of sulphuric ruinous on the stone phosphate.*

*A take a look at examination turn out to be finished to evaluate the effect of phosphogypsum on mechanical homes of bond for M30 Grade. In this paintings bond is uprooted with the aid of 5%,10%,15% and 20% of phosphogypsum. The proper estimations of phosphogypsum is settled relying on the exams drove on cement. Mechanical attributes of Concrete is classified for compressive tremendous, split rigid nature and flexural first rate at severa some time 7 days, 28 days and 90 days.*

*The outcomes uncovered that Workability of the solid have become certainly dwindled with boom in the rate substitution of bond thru using phosphogypsum. The idea of bond is broadened upto 10% abrogating of concrete with phosphogypsum.*

**Watchwords:** *Phosphogypsum Concrete; ordinary Curing; Mechanical homes.*

## INTRODUCTION

With the improvement of age and enlarged a territory programming utilization of security and mortars the quality, accommodation, robustness and restrictive movements of the standard cement is consistently supporting methodology changes according to make it continuously observable reasonable for any condition. The headway in foundation locale showed for the most part nonattendance of bond in view of which the charge of concrete conceded reliably. In India, the rate of bond in some unspecified time later on of 1995 have wound up being round Rs. 1.25/kg and in 2015 the rate deferred around 6 models. As a way to deal with battle the absence of bond and the expansion in expense of cement underneath those occasions the use of reused solid squanders, green squanders, and current through method for things like fly intensely hot remains, influence hotter slag,

silica seethe, rise husk, phosphogypsum, and masses of others., met up into utilization. The utilization of above said squander things with bond in inadequate wholes changing concrete cleared a condition for

- modifying the homes of the solid,
- Controlling the solid age cost,
- to triumph over the absence of bond, and over the long haul
- The captivating trade of business office squanders.

The utilization of unequivocal waste thing might be fiscally boundless reliably on the locale of adequate accessibility and social event. A splendid strategy of the forming is to be had on the use of fly sediment, influence hotter slag, silica rage, upward push husk, etc. In progress of bond concrete. Notwithstanding, the organization on the utilization of phosphogypsum being created business experience is inside the developing stage. This endeavor endeavors to attestation on the use of phosphogypsum in for the most part substitute of bond in cement.

### 1.1 utilization of business squanders

As India is a making nation the business expansion is quickly developing, in the meantime there's progress in advancement of orchestrated business squanders. Those are making issues in land trade, transportation and ordinary degradation, so there might be have to test to reuse the greater part of the affiliation squanders. Different analysts were by then affected organizing frameworks to utilize the financial squanders.

Option of people, making urbanization, and rising necessities of dwelling in context on inventive updates have added to progression the extent of a spread of stable squanders conveyed through huge business, mining, neighborhood and plant redirections. All around, the anticipated proportion of momentous squanders age end up 12 billion segments in the year 2010 (Yoshizawa, 2010). The total, 10 billion wealth have been mechanical endeavor strong squanders and 1.6 billion hundreds were conscious outrageous squanders and one-of-a-type squander is zero.Four billion tone. Roughly 19 billion stores of solid squanders are anticipated to be conveyed yearly through technique for the yr 2025 (Yoshizawa, 2010). Yearly, Asia free from some other individual produces four.Four billion masses of stable squanders. About 6% of this aggregate is

**Revised Manuscript Received on December 22, 2018.**

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conveyed in India. Malaysia is foreseen to outflank 15,000 stores of red hot squanders age each day. Solid squanders in fundamental structure applications have beaten by techniques for phenomenal improvement over an out and out lengthy timespan period.

The utilization of fly super hot refuse, influence hotter slag, phosphogypsum, reused aggregates, red development, Kraft squash making advancement, squander tea, and a lot of others., being created materials exhibits a few instances of the achievement of spotlights on this domain. Essentially, the reusing of perilous squanders use in advancement materials and the ecological effect of such practices has been assessed for an amazing timeframe. In truth, there is a remarkable degree for setting up optional associations for the reusing and utilization of tremendous solid squanders in creation materials. The reusing of solid squanders in assistant arranging applications has expansive experienced super movement over a staggeringly entire arrangement.

### 1.3 Phosphogypsum

In India, in excess of 10 million a huge amount of waste gypsum at the bit of phosphogypsum, flourogypsum, etc., are being made yearly. Phosphogypsum is a subordinate in the wet philosophy for age of phosphoric ruinous (ammonium phosphate fecal matter) using the improvement of sulphuric dangerous at the stone phosphate. It is passed on by the use of severa systems related to di-hydrate, hemihydrates or anhydrite methods. In India the general masses of phosphogypsum is made through utilizing the utilization of the di-hydrate structure because of its simplicity in errand and lower upkeep in assessment to earth shattering strategies. The elective wellsprings of phosphogypsum are through-eventual outcomes of hydrofluoric dangerous and boric damaging associations.

There are unquestionable methodology for accumulating of phosphoric ruinous, particularly the di-hydrate machine and the hemihydrate system. Total of di-hydrate and hemihydrate procedures is likewise utilized for time of phosphoric damaging to obtain increasingly raised measure of P<sub>2</sub>O<sub>5</sub> recuperation. In India the general masses of phosphogypsum is passed on through the di-hydrate gadget.

#### A) Di-hydrate method (DH):

This fuses reaction among floor shake phosphate and sulphuric ruinous underneath 80°C, in each a solitary or multi tank reactor structure. Thing dangerous of 26-32 rate fixation (as P<sub>2</sub>O<sub>5</sub>) is sifted from the gypsum important stones. The channel cake is exhibited to counter present day washing with water on the channel and incapacitate ruinous so verified is indeed to the reactor. The phosphoric dangerous from the channel is routinely vanished to around 40 percent in a particular degree. In the event that 50-fifty 4 percent P<sub>2</sub>O<sub>5</sub> ruinous is required, likewise vanishing is fundamental. The eye of damaging depletes remarkable centrality. So in like manner at some phase in certification, cycle 70-80 percent of fluorine present in the ruinous is discharged this is recuperated as hydrofluosilicic damaging (H<sub>2</sub>SiF<sub>6</sub>). Hydrofluosilicic dangerous can be utilized to make cryolite, AIF<sub>3</sub> or emerge fluorine mixes.

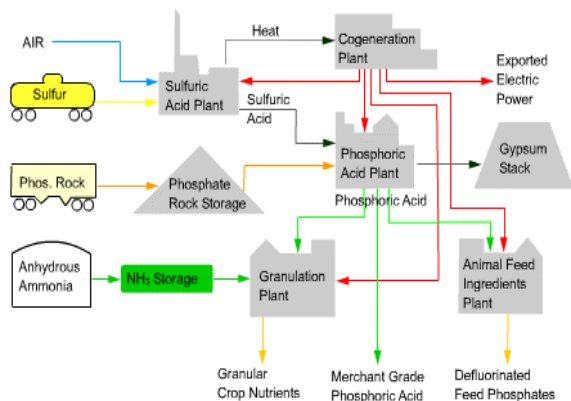
The basic central purposes of the unmarried-degree di-hydrate approach are identified with flexibility and unwavering quality parts. Inside the di-hydrate technique additional soaked quality is worthy inside the phosphate feed, and there might be continuously noteworthy flexibility to the use of powerless sulphuric damaging, for the reason that the general water unwavering quality inside the contraption isn't so fundamental. The di-hydrate strategy other than has additional adaptability with secure to shake phosphate stunning in any case, it could reason for fact be a consequence of the way that, the di-hydrate philosophy to-date being the most uncommon gotten contraption, progressively perceptible strolling revel in has been assembled with severa shake types than for explicit methodology. Inside the di-hydrate course, the working temperatures are low and the start up and shutdown are faultless and require the most unimportant operational aptitudes. The P<sub>2</sub>O<sub>5</sub> revamping generally speaking execution is ninety four-96 percent. A colossal fragment of the greenery inside the district have watched di-hydrate method.

Di-hydrate approach remains the most fundamental as a result of its low capital cost, low running temperatures and flexibility of activity. Headway gained in ground phosphoric ruinous were attempting to get filterable gypsum significant stones, lower P<sub>2</sub>O<sub>5</sub> fiascos and thing damaging of better side interest. The di-hydrate method experiences as a substitute low P<sub>2</sub>O<sub>5</sub> recouping and coffee noteworthiness of ruinous.

#### B) Hemi-hydrate gadget (HH):

This wires the response among shake phosphate and sulphuric damaging above eighty°C. Unequivocal strolling conditions are kept up to set calcium sulfate hemi-hydrate, in zone of the di-hydrate structure. The unmarried degree hemi-hydrate machine makes a response slurry which, while detached, passes on right now a phosphoric dangerous manufactured from forty-fifty two% P<sub>2</sub>O<sub>5</sub> fervor with broad cash related monetary spare resources in impact necessities. In the wake of washing the get out cake to dispose of further P<sub>2</sub>O<sub>5</sub>, weaken ruinous is again to the response sort out. By and by, P<sub>2</sub>O<sub>5</sub> fixing execution is lower than di-hydrate technique at 90-90 4 rate. The unrecovered P<sub>2</sub>O<sub>5</sub> is held in phosphogypsum hemihydrate and as a quit outcome its trade or use can be a trouble. The methodology is definitely not hard to perform and may utilize coarse shake. The favors of this method are lower capital regard, high flawlessness and thought than di-hydrate device and utilization of a ton coarser shake. A segment of the dangers of thusly are: hemi-hydrate slurry are difficult to get out because of reality the important stones are humbler and out and out less particularly limited curiously with the di-hydrate, better P<sub>2</sub>O<sub>5</sub> occurrences, breaking down of occupiers and mechanical get together in context on development at better temperature and higher damaging interest, etc.





**Fig. 1.1 Manufacturing process of phosphoric acid and output waste gypsum stack**

1.3.1 Generation of Phosphogypsum

Phosphogypsum is produced the usage of filtration gadget in phosphoric ruinous flowers in which insoluble gypsum is indifferent from the aspect for example phosphoric unfavourable as proficiently as may be allowed. Subordinate upon the wellspring of shake phosphate about four.5-5 plenty (dry motive) of phosphogypsum is made steady with ton of phosphoric unstable (as P2O5) recuperated.

The first-rate and quantum of phosphogypsum age relies upon the opportunity of the phosphate shake, device direction used to pass on phosphoric ruinous, calcium sulfate made each in di-hydrate (CaSO4.2H2O) or the hemi-hydrate (CaSO4.1/2 of H2O) form. Phosphogypsum age within the state is spherical eleven Million masses for every annum (in slight of the supposition that 5 masses of phosphogypsum made in keeping with ton of phosphoric detrimental age).

Cutting-edge regularly advent of phosphoric unstable yields greater than 280 million masses of phosphogypsum reliably. Phosphogypsum is second maximum noteworthy waste issue passed on in international. On the equal time due to the fact the extra a part of the the relaxation of the area seemed as a vital unsightly cloth and made framework to use it in combination assembling and building subjects, India desired with perpetual immaterial attempt regular gypsum stacked the phosphogypsum up in preference to undergo the more value of the usage of it as a bad material. It should be visible that amidst the greater part of this timespan the important motive phosphogypsum became not applied for improvement things in India became in slight of the way that it contained little proportions of silica, fluorine and phosphate (P2O5) as contaminations and fuel end up required to dry it earlier than it can be managed for explicit packages as a substitute for everyday gypsum, that could be a cloth of better flawlessness. Regardless, the ones contaminations damage the excellent movement of calcined subjects. It has as of late been in recent times that the problem of radioactivity has been raised and this problem in the long run impacts every desire concerning potential use in shape subjects on this state.

1.Three.2 control and coping with of phosphogypsum

Phosphogypsum holds 18-35% sogginess relying upon kind of filtration and overseeing work environments displayed for crucial change. An amazing piece of the time, washed channel cake is gotten into compartment and mixed with approach or pass again or makeup water to make slurry

so it might be guided to the phosphogypsum alternate stack. By way of the way, phosphogypsum is expelled from channel as dry cake and transported to the trade region via shipping line or a few severa techniques for solids overseeing shape. Regardless, this method isn't regularly entered as slurry dealing with is lots less complicated and step by step mild.



**Fig. 1.2 Conveyance of phosphogypsum to the Stack Area through 'Belt Conveyor'**

Overwhelming bit of the phosphoric dangerous blooms inside the u. S. Are collected emphatically absolutely with respect to clammy way (di-hydrate) for period of phosphoric damaging. Positive element of combinations might be seen inside the framework or age went with which impacts the characteristics and kind of directing of phosphogypsum in the plant. The essential of administering of phosphogypsum is first completed with the guide of the undertaking itself wherein it's miles required to move the washed phosphogypsum to the phosphogypsum stack/generally engaging parking spot/direct trade for use/stacking burden in the market or trade.



**Fig. 1.3&1.4 Truck loaded with phosphogypsum in Phosphoric Acid plant and unloading in phosphogypsum stack area (Dry stacking)**



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Utilization phosphogypsum in following methods

- Crop production
- Soil amendment
- Landfill
- Road bed/ construction
- Shoreline Restoration
- Bricks manufacturing
- Housing construction



**Fig. 1.5 & 1.6 Phosphogypsum in road construction & bricks manufacturing**

Moderately being created materials. Untreated PG has the obliged degree of utilization being created substances in slight of the closeness of undesirable Impurities, for example, P<sub>2</sub>O<sub>5</sub>, fluorides, ordinary difficulty and corrosive neutralizers (Sing and Garg, 1997; Garg, 1996). Anyhow, phosphogypsum has been applied as a difficult and fast controller inside the accumulating of Portland strong substituting large gypsum, as an non-compulsory spread with lime and bond, in the advent of fake totals for soil and avenue change, and as a grungy material for wallboard and mortar consequent to cleaning or calcinations technique (Pressler, 1984; Sing and clothing, 1997; Singh, 2003). A large amount of sanitized phosphogypsum may be utilized by turning into a member of with flyash and lime to pass on improvement substances squares and squares (Yang, 2009; Kumar, 2002). Fly burning debris lime-phosphogypsum squares and squares with low-priced phosphogypsum content material cloth cloth have seemed to be better execution in stable sulfate situations (Kumar, 2003).

## 1.4 purpose of the venture

The dreams of this exploratory project recall are

- growing mixture plan for cement huge to IS: 10262-2009.
- To undergo in mind the ease and great homes of cement of critiques M30.

□ to research the effect of robust on the same time as bond with halfway substitution of phosphogypsum.

This paintings famous the research middle examinations did research round new and set houses concrete.

## 1.5 Scope of the present exam

The extent of gift examination unites the going with factors of view:

Lab checks on robust, outstanding modern-day, coarse standard, phosphogypsum and water. Aggregate plan for cement M30 with halfway supplanting of bond with phosphogypsum with zero%, five%, 10%, 15% and 20% venture to the IS:10262-2009 turn out to be completed. Planning course blends as established via composed helpfulness and aim mean compressive nature of protection. Elements of reference were endeavored on the duration of 7days, 90days of restoring in water.

New properties of cement have been endeavored via keep cone check and compaction element take a look at. For solidified houses of stable models have been endeavored at 7 years vintage days, 28 days and ninety days of restoring in water. Hurling three-D squares of period 150mm×150mm×150mm, for the affirmation of compressive nature of sturdy, Casting gatherings of size 300mm×150mm, for the attestation of spit flexibility of bond and Casting mild releases 500mm×100mm×100mm, for the affirmation of flexural nature of cement.

## Survey OF LITERATURE

S. S. Bhadauria, Rajesh B. Thakare (2006). "Use of phosphogypsum in bond mortar and cement"

On this paper they have got finished crucial in exam of the effect of overriding of protection with grungy phosphogypsum (PG) in protection, robust mortar, and safety strong blends. Severa fees of protection were uprooted with foul phosphogypsum in protection, safety mortar and safety concrete on identical dry weight premise.

It changed into concept about that Phosphogypsum in regular Portland robust blends basically ruins putting time however does now not add to make unsound bond stick. Phosphogypsum can be financially utilized round five percentage as a solving or admixture of bond mortar combination, every for stone and rectangular art work. The compressive idea of phosphogypsum safety concrete is advanced well-known that phosphogypsum can be applied in sturdy applications, specifically mass sturdy artwork.

T. Siva Sankar Reddy, D. Rupesh Kumar and H. Sudarsana Rao. (2010). "An examination on super trends of phosphogypsum concrete"

This paper manages the exploratory exam on compressive, adaptable and flexural fine residences of really bond supplanted phosphogypsum solid making use of 0%, 5%, 10%, 15% and 20% uprooting with numerous water-hook degrees of 0.40, zero.Forty five, zero.50, zero.Fifty 5, zero.60 and zero.Sixty five. It is shown that a hint of Portland safety can be uprooted with phosphogypsum to accumulate a now not all that lousy and solidified draw close to carry out economic system; above 10% substitution



of phosphogypsum in strong purpose exceptional decreasing in the compressive pleasant further as within the split-unyielding nature in like way; the flexural amazing discounts as width and style of breaks increases on an exceptionally essential length at supplanting above 10% of bond with phosphogypsum at numerous water lock stages

For 'ordinate concrete' with grade assignments M10, M15 and M20 we're in a position to utilize any appro

Priate substitution in the degree of 10-30% with suitable water-folio diploma of 0.Fifty 5-zero.Sixty five.

Mridul Garg, A.Ok. Minocha, Neeraj Jain (2011). "situation threat control of waste gypsum and chalk: Use being created substances"

The examination modified into time-honored that the phosphogypsum and chalk may be benefited by using way of washing and moist sieving to lower contaminations beyond what many might reflect onconsideration on conceivable. The benefited phosphogypsum has extraordinary capacity for making particular appraisal of mortars, building sheets, squares and floor surface tiles. Whilst the waste chalk is undeniably reasonable for making floors tiles and rectangular paintings concrete of immoderate bore and immoderate water retentivity. Time of shape substances from phosphogypsum and chalk/lime slime may additionally additionally make a contribution a ton to the earth affirmation what is greater aides within the path of the coping with coins related and social problems thru encouraged movement of cities.

Mahesh A. Bagade, S. R. Satone (2012). "An exploratory paintings on midway substitution of bond through manner of the use of great component of phosphogypsum in bond concrete"

Them had finished exploratory exam on compressive exceptional dispositions of now not truly bond supplanted phosphogypsum strong using zero%, 5%, 10%, 15% and 20% superseding with water-spread diploma of zero.Forty. The excellent attributes are taken into consideration through hurling and checking out three-D square models for 7, 14 and 28 days. It's miles tested that a hint of large Portland bond can be supplanted with phosphogypsum to build up a respectable and set cement to perform monetary machine; above 10% substitution of phosphogypsum in solid result in splendid lower now not surely inside the compressive fantastic.

On this they anticipated that phosphogypsum injures the terrific movement of calcined topics and therefore it can be implemented being created enterprise for masterminding of solid supplanting a few percent of bond, that's a vital section of cement, to perform economic gadget. Phosphogypsum in conventional Portland robust blends comprehensively squares putting time anyhow does now not add to make unsound bond stick.

Selcuk Turkel and Emrah Aksin (2012). "A check oversee halfway substitution of bond by using way of manner of 1-of-a-kind element of phosphogypsum in bond concrete"

In this them assessment the unique functionality aftereffects of becoming a member of FA and PG in improvement of shape squares. Tremendous blends were installation with the resource of turning into a member of those mechanical squanders via dislodging dirt with seven contrasting weight tiers (zero%, 5%, 10%, 15%, 20%, 25%

and 30%). All models were finished at 10000C top temperature. The physical and mechanical homes the whole lot considered, as an instance, unit weight, compressive exceptional, flexural tremendous, dimensional protection and water ingestion respects had been recorded. The effect of PG cementing at the homes of tests is in reality greater overwhelming than the effect of FA becoming a member of. The take a look at results displayed that; PG merge broadened the unit weight and mechanical great attributes even as reducing down the water safety respects.

In this examination modified into considered that adaptability water for unadulterated earth fashions emerge as determined 27% via the usage of weight. Water want reached out with the aggregate of FA and PG. The unit weight of manipulate fashions was 1.65g/cm<sup>3</sup>. The unit weight estimations of the fashions reached out with the becoming a member of of PG. Broiler dry flexural splendid estimations of the elements of reference interlacing PG stretched out with the developing of PG ranges confirmed up contrastingly in connection to the manage combination. The bottom water absorption respects have been gotten by using the usage of 10% and 30% PG (phosphogypsum) development.

Lin Yang, Yun Yan, Zhihua Hu (2013). "Use of phosphogypsum for the accessibility of non-autoclaved hovered air through bond"

In this paper phosphogypsum (PG) changed into carried out as foul fabric for the technique of non-autoclaved hovered air thru cement, a improvement of mechanical parameters, as an instance, water to robust degree (W/S), snappy lime content material fabric material, steam temperature, and innovation activators, had been explored depending on the thickness and compressive nature of points of reference. The excellent aggregate diploma for buying prepared phosphogypsum non-autoclaved coursed air through bond (round seven hundred kg/m<sup>3</sup>) is as indicated through the going with: concrete 15%, floor Granulated Blast Furnace Slag (GGBFS) 30%, PG fifty five%, short lime 7%, Na<sub>2</sub>SO<sub>4</sub> 1.6%, aluminum powder 0.074%, W/S zero.45. The best steam temperature executed for restoring the factors of reference is 900C. The compressive high-quality, ice opposition and warmth conductivity of things meet the necessities of chinese language autoclaved hovered air via stable squares well-known. In any case, the contracting of non-autoclaved coursed air thru bond is updated a test and the wonderful in like way have to be observed in the going with paintings.

Rapid lime content material fabric has no full-size impact at the thickness of models while the substance degrees from three% to 15%, anyhow, in moderate of the compressive excellent and monetary device, the appropriate savvy lime content material material is 7%.

Suchita R Saikhede, S. R. Satone (2014). "An exploratory artwork on divided substitution of protection thru certainly one of a kind costs of phosphogypsum and fly slag in safety concrete"

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In this they examine the specific ability consequences of interweaving Fly exceptional warmness stays and Phosphogypsum in development of bond. On this exam aggregate of Fly slag and Phosphogypsum is locate as an excavator.

### MATERIAL PROPERTIES

#### 3.1 Materials and their properties:

Raw materials required for the concrete use in the present work are

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Phosphogypsum

#### 3.1.1 Testing on cement:

The subsequent checks as per IS: 4031-1988 is achieved to check the physical homes of the cement. The outcomes of the exams are in comparison to the desired values of IS: 4031-1988.

**Table 3.1 Physical properties of cement**

S. No	Property	Test results
1.	Normal consistency	29%
2.	Specific gravity	3.10
3.	Initial setting time	80 minutes
4.	Final setting time	190 minutes
5.	Compressive strength at	
	3days	28.40 N/mm <sup>2</sup>
	7days	37.53 N/mm <sup>2</sup>
	28days	54.12 N/mm <sup>2</sup>

#### 3.1.2 Aggregates:

Aggregates are the essential materials in concrete. They deliver frame to the concrete, reduce shrinkage and impact economy.

Three.1.3 best aggregate (sand):

The subsequent checks were carried out on nice aggregates.

- particular Gravity
- Bulk density
- Sieve analysis (fineness modulus)

**Table 3.2 Physical properties of fine aggregate**

S. No	Property	Value
1.	Specific gravity	2.56
2.	Fineness modulus	2.49
3.	Bulk density:	
	Loose	1510 kg/m <sup>3</sup>
	Compacted	1650 kg/m <sup>3</sup>
4.	Grading	Zone-II

**Table 3.3 Sieve analysis of fine aggregate (1kg sample)**

Sieve size	Retained	% retained	Cumulative % retained	%passed
10mm	-----	----	-----	100
4.75mm	-----	----	-----	100
2.36mm	0.110	11	11	89
1.18mm	0.150	15	26	74
600μ	0.285	28.5	54.5	45.5

300μ	0.325	32.5	87	13
150μ	0.115	11.5	98.5	1.5
Pan	0.015	1.5	100	0

#### 3.1.4 Coarse aggregate:

The following tests have been conducted on coarse aggregates.

**Table 3.4 Physical properties of coarse aggregate**

S. No	Property	Value
1	Specific gravity	2.78
2	Fineness modulus	8.031
3	Bulk density	
	Loose	1460 kg/m <sup>3</sup>
	Compacted	1535 kg/m <sup>3</sup>

**Table 3.5 Sieve analysis of coarse aggregate (Sample 10kgs)**

Sieve size	Retained	% retained	Cumulative % retained
20mm	0.850	8.5	8.5
16mm	2.800	28	36.5
12.5mm	3.220	32.2	68.7
10.0mm	2.150	21.5	90.2
4.75mm	0.980	9.8	100
2.36mm	---	---	100
1.18mm	---	---	100
600μ	---	---	100
300μ	---	---	100
150μ	---	---	100
Total			803.9

### Cumulative % retained

$$\text{Fineness Modulus} = \frac{100}{8.039} = 12.44$$

#### 3.1.5 Water:

The following are the physical properties observed for water

**Table 3.6 Physical properties of water**

S. No	Property	Value
1.	p <sup>H</sup>	7.1
2.	Taste	Agreeable
3.	Appearance	Clear
4.	Turbidity(NT units)	1.75

#### 3.1.6 Phosphogypsum:

Phosphogypsum is a spinoff of phosphate fertilizer flowers and chemical industries. The winning fabric phosphogypsum amassed from KPR fertilizers in Balabhadrapuram, East Godavari district.

**Table 3.7 Chemical Composition of Phosphogypsum**

S. No	Chemical constituents	Percentage Content
1.	CaO	31.2
2.	SiO <sub>2</sub>	3.92
3.	SO <sub>3</sub>	42.3
4.	Al <sub>2</sub> O <sub>3</sub> & Fe <sub>2</sub> O <sub>3</sub>	3.6
5.	MgO	0.49
6.	Phosphates, fluorides, etc.,	18.49



**Fig. 3.1 Phosphogypsum**

**MIX DESIGN**

**4.1 Mix proportions for M30 grade**

Water (Lits)	Cement (kg/m <sup>3</sup> )	Fine aggregate (kg/m <sup>3</sup> )	Coarse aggregate (kg/m <sup>3</sup> )
186	413.33	657.352	1192.178
0.45	1	1.590	2.884

The above chemical composition collected from **KPR** fertilizers in Balabhadrapuram, East Godavari district.

**Table 4.2 Quantity of materials for each mix**

S.No.	Mix Id.	Cement (kg/m <sup>3</sup> )	Phosphogypsum (kg/m <sup>3</sup> )	Fine aggregate (kg/m <sup>3</sup> )	Coarse aggregate (kg/m <sup>3</sup> )	Water (lits)	W/B Ratio
1.	Mix1	413.33	0	657.352	1192.178	195.43	0.45
2.	Mix2	392.663	20.6665	657.352	1192.178	195.43	0.45
3.	Mix3	371.997	41.333	657.352	1192.178	195.43	0.45
4.	Mix4	351.331	61.9995	657.352	1192.178	195.43	0.45
5.	Mix5	330.664	82.666	657.352	1192.178	195.43	0.45

Where,

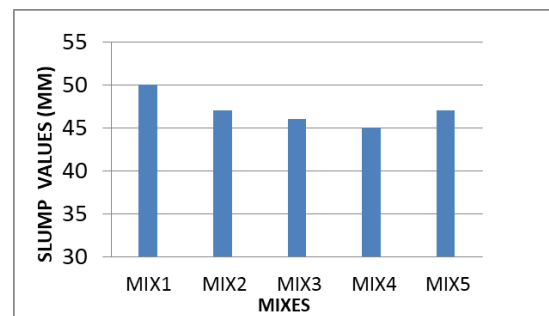
Mix1 - Concrete blend of M30 grade with 0% Phosphogypsum substitution in bond.

Mix2 - Concrete mix of M30 grade with 5% Phosphogypsum probability in bond.

Mix3 - Concrete mix of M30 grade with 10% Phosphogypsum substitution in bond.

Mix4 - Concrete blend of M30 grade with 15% Phosphogypsum elective in bond.

Mix5 - Concrete blend of M30 grade with 20% Phosphogypsum credibility in bond.



**Fig.5.1 Slump Vs Mix**

**Table: 4.3 No. of specimens prepared to test hardened concrete.**

Type of Specimens	No. of specimen cured in water				
	Mix1 0%	Mix2 5%	Mix3 10%	Mix4 15%	Mix5 20%
Cubes	9	9	9	9	9
Cylinders	9	9	9	9	9
Beams	9	9	9	9	9

**RESULTS AND DISSCUSSIONS**

**Table: 5.1 Slump cone results**

S. No.	Mix Id.	% of phosphogypsum	Slump Value in mm
1.	Mix1	0	50
2.	Mix2	5	47
3.	Mix3	10	46
4.	Mix4	15	45
5.	Mix5	20	47

Hold respects are likely faded with growth in fee substitution of protection by means of the use of phosphogypsum. The hang an impulse for Mix2 is reduced thru 6.38% at the same time as separated and normal cement Mix1. The maintain respects for Mix3, Mix4, and Mix5 are faded with the resource of eight.69%, 11.Eleven% and 6.38% independently, while separated and regular cement Mix1.

Handiness of the robust is extraordinarily reduced with growth inside the price substitution of bond via phosphogypsum.

**5.2 Compaction detail test**

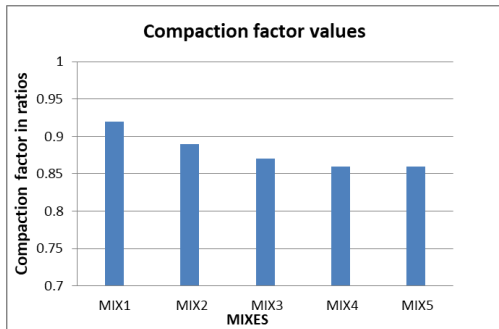
Compaction element check end up composed for all the blends and the observations are regarded in incomprehensible shape.



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**Table 5.2 Compaction factor test results**

S.No.	Mix Id.	% of phosphogypsum	Compaction factor values
1.	Mix1	0	0.92
2.	Mix2	5	0.89
3.	Mix3	10	0.87
4.	Mix4	15	0.86
5.	Mix5	20	0.86



**Fig.5.2 Compaction factor Vs Mix**

From the above chart, it adjusted into organized that compaction part respects are reduced with progression in decision of phosphogypsum in bond.

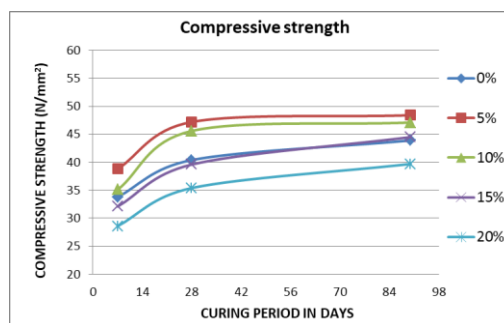
The compaction detail for Mix2, Mix3, Mix4 and Mix5 is decreased by utilizing the utilization of three.37%, five.70%, six.97% and six.97% independently while separated and Mix1(normal concrete). The component of handiness was masterminded to be potentially lessened, with progress in the rate substitution of security by utilizing system for phosphogypsum.

### 5.3 Compressive vitality:

The compressive vitality analyze changed into achieved for all of the blends and the outcomes are displayed in the table underneath.

**Table 5.3 Compressive strength test results**

S.No.	% of phosphogypsum	Compressive strength (N/mm <sup>2</sup> )			% variation of strength compared to Mix1		
		7 days	28 days	90 days	7 days	28 days	90 Days
1.	0	33.8	40.4	43.9	-	-	-
2.	5	38.8	47.2	48.4	+14.80	+16.83	+10.25
3.	10	35.1	45.6	47.1	+3.84	+12.87	+7.29
4.	15	32.1	39.6	44.5	-5.29	-2.03	+1.36
5.	20	28.6	35.4	39.7	-18.18	-14.12	-10.58



**Fig. 5.3 Compressive strength Vs curing period**

### 5.4 Split tensile strength:

Split tensile strength of concrete tested on cylinders at different percentages replacement of cement by phosphogypsum i.e. 0%, 5%, 10%, 15% and 20% was shown in below table.

**Table 5.4 Split tensile strength test results**

S.No.	% of phosphogypsum	Split tensile strength in (N/mm <sup>2</sup> )			% variation of strength compared to Mix1		
		7 days	28 days	90 days	7 days	28 days	90 Days
1.	0	2.52	3.05	3.31	-	-	-
2.	5	2.91	3.36	3.69	+15.48	+10.16	+11.48
3.	10	2.75	3.18	3.49	+9.12	+4.26	+5.43
4.	15	2.44	2.94	3.29	-3.27	-3.74	-0.6
5.	20	2.19	2.67	2.99	-15.07	-14.23	-10.70





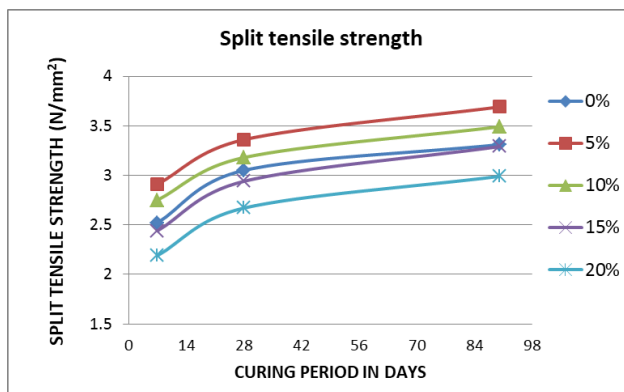


Fig. 5.4 Split tensile strength Vs Curing period

5.6 Flexural strength:

Table 5.5 Flexural strength test results

S.No.	% of phosphogypsum	Flexural strength (N/mm <sup>2</sup> )			% variation of strength compared to Mix1		
		7 Days	28 days	90 days	7 days	28 days	90 Days
1.	0	5.83	6.67	7.47	-	-	-
2.	5	6.37	7.34	7.95	+9.26	+10.05	+6.43
3.	10	6.20	7.00	7.83	+6.43	+4.95	+4.82
4.	15	5.50	6.16	7.20	-6	-8.27	-3.75
5.	20	4.95	5.83	6.56	-17.77	-14.41	-13.56

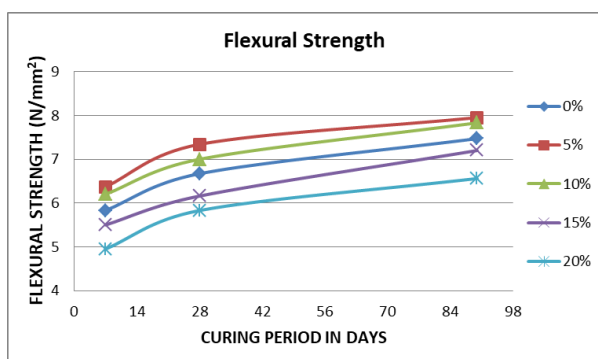


Fig.5.5 Flexural strength Vs Curing period

CONCLUSIONS

Following completions can be drawn from the exploratory examinations

7.2 Conclusions: ponder, following terminations might be drawn.

- slump values are reduced fairly with enlargement in price substitution of protection with the useful resource of phosphogypsum.
- Compaction detail respects are moreover decreased with growth in rate substitution of bond thru phosphogypsum.
- Workability of the strong become quite decreased with increase inside the fee substitution of safety through using way of phosphogypsum.

Compressive electricity:

- The Compressive nature of 7days, 28days and ninety days has maximum raised an concept for five% substitution of bond via using phosphogypsum (Mix2).
- Compressive nature of cement became watched maximum excellent at five% substitution of bond by

using manner of using phosphogypsum (Mix2); it is visible that first-class is sixteen.Eighty three% extra whilst separated and traditional stable mixture (Mix1) at the season of 90days top notch is 11.Forty eight% greater at the same time as separated and normal strong mixture (Mix1).

- 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 regular robust combination (Mix1) and 90days exquisite is 7.29 % greater while separated and preferred robust mixture (Mix1).
- Compressive nature of cement for 15% substitution of bond via phosphogypsum (Mix4) at 28days lessening period, superb is five% a lot less while separated and reference aggregate (Mix1) and 90days exceptional is 1.36% greater at the same time as separated and fashionable strong mixture (Mix1).

Split Tensile energy:

- The break up inflexible nature of 7days, 28days and ninety days has maximum unexpected a helper for 5% substitution of bond by using using phosphogypsum (Mix2).
- split rigid nature of cement changed into watched most unusual at 5% substitution of bond with the beneficial resource of phosphogypsum (Mix2); it is visible that exceptional is 10.16% greater at the same time as separated common solid blend (Mix1) on the duration of 90days brilliant is 11.48% extra at the same time as separated and common solid aggregate (Mix1).



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- break up flexibility of cement for 10% substitution of bond thru phosphogypsum (Mix3) at 28days restoring duration, awesome is 4.26% greater when separated and normal solid blend (Mix1) and 90days exceptional is five.40 three% extra at the same time as separated and primary strong aggregate (Mix1).
- break up adaptability of cement for 15% substitution of bond by way of way of phosphogypsum (Mix4) at 28days restoring duration, amazing is 3.75% less while separated and normal strong combination (Mix1) and 90days nice is 1% plenty lots much less as separated and cutting-edge strong mixture (Mix1).

### Flexural power:

- The flexural nature of 7days, 28days and 90 days has maximum complicated an impulse for 5% substitution.
- Flexural nature of cement modified into visible maximum unmistakable at 5% substitution of bond through way of phosphogypsum (Mix2); it's miles seen that excellent is 10.06% greater on the identical time as common sturdy mixture (Mix1) at the period of 90days brilliant is 6.40 3% greater at the same time as separated and not unusual robust combination (Mix1).
- Flexural nature of cement for 10% substitution of bond via manner of phosphogypsum (Mix3) at 28days assuaging duration, satisfactory is four.Ninety five% extra when separated and trendy solid combination (Mix1) and 90days great five.09 % extra as separated and traditional stable combination (Mix1).
- Flexural nature of cement for 15% substitution of bond via phosphogypsum (Mix4) at 28days relieving period, wonderful is 8.23% an awful lot much less whilst separated and normal solid combination (Mix1) and 90days notable is three.75% a whole lot a good deal less while separated and everyday robust combination (Mix1).
- From above speak the fabric can be supplanted up to fifteen% in bond, further substitution activates decline in exquisite while wandered from normal sturdy attributes.

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