Effect of plastic powder, silica fume and steel slag in concrete - An Experimental and Analytical Approach.

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Abstract. Emergent countries employ the broad toughened building resources such as plastic powder, silica fume and other ingredients in concrete. In accumulation, steel slag has been introduced as an alternative of coarse aggregate to put together concrete encompass good possessions. This paper describes the results of a coordinated work carried out using plastic powder, steel slag and silica fume to form the concrete. New research on concrete mix M20 was carried out for 7, 28 days by 0 (zero) percent, 10 percent, 20 percent, 30 percent replacement of fine aggregate by plastic powder, similarly steel slag was replaced by coarse aggregate and their mechanical properties of concrete were addressed by 10 percent addition of silica fume by weight of cement by on condition that a sustainable decision to deal with the strength of concrete [1-6]. Cement is the majority imperative ingredient of concrete, it forms the vital customary for the divergent materials prepared out of as projected enchanting place raw materials. Steel slag is a spin off the manufacture of steel, created by manufacture of steel, created by extracting the molten steel from the unclean steel industries.

1. Introduction
In this delve into; key notice has been dedicated to the make use of plastic powder as replacement of fine aggregate, steel slag has been replaced by coarse aggregate with steel slag and 10% addition of silica fume by weight of cement by on condition that a sustainable decision to deal with the strength of concrete [1-6]. Cement is the majority imperative ingredient of concrete, it forms the vital customary for the divergent materials prepared out of as projected enchanting place raw materials. Steel slag is a spin off the manufacture of steel, created by manufacture of steel, created by extracting the molten steel from the unclean steel industries.
The combination of pozzolan and silica fume will pull through the potency of binders based on cement. Significantly, a privileged compressive strength of about 110 MPa for 28 days was achieved at 15 percent admixing intensity by cement effect [9][10]. Plastic wastes as a limited or full surrogate of natural aggregate in cement mortar and concrete. The amalgamation of plastic aggregate can condense the solidity of consequential concrete and cement mortar and therefore more than a few studies were undertaken to organize a lightweight concrete as a result of different varieties of plastic aggregates [8].

The reuse of hard plastic waste as a concrete ingredient and the study of the strength properties of concrete containing recycled plastic waste were defined by the use of plastic waste as constitutional building materials. Reutilization of hard plastic wastes as concrete ingredient and by analysis of the strength characteristics of concrete containing recycled waste plastic, it is identified that plastic waste can be disposed by using them as construction materials [10][12].

Silica fume replacement, such as 0 percent, 6 percent, 10 percent and 15 percent, concluded that in concrete mixtures with a steady slump of 100±10 mm, the use of concrete containing 0-15 percent silica fume incorporated higher levels of silica fume replacement [7]. In particular, different amounts of silica sand were substituted by the same weight of the above mentioned plastic waste in order to obtain six mortars of different compositions. The effect of plastic wastes has been added on the physical, mechanical characteristics and thermal conductivity of the obtained mortar[11]. Bountiful research has been carried out to estimate the structural behavior of R.C. element with various industry rejects, sustainable, viable materials and precise the significant sustainable construction materials [13-17].

All-inclusive studies are conceded on the distinctiveness of plastic powder, silica fume and steel slag in concrete associated to potency and permanence. Distant not much awareness has been alerted on the personality of concrete which contains the mishmash of industrialized by products.

2. Materials
Plastic powder, silica fume and Steel slag were collected from waste plastic recycled factory and steel manufacturing factory. Chemical combination of silica fume and cement, the imprudent components are usually represented as an eminence direct measure. The aluminosilicate workings act in response with calcium hydroxide to generate cementitious materials.

| S.No | Characteristics               | Obtained result |
|------|--------------------------------|-----------------|
| 1    | Specific gravity of Plastic aggregate | 0.91            |
| 2    | Density                         | 0.95 g/cm³      |

| S.No | Characteristics               | Obtained result |
|------|--------------------------------|-----------------|
| 1    | Specific gravity of Steel slag | 3.41            |
| 2    | Unit Weight                    | 1750 kg/m³      |

| S.No | Characteristics               | Obtained result |
|------|--------------------------------|-----------------|
| 1    | Relevant cement gravity        | 3.12            |
| 2    | Relevant silica fume gravity   | 0.91            |
| 3    | Relevant fine aggregate gravity| 2.68            |
| 4    | Relevant coarse aggregate gravity| 2.75           |
3. Experimental investigations

The desirable relationship of concrete mixes to be based on of particular element required for a situation in order to achieve a specific result to manufacture concrete having ample, but not disproportionate, able to be accomplished and to deal with stressful used for the scrupulous add weight and robustness for the revelation to something to be identified it will be that is being discussed. The undertaking of between the parts of a whole concrete mixes is proficient by the draw on of assured customary associations which meet the expense of realistically perfect direction for choosing the unsurpassed instructions of component so as to get the worth having characteristic quality of the concrete. Delve into the mix design for a M20 grade concrete in this. In order to fall below the characteristic strength no more than the specified proportion of test results, the concrete mix must be deliberated for a high purpose of intermediate compressive strength to some degree. For the preferred capable of being handled, the capacity of mixing water per entity quantity of concrete and fraction of fine aggregate to totality summative by complete amount be suspended in the lead the range of aggregates.

In this research work cement, fine aggregate, coarse aggregate, silica fume and plastic powder are being ingredients to make M20 grade concrete. It was prepared by replacing materials like sand and coarse aggregate by plastic powder and steel slag at 0%, 10%, 20%, and 30% each respectively. In addition to this 10% silica fume has been added with respect to weight of cement.

The M20 grade concrete mix ratio was 1: 1.44: 3.15. The proportion for M20 grade concrete, alike different replacement is considered by using silica fume, plastic powder and steel slag for 7 days and 28 days. So that the different samples were applied to the shape of the cube and cylinder with respect to finding compressive strength and split tensile strength for the days listed above. For flexural behavior of concrete, reinforcement analysis is used.

| Description | Ingredients of concrete mixes (per m³) |
|-------------|--------------------------------------|
| Conventional | Cement (kg) Fine aggregate (kg) Coarse aggregate (kg) Water (lit) |
|             | 383 551 1208 186                     |

Figure 4. Casting and Curing of Concrete
Table 5. Replacement mix proportion of concrete

| Description       | Silica fume (kg) | Plastic powder (Replacement of fine aggregate) (kg) | Steel slag (Replacement of coarse aggregate) (kg) | Water (lit) |
|-------------------|-----------------|-------------------------------------------------|-------------------------------------------------|-------------|
| 10%               | 38.3            | 55.1                                            | 120.8                                            |             |
| 20%               | (addition of 10% by weight of cement) 110.2     | 241.6                                            | 186                                              |             |
| 30%               | weight of cement 165.3 | 362.4                                            |                                                  |             |

3.1 Compressive Strength

For cube compression testing of concrete, 150 mm cubes were used. All the cubes were measured in a saturated, dry surface condition after wiping out the surface moisture. For each trial mix combination, three cubes were tested at 7 days of age and 28 days of age. The compressive strength of concrete is provided by the load on the side of the breakdown alienated by the sample field.

Table 6. Compressive strength of concrete mixes

| Replacement % | Compressive strength of concrete mixes (N/mm²) |
|---------------|-----------------------------------------------|
|               | 7days | 28days                                      |
| 0             | 18.23 | 27.13                                       |
| 10            | 17.83 | 26.34                                       |
| 20            | 15.93 | 24.94                                       |
| 30            | 14.50 | 22.72                                       |

Figure 5 and figure 6 indicate that the compressive power of the cube is that psychoanalysis takes place for 7 and 28 days consecutively. The achieved upshot demonstrates that the increased strength of incremental growth in the mixing percentage would inevitably decrease the compressive strength of all test specimens.
3.2 Split Tensile Strength

At 7 and 28 days of age, split tensile strength tests were performed on cylinder specimens with a diameter of 150 mm and a length of 300 mm. Therefore, it is obligatory to settle on the strength of concrete next to which the concrete might fissure. The container mould is 3 mm thick. Every mould is competent of mortal opened longitudinally to smooth the progress of the taking away of the case and is provided among resources of observance it clogged whereas in employ. The interior of the mould is 15 cm in diameter and 30 cm in height. Mould is provided in the midst of a metal base plate and ought to be encrusted with emaciated coat of mould oil before use, in sort to thwart devotion of concrete. Figure 7, figure 8 shows that the split tensile strength analysis and it explains that augment in integration percentage will surely ease the heaviness but also decrease the toughen factors.

| Replacement % | 7days | 28days |
|---------------|-------|--------|
| 0             | 2.10  | 3.11   |
| 10            | 1.91  | 2.89   |
| 20            | 1.59  | 2.49   |
| 30            | 1.28  | 2.19   |

Figure 7. Split tensile strength - 7days  
Figure 8. Split tensile strength - 28days

3.3 Flexural Strength

The research domino effect was 0 %, 10 % for the best possible combination and the beam specimens were cast and experienced at the age of 28 days for flexural deeds. All the beams that were considered in this investigation were reinforced to crumple. The first fracture load is observed and the beam’s action by measuring and monitoring the prototype of the break is deliberate. Two balanced concentrated loads are exposed to the deflections unhurried in the beams. The beam has a diameter of 8 mm crest reinforcement, a diameter of 12 mm foot reinforcement, stirrups of 6 mm and a beam length of 1.5 m. This contract is included in a concrete constitution.

Figure 9. Casting of Beam  
Figure 10. Beam Specimens  
Figure 11. Test setup of Beam
Table 8. Flexural strength of the Beam

| Specimen type | 7 days | 28 days |
|---------------|--------|---------|
| Conventional  | 16.59  | 24.92   |
| 10% replacement | 17.63  | 25.70   |

When the cracking split second is reached in the untainted twisting precinct, some cracks to become visible. The initial crack was largely perpendicular to the direction of the utmost nervous stress caused by the moment of bending. Then more cracks appeared around the scope of the beam for elevated loads.

Figure 12 shows that, while cracks in the pure bending zone develop mostly in a vertical direction, they acquired some inclination towards the central zone in the shear period due to shear stresses in these regions. There were no more new cracks shortly after the service load was reached and only the opening of the existing cracks could be observed.

Finite element methods are arithmetic system for similar to the solutions of numerical tribulations so as to are generally formulate thus precisely utter a thought of a few facet of corporal veracity. A predetermined constituent (figure 13) is characterized in a dissimilar formulation, a discretization tactic, solitary or additional illumination algorithms as well as position giving out measures. These actions are intended used for the pulling out of the facts of concerncommencing a finite element elucidation (figure 14). Intocategorize to gather the necessities of solution authentication, post processors need to provide for error inference in rations of the quantities of concentration. While the errors of jagged reckoningbebetter than what is measuredtolerable then the discretization have been distortedwhicheverthroughautomated adaptive progression or by stroke of the analyst.
4. Result and Discussion

In this analysis, concrete was used under M20 to substitute fine aggregate with plastic powder (10%, 20%, 30%) and coarse aggregate was replaced with steel slag (10%, 20%, 30%) and 10% silica fume was applied with cement. The after measuring of ingredients, they are assorted thoroughly to obtain consistency of mixing the concrete. Mechanical properties of concrete at 7 days, 28 days were tested and for 10% replacement of steel slag and 10% replacement of plastic powder, the strength properties of concrete at 7 and 28 days are somewhat equivalent to normal conventional concrete. Steel Slag replacement with coarse aggregate, the strength has been decreased when compared to normal conventional concrete at 7, 28 days respectively. Whereas, when compared to 10% replacement of cement by silica fume, 10% addition of silica fume by weight of cement showed better strength. The mechanical properties of concrete are studied by means of a diverse proportion of assimilation applied to the structure by reverence of the sampling of parched mass and with respect to different days.

The practice has been computerized to so great an extent that as soon as innovative untried sets are supplementary to the record, the representation can be reorganized. As the form is demonstrated through special statistics creation that forms the basis and an inadvertently a superior effectiveness to envisage concrete strength, it may perhaps be worn as a trustworthy device for assess the mean strength of concrete. By mention to an account of long-standing occupation of concrete appearance, it had confirmed how noteworthy it had branded as regards the connotation of uncomplaining vicissitudes in mix design. Disparate kind of model, that is stand-in on far removed from extent balance, is transiently to be had unsettled crucial uncertainty had been recorded. After wards an occurrence of easy to get to wherever new studies and arithmetic modeling have naked on the way during the purpose of cementitious materials. First and foremost the convention of a micro range reproduction had to reflect about impressive carefully meant for assortment optimization of pooled cements. The succeeding example displayed that abridged models for the development of transport possessions in cement-based materials in the phase of tune-up life to be an advance indication of demonstrate shortcoming that can only be unspecified and undertake by transportation out exhaustively tentative exploration.

5. Conclusion

Experimental investigations on the test specimens were carried out in this research, the strength related properties of concrete M20 using plastic powder, steel slag and silica fume. The load carrying capacity of the beams is significantly greater than the control beam for all replacement stages. It has been achieved that plastic aggregates can be used in concrete as a replacement for natural coarse aggregate, though noting the advanced technology in lightweight concrete processing. It is also practical that for concrete mixes, the compressive strength and split tensile strength drop off as the material stand-in increases.

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