IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 17, Issue 4 Ser. IV (Jul. – Aug. 2020), PP 42-52
www.iosrjournals.org

Partial Replacement Coarse Aggregate by EPS

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Abstract: *Now a day's concrete plays a major role in construction industry. Availability of construction material is less day by day. So we can introduce a new kind of material in construction industry to reduce the cost as well as user friendly material. The main objective of the project, by using the available waste material to introduced in concrete industry. Fully replacement of concrete is not possible, so we can made an attempt to develop partial replacement of concrete material. In the last few decades there has been rapid increase in the waste materials and by-products. Some of the industrial by-products like GGBS, fly ash, copper slag, steel slag, Expanded polystyrene (EPS) have been successfully replaced for cement and concrete in the construction industry. It reduces the consumption of natural resources. Steel slag is one of the materials that is considered as a by-product (waste material) obtained during the matte smelting and refining of copper. It has the physical properties similar to the fine aggregate, so it can be used as a replacement for fine aggregate in concrete. Likewise replacement of coarse aggregate is done by some materials, which makes the concrete light weight. This work shows the results of an experimental study on various workability and durability tests on concrete containing Polystyrene as a replacement of coarse aggregate such as compressive test, split tensile test and flexural strength. For this research work M50 & M60 grade are used and the tests are conducted for various proportions of Polystyrene with coarse aggregate 2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5% & 25%. The obtained results were compared with those of conventional concrete.*

Key Word: *Lightweight concrete, Construction materials, concrete, Building materials, Low density concrete, Compressive Strength, Split Tensile and Flexural Strength.*

Date of Submission: 29-08-2020 Date of Acceptance: 14-09-2020

I. Introduction

Concrete is a most commonly used building material which is a mixture of cement, sand, coarse aggregate and water. It is used for construction of multi-storey buildings, dams, road pavement, tanks, offshore structures, canal lining. The method of selecting appropriate ingredients of concrete and determining their relative amount with the intention of producing a concrete of the necessary strength durability and workability as efficiently as possible is termed the concrete mix design. The compressive strength of harden concrete is commonly considered to be an index of its extra properties depends upon a lot of factors e.g. worth and amount of cement water and aggregates batching and mixing placing compaction and curing. The cost of concrete prepared by the cost of materials plant and labour the variation in the cost of material begin from the information that the cement is numerous times costly than the aggregates thus the intent is to produce a mix as feasible from the practical point of view the rich mixes may lead to high shrinkage and crack in the structural concrete and to development of high heat of hydration is mass concrete which may cause cracking. The genuine cost of concrete is related to cost of materials essential for produce a minimum mean strength called characteristic strength that is specific by designer of the structures. This depends on the quality control measures but there is no doubt that quality control add to the cost of concrete. The level of quality control is often an inexpensive cooperation and depends on the size and type of job nowadays engineers and scientists are trying to enhance the strength of concrete by adding the several other economical and waste material as a partial substitute of coarse aggregates and cement or as a admixture fly ash, Glass Powder, steel slag, stone dust, EPS etc are the few examples of these types of materials. These materials are generally by-product from further industries for example fly ash is a waste product from power plants and a by-product resulting from decrease of high purity quartz by coal or coke and wood chips in an electric arc furnace during production of silicon metal or ferrosilicon alloys but nowadays Glass Powder is used in large amount because it enhances the property of concrete.

II. Material And Methods

Sand: Sand is a naturally occurring coarse material collected of finely separated rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand may also consign to a textural class of soil or soil type; i.e. a soil contain more than 85% sand-sized particle (by mass).In terms of particle size as used by geologists, sand particle range in diameter as of 0.0625 mm to 2 mm. An individual particle in this range size is termed a *sand grain*. Sand grains are among gravel (with particles ranging from 2 mm up to 64 mm) and silt(particles smaller than 0.0625 mm down to 0.004 mm). The dimension specification between sand and gravel has remained even for other than a century, but particle diameter as small as 0.02 mm be considered sand under the Albert Atterberg standard in utilize during the early on 20th century. A 1953 engineering standard published by the American Association of State Highway and Transportation Officials set the least sand size at 0.074 mm. A 1938 specification of the United States Department of Agriculture was 0.05 mm. Sand feel granular when rubbed between the fingers (silt, by comparison, feels like flour).

Cement: Ordinary Portland cement is used to prepare the mix design of M30 & M40 concrete. The cement used was fresh and without any lumps Water – cement ratio is 0.40 for this mix design using IS 456:2007.Cement is an extremely ground material having adhesive and cohesive properties which provide a binding medium for the discrete ingredients. Chemically cement constitutes 60-67% Lime (CaO), 17-25% Silica (SiO_2), 3-8% Alumina (Al_2O_3), 0.5-6% Iron Oxide (Fe_2O_3), 0.1-6% Magnesia (MgO), 1-3% Sulphuric Trioxide (SO_3), 0.5-3% Soda And Potash (Na_2O+K_2O).

Aggregate: Aggregate are the essential constituent in concrete. They provide body to the concrete, decrease shrinkage and effect economy. Construction aggregate, or basically "Aggregate", is a wide group of coarse particulate material used in construction, as well as sand, gravel, crushed stone, slag, recycled concrete and geosyenthetic aggregates. Aggregates are the mainly mine material in the world. Aggregates are an element of composite materials such as concrete and asphalt concrete; the aggregate serve as reinforcement to add strength to the overall combined material. Due to the comparatively high hydraulic conductivity value as compare to most soils, aggregates are generally used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and road side edge drains. Aggregates used as support material under foundations, roads, and railroads.

Expanded polystyrene (EPS): Expanded polystyrene (EPS) is a rigid and tough, closed-cell foam with a normal density range of 11 to 32 kg/m^3. It is usually white and made of pre-expanded polystyrene beads. EPS is used for food containers, moulded sheets for building insulation, and packing material either as solid blocks formed to accommodate the item being protected or as loose-fill "peanuts" cushioning fragile items inside boxes. A significant portion of all EPS products are manufactured through Injection Maudling (or Moulding to use the US spelling) Mould tools tend to be manufactured from steels, , (which can be hardened and plated), and Aluminum alloys. The Moulds are controlled through a split via a channel system of gates and runners. EPS is colloquially called "Styrofoam" in the United States and Canada, an incorrectly applied generalization of Dow Chemical's brand of *extruded* polystyrene.

Methods for Curing:

Compressive Strength Test: The test was conducted on cubes of size 150mm x 150mm x 150mm (for concrete and mortar) specimens were taken out from curing tank at the age of 7, 14, and 28, days of curing. Surface water was then allowed to drip down. Specimens were then tested on 200 tones capacity Compression Testing Machine (CTM). The position of cube while testing was at right angles to that of casting position. Axis of specimens was carefully aligned with the centre of thrust of the spherically seated plates. The load was applied gradually without any shock and increased at constant rate of 3.5 N/mm^2/minute until failure of specimen takes place. The average of three samples was taken as the representative value of compression strength for each batch of concrete. The compressive strength was calculated by dividing the maximum compressive load by the cross sectional area of the cube specimens. Thus the compressive strength of different specimens was obtained.

Curing: The test specimens are stored in place free from vibrations, in most air of at least 90% relative humidity and at a temperature of 27 degree centigrade for 24 hours from the time of addition of water to the dry ingredients. After this period, the specimens are marked and remove from the moulds and unless required for the test within 24 hours, immediately submerged in clean and fresh water or saturated lime solution and keep there until taken out just prior to test. The water or solution in which the specimens are submerged, are renewed every seven days and are maintained at a temperature of 27degrees centigrade. The specimens are not to be allowed to become dry at any time until they have been tested. The specimens are tested at 7, 14, and 28, days of curing.

Split Tensile Test: This test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and load is applied until failure of the cylinder, along the vertical diameter.The test was conducted on cylinders of size 100 mm dia and of 300 mm length. Specimens were taken out from curing tank at the age of 28, days of water curing. Surface water was then allowed to drip down. Specimens were then tested on 200 tones capacity Compression Testing Machine (CTM). And test as per IS: 516 and 1199. Different types of specimens prepared.

The split tensile strength was determined by using the following formula.

Split tensile Strength (MPa) = $2P / \Pi DL$

P = Splitting Load in KN, D= diameter of cylinder sample and L = length of cylinder sample.

Flexural Strength Test: All the beam specimens were tested on a Universal testing machine of 2000 kN capacity in the "Structural Engineering". The testing procedure of all the beam specimens was same. First the beams were cured for a period of 28 days then its surface is cleaned with the help of sand paper. After this the specimens were given a white wash and identification number. The white wash was given to enable the detection of cracks during testing at various stages of loading. Two point transverse loading was used to testing the beam specimens. Two-point loading is conveniently.

III. Literature Review& Objective

S. Mahmoud et.al (2018) Expanded polystyrene (EPS) as partial replacement in concrete for coarse aggregates increases the durability of reinforced concrete and reduces coarse aggregates usage. However, the low bulk density and high specific surface area of expanded polystyrene (EPS) offer challenges in its application and transport. In this study, the density of Expanded polystyrene (EPS) was increased by producing expanded polystyrene (EPS) granules mixed with a solid super plasticizer. The effects of expanded polystyrene (EPS) granulation on durability and mechanical properties of concrete were tested. Results indicated an increase in strength and surface electrical resistivity, and a decrease in permeability for both slurry Expanded polystyrene (EPS) and granule, compared to the control sample.

Z. Zhang et.al(2017)the aim of this study was to investigate the differences of effect of Expanded polystyrene (EPS) in paste, mortar and concrete were studied by determining the non-evaporable water content of pastes, measuring the compressive strengths of pastes, mortars and concretes containing 5% and 10% raw Expanded polystyrene (EPS) or dandified Expanded polystyrene (EPS) with water-to-binder ratios(W/B) of 0.29 and 0.24 and investigating the properties of interfacial transition zone between hardened paste and aggregate. The results show that Expanded polystyrene (EPS) can significantly increase the hydration degree of paste. The addition of Expanded polystyrene (EPS) trends to increasing the compressive strengths of hardened pastes, mortars and concretes, and the strength activity index of dandified Expanded polystyrene (EPS) in concrete is the highest while that in paste is the lowest. The agglomeration of Expanded polystyrene (EPS) has been found in blended paste which is hardly seen in concrete. The Expanded polystyrene (EPS) can improve the interface bond strength between hardened cement paste and aggregate. The crystalline orientation degree, the crystalline size and the content of calcium hydroxide at the interface are obviously decreased by adding Expanded polystyrene (EPS). The different dispersion and the improvement of the interfacial transition zone are the main factors causing the different role of Expanded polystyrene (EPS) in paste, mortar and concrete.

M.I. Khan and Y.M. Abbas(2017) this research evaluated reports the influence of hot weather conditions and subsequent curing requirements on the strength and durability of multi-cementitious concrete. Five curing schemes were considered using persistent moist curing for various ages followed by exposure to natural hot weather conditions. It was observed that curing in hot weather tended to increase the initial strength of ternary blended concrete for up to 28 days; however, the development of long-term strength had insignificant effect. Binary blended concrete with Expanded polystyrene (EPS) (EPS) exposed to hot weather have higher early age strength development compared to those under standard curing. The compressive strength and permeability of concrete was more sensitive to hot weather curing at an early age as its fly ash (FA) content increased. However, the effects of curing age diminished with high FA content and the susceptibility of long-term strength to hot weathering decreased as EPS content increased. The porosity of concrete cured with continuous moistening was lower compared to those under hot weathering. The chloride permeability of binary blended concrete containing EPS was less affected by hot weather curing. Using numerical models, it was found that the optimized persistent moist curing age for concrete without EPS was dependent on target strength and durability requirements.

Francis N. Okoye et.al(2017) Geo-polymer is a green cementitious material and has excellent mechanical properties, low energy in its production and emits less carbon dioxide. In this paper, the effect of Expanded polystyrene (EPS) on durability properties of fly ash based geo-polymer concrete have been investigated by immersing the cubes in 2% sulphuric acid and 5% sodium chloride solutions. The resistance of specimens to chemical attack was evaluated visually, measuring change in the weights and percent losses in compressive strength at different intervals of time. A control mix was also cast as M40 with ordinary Portland cement concrete for comparison. Percent losses in compressive strengths in the case of control (M40) and GPC3 in 2% H2SO4 at 90 d were found 36 and 8%. Percent losses in compressive strengths in the case of control (M40) and GPC3 in 5% NaCl at 90 d were 18% and about 0%.Thus the resistance of geopolymer concrete incorporating Expanded polystyrene (EPS) in sulphuric acid and chloride solution was significantly higher than that of the control.

Ali Khodabakhshianet.al(2017) this paper presents the results of an experimental investigation of durability properties carried out on 16concrete mixes containing marble waste powder and Expanded polystyrene (EPS) as partial replacement of ordinary Portland cement. The latter was partially replaced at different ratios of Expanded polystyrene (EPS) (0%, 2.5%, 5%, and 10%) and marble waste powder (0%, 5%, 10%, and 20%). In all concrete mixes, constant water/binder ratio of 0.45 and target initial slump of S2 class (50e90 mm) was used. Workability and bulk density tests were carried out on fresh concrete, while compressive strength, electrical resistivity, water absorption, durability to sodium sulphate, magnesium sulphate and sulphuric acid attack tests were performed to evaluate some relevant properties of concrete in the hardened state.

Rafat Siddique et.al (2017) Influence of bacteria on strength and permeation characteristics concrete incorporating Expanded polystyrene (EPS) (EPS)as a substitution of cement has been investigated in this study. The cement was partially substituted with5, 10 and 15% EPS and with constant concentration of bacterial culture, 105 cru/mL of water. Cement was substituted with Expanded polystyrene (EPS) in concrete by weight. At 28 d, nearly 10–12% increase in compressive strength was observed on incorporation of bacteria in EPS concrete. At 28 d, the compressive strength of concrete increased from 32.9 to 36.5 MPa for EPS, 34.8 to 38.4 MPa for EPS5, and 38.7 to 43.0 MPa for EPS10and 36.6 to 40.2 MPa for EPS15 on addition of bacteria. Water absorption, porosity and capillary water rise reduced in the range of 42–48%, 52–56% and 54–78%, respectively, in bacterial concrete compared to corresponding on bacterial samples at 28 days.

L. Wang et.al(2017).The effects of Expanded polystyrene (EPS), PVA fiber and their combinations on the mechanical properties, micro structure, abrasion resistance and volume stability of cement pastes and/or fly ash concrete were studied experimentally in this work. The results indicated that the compressive strength and tensile strength of concrete containing both Expanded polystyrene (EPS) and PVA fiber were obviously improved compared with the control concrete. The addition of PVA fiber in concrete considerably reduced the drying shrinkage and improved the anti-cracking resistance of cement pastes and concrete, and the abrasion resistance of concrete significantly increased with the addition of expanded polystyrene (EPS) and PVA fiber. These findings have been successfully EPS adopted to guide the design and construction of hydraulic structures in the southwest of China

D. Pedroet.al (2017) this paper intends to evaluate the real influence of a commercial dandified Expanded polystyrene (EPS) and of recycled concrete aggregates (RA) on the behavior of high-performance concrete (HPC). For that purpose, three families of concrete with 0%, 5% and 10% Expanded polystyrene (EPS) (EPS) of the binder's mass were produced. In addition to the commercial Expanded polystyrene (EPS), fly ash (FA) and super plasticizer (SP) were also incorporated in the concrete mixes. Each type of concrete comprises a reference concrete (RC) and three recycled aggregates concrete (RAC) mixes with replacement percentages (in volume) of fine natural aggregates (FNA) with fine recycled aggregates (FRA) and of coarse natural aggregates (CNA) with coarse recycled aggregates (CRA) of 50/50, 0/100 and 100/100, respectively. Considering the mechanical performance and durability of the concrete mixes, results show that it is possible to incorporate significant amounts of FRA and CRA. Regarding the Expanded polystyrene (EPS), the densification process used in its manufacture seems to lead to the formation of agglomerates that change the real particle size of the EPS, originating a loss of performance of the concrete made with them.

Niragi Dave et.al (2016) The aim of this research work is to produce quaternary cement binders and mortars with combination of ordinary Portland cement (OPC) and supplementary cementitious materials (SCMs), such as, fly ash (FA), silica flume (EPS), ground granulated blast furnace slag (GGBS), metakaol in (MK) and lime powder (LP) at 30% and 50% replacement levels. Water-binder ratio was kept constant (0.5) for binders and mortars. Normal consistency, setting time, density, water absorption and compressive strength (at ages of 3, 7, 28, 56 and 90 days) tests was carried out on quaternary binders. Compressive strength (at ages of 3, 7, 28, 56 and 90 days) and rapid chloride permeability (RCPT) (at 28 and 90 days), tests were carried out on quaternary cement mortars mixes of 1:3, 1:4, 1:5 and 1:6. The purpose of this investigation

Was to develop a new quaternary binder which can reduce our dependency on cement. The related combinations of quaternary binders showed better development in compressive strength than control binder. Quaternary mortars with the combinations of GGBS and MK showed better development in compressive strength and permeability than quaternary mortar with combination of lime powder. The overall performance of quaternary binders and mortars are adequate for industrial application.

Yang Juet.al (2017) the distinct spalling performances of reactive powder concrete (RPC) specimens with various expanded polystyrene (EPS) contents exposed to high temperatures were observed via high-resolution photography. The RPC microstructures and pore structures after high-temperature exposure were characterized using scanning electron microscopy and mercury intrusion porosimetry. The results provide experimental evidence of the high-temperature spalling mechanism of RPC. Increasing the EPS content in RPC increases its compressive strength and compactness, offering greater mitigation of devastating spalling behavior, but also producing more pulverized spalling remnants. This is attributed to the post-heating cracked micro structure and refined pores, which promote localized rather than entirely explosive spalling.

Objective: To investigate the strength properties of EPS as replacement of coarse aggregates in concrete mix is a subject of interest to many researchers all over the world and EPS have been observed to improve the strength and durability properties of concrete. In the present work, the effect of addition of EPS on strength characteristics of concrete are investigated. The precise objectives of the study are follows-

- To determine the Workability of concrete with and without EPS in different proportions at different grade.

- To determine the Compressive Strength of concrete with and without EPS in different proportions at different grade.
- To determine the Split Tensile Strength of concrete with and without EPS in different proportions at different grade.
- To determine the Flexural Strength of concrete with and without EPS in different proportions at different grade.
- To find the optimum percentage of EPS for obtaining the maximum strength of concrete. Comparative study of the Behavior of the concrete with & without EPS.

IV. Result and Discussion

Compressive Strength Test Results: The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, and 28, days. The compressive strength test results of all the mixes at different curing ages are shown in Table 4.10 & 4.11. Variation of compressive strength of all the mixes cured at 7, 14, and 28, days shows the variation of compressive strength of concrete mixes w.r.t control mix (100%OPC+0%EPS) after 7, 14, and 28, days respectively.

Table-Compressive strength (MPa) results of all mixes at different curing ages.

Mix	Description –M50	7 days	14 days	28 days
1	100% NCA+0%EPS	37.94	45.29	61.20
2	97.50% NCA+2.50%EPS	36.98	44.13	59.64
3	95% NCA+5%EPS	35.12	41.91	56.64
4	92.50% NCA+7.50%EPS	31.80	37.95	51.29
5	90% NCA+10%EPS	29.53	35.25	47.63
6	87.50% NCA+12.50%EPS	27.89	33.29	44.98
7	85% NCA+15%EPS	25.63	30.59	41.34
8	82.50% NCA+17.50%EPS	23.94	28.58	38.62
9	80% NCA+20%EPS	21.64	25.83	34.90
10	77.50% NCA+22.50%EPS	18.29	21.83	29.50
11	75% NCA+25%EPS	17.55	20.94	28.30

Graph-Compressive strength (MPa) results M-50 of all at different curing ages.

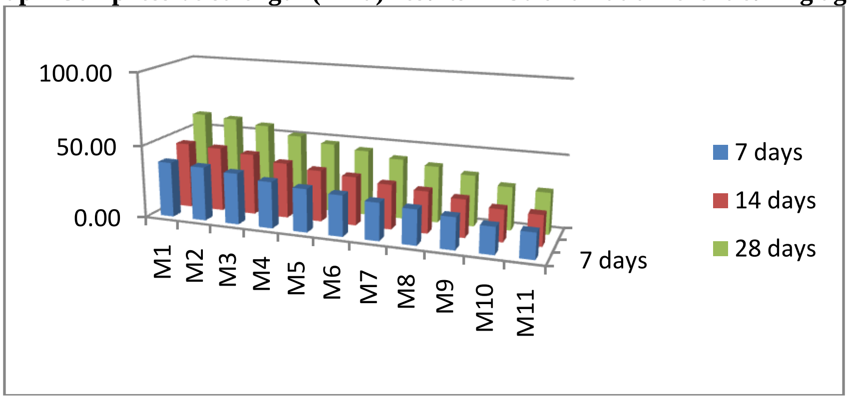
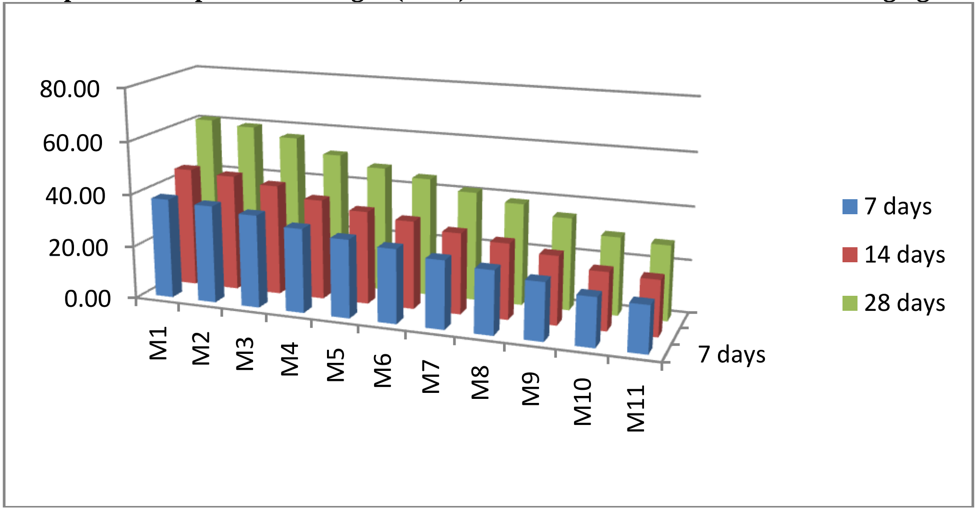


Table- Compressive strength (MPa) results of all mixes at different curing ages.

Mix	Description –M60	7 days	14 days	28 days
1	100% NCA+0%EPS	43.50	51.92	70.16
2	97.50% NCA+2.50%EPS	42.33	50.52	68.27
3	95% NCA+5%EPS	38.66	46.14	62.35
4	92.50% NCA+7.50%EPS	36.96	44.12	59.62
5	90% NCA+10%EPS	33.70	40.23	54.36

6	87.50% NCA+12.50%EPS	31.82	37.98	51.32
7	85% NCA+15%EPS	30.14	35.98	48.62
8	82.50% NCA+17.50%EPS	26.98	32.20	43.52
9	80% NCA+20%EPS	24.51	29.26	39.54
10	77.50% NCA+22.50%EPS	23.32	27.84	37.62
11	75% NCA+25%EPS	20.58	24.57	33.20

Graph 4.2 Compressive strength (MPa) results M-60 of all at different curing ages.



Split Tensile Strength Test Results: The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 7, 14&28 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table below. Variation of splitting tensile strength of all the mixes cured at 7,14 &28 days is also shown in Fig. Shows the variation of splitting tensile strength of concrete mixes w.r t below tables. Splitting tensile strength (MPa) results of all mixes at different curing ages.

Table- Split Tensile Strength (MPa) results of all mixes at different curing ages.

Mix	Description –M50	7 days	14 days	28 days
1	100% NCA+0%EPS	3.14	4.01	5.14
2	97.50% NCA+2.50%EPS	3.03	3.87	4.96
3	95% NCA+5%EPS	2.93	3.75	4.81
4	92.50% NCA+7.50%EPS	2.90	3.71	4.76
5	90% NCA+10%EPS	2.64	3.37	4.32
6	87.50% NCA+12.50%EPS	2.49	3.19	4.09
7	85% NCA+15%EPS	2.34	3.00	3.84
8	82.50% NCA+17.50%EPS	2.21	2.82	3.62
9	80% NCA+20%EPS	2.04	2.61	3.35
10	77.50% NCA+22.50%EPS	1.91	2.44	3.13
11	75% NCA+25%EPS	1.82	2.32	2.98

Graph- Split Tensile Strength (MPa) results M-50 of all at different curing ages.

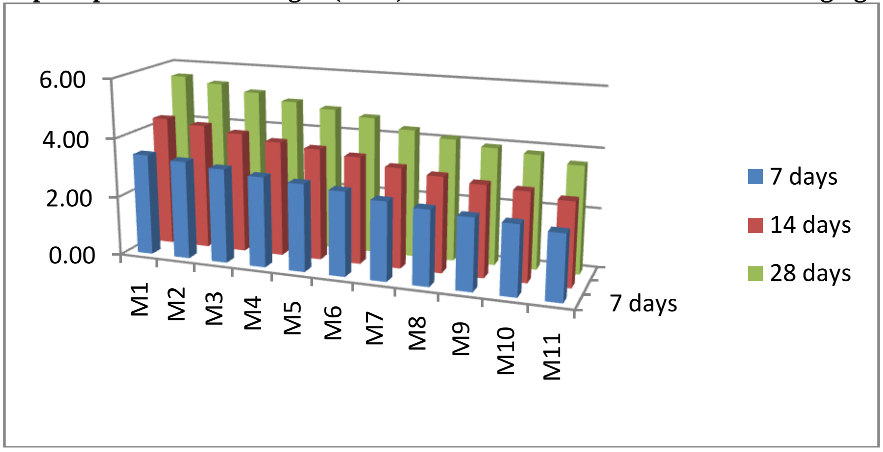
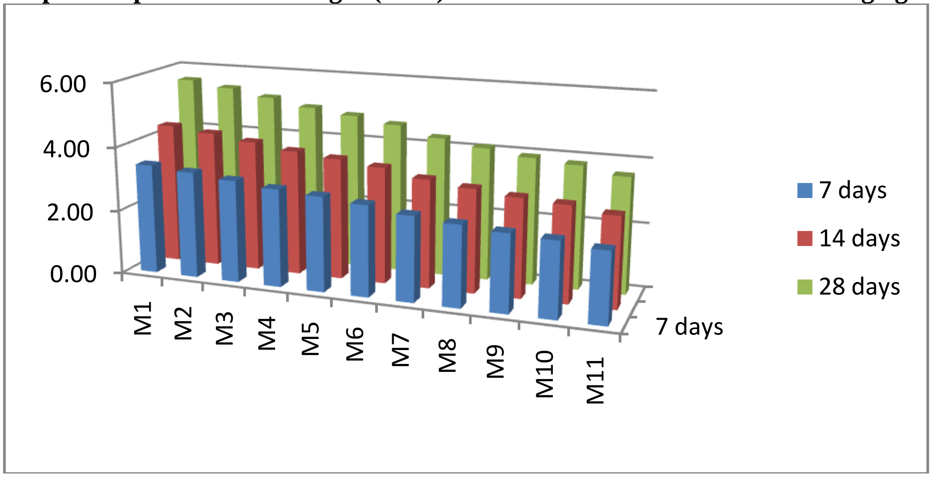


Table- Split Tensile Strength (MPa) results of all mixes at different curing ages.

Mix	Description –M60	7 days	14 days	28 days
1	100% NCA+0%EPS	3.42	4.38	5.61
2	97.50% NCA+2.50%EPS	3.31	4.24	5.43
3	95% NCA+5%EPS	3.18	4.06	5.21
4	92.50% NCA+7.50%EPS	3.04	3.88	4.98
5	90% NCA+10%EPS	2.94	3.76	4.82
6	87.50% NCA+12.50%EPS	2.82	3.61	4.63
7	85% NCA+15%EPS	2.64	3.37	4.32
8	82.50% NCA+17.50%EPS	2.51	3.21	4.12
9	80% NCA+20%EPS	2.40	3.07	3.94
10	77.50% NCA+22.50%EPS	2.34	2.99	3.83
11	75% NCA+25%EPS	2.20	2.81	3.60

Graph 4.4 Split Tensile Strength (MPa) results M-60 of all at different curing ages.



Flexural Strength Test Results:The results of the Flexural Strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The Flexural Strength test was conducted at curing ages of 7, 14& 28 days. The Flexural Strength test results of all the mixes at different curing ages are shown in Table below. Variation of Flexural Strength of all the mixes cured at 7, 14 & 28 days is also shown in Figure. shows the variation of Flexural Strength of concrete mixes w.r.t control mix (100%OPC+0%EPS) after 7,14 &28 days respectively.

Table-Flexural Strength (MPa) results of all mixes at different curing ages.

Mix	Description –M50	7 days	14 days	28 days
1	100% NCA+0%EPS	3.25	4.16	5.33
2	97.50% NCA+2.50%EPS	3.18	4.06	5.21
3	95% NCA+5%EPS	3.15	4.02	5.16
4	92.50% NCA+7.50%EPS	3.10	3.97	5.09
5	90% NCA+10%EPS	3.03	3.87	4.96
6	87.50% NCA+12.50%EPS	2.95	3.77	4.83
7	85% NCA+15%EPS	2.76	3.53	4.53
8	82.50% NCA+17.50%EPS	2.57	3.28	4.21
9	80% NCA+20%EPS	2.39	3.05	3.91
10	77.50% NCA+22.50%EPS	2.19	2.80	3.59
11	75% NCA+25%EPS	2.01	2.57	3.29

Graph-Flexural Strength (MPa) results M-50 of all at different curing ages.

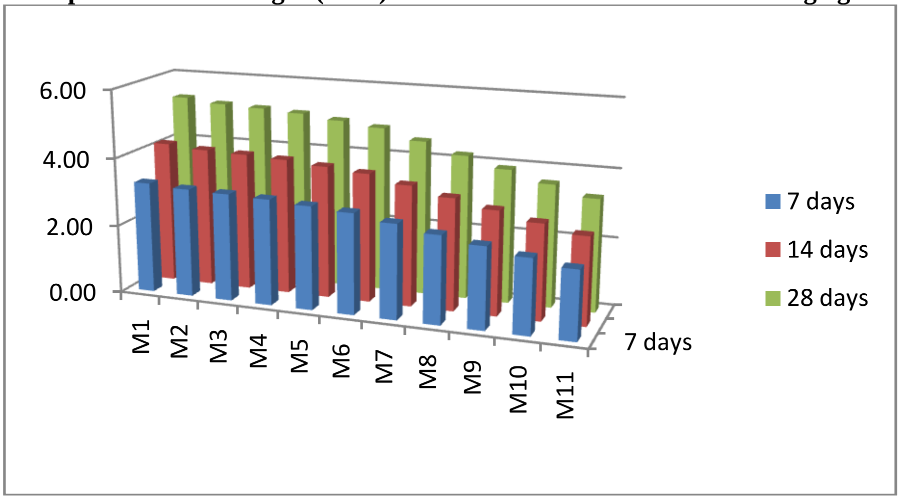
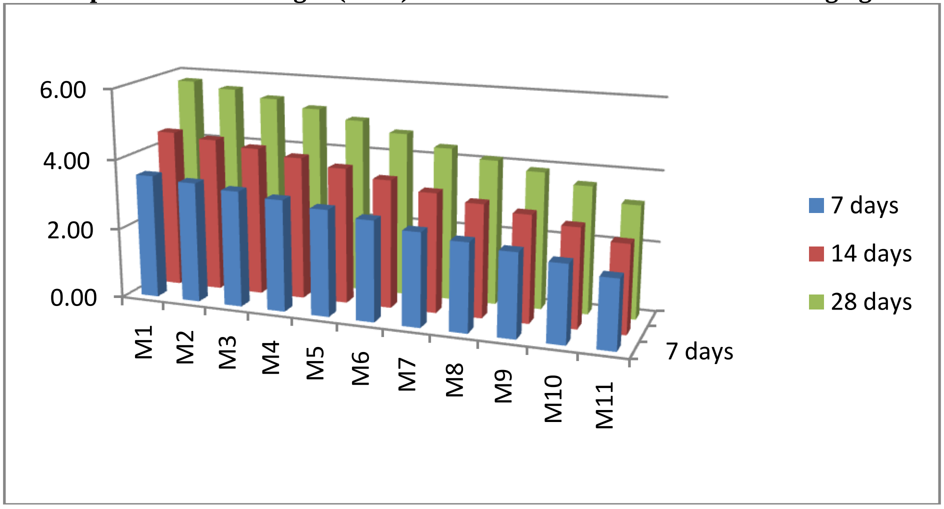


Table-Flexural Strength (MPa) results of all mixes at different curing ages.

Mix	Description –M60	7 days	14 days	28 days
1	100% NCA+0%EPS	3.53	4.51	5.78
2	97.50% NCA+2.50%EPS	3.43	4.38	5.62
3	95% NCA+5%EPS	3.31	4.23	5.42
4	92.50% NCA+7.50%EPS	3.18	4.06	5.21
5	90% NCA+10%EPS	3.03	3.87	4.96
6	87.50% NCA+12.50%EPS	2.85	3.65	4.68
7	85% NCA+15%EPS	2.66	3.40	4.36
8	82.50% NCA+17.50%EPS	2.51	3.21	4.12

9	80% NCA+20%EPS	2.38	3.04	3.90
10	77.50% NCA+22.50%EPS	2.21	2.82	3.62
11	75% NCA+25%EPS	1.96	2.50	3.21

Graph-Flexural Strength (MPa) results M-60 of all at different curing ages.



Workability of Concrete Mixes: The workability of concrete mixes was found out by slump cone test as per procedure given in chapter 3. W/c ratio was kept constant 0.35 and 0.24 for all the concrete mixes. The workability results of different concrete mixes were shown in Tables.

Table- Workability values for different concrete mixes M-50& M-60

Mix no.	Description	Slump (mm) M-50	Slump (mm) M-60
1	100% NCA+0%EPS	58	45
2	97.5% NCA+2.5%EPS	62	51
3	95% NCA+5%EPS	68	58
4	92.5% NCA+7.5%EPS	70	61
5	90% NCA+10%EPS	74	64
6	87.5% NCA+12.5%EPS	76	69
7	85% NCA+15%EPS	79	72
8	82.5% NCA+17.5%EPS	81	75
9	80% NCA+20%EPS	85	79
10	77.5% NCA+22.5%EPS	89	82
11	75% NCA+25%EPS	91	86

V. Conclusion

In the current investigation, Expanded polystyrene (EPS) was used to examine. The experimental data obtained has been analyzed and discussed in above, to fulfill to the best of ability, the objectives set forth for the present investigation. This chapter gives the broad conclusions that are drawn from the investigation.

Based on the scope of work carried out in this investigation, following conclusions are drawn.

- Workability increases with increase in polystyrene beads content.
- Increase in the EPS beads content in concrete mixes reduces the compressive Strength of concrete.
- Increase in the EPS beads content in concrete mixes reduces the Split Tensile Strength of concrete.
- Increase in the EPS beads content in concrete mixes reduces the Flexural Strength of concrete.
- With the increase in w/c ratio strength of concrete decreases.

- Although the strength of concrete is reduced with increase in EPS beads content, its lower unit weight meets the criteria of light weight concrete.

VI. Future Scope

- Experiments can be done by changing different type of cement, manufactured sand and other cementitious materials with EPS Beads.
- The study can be done for different mixes.
- Introducing foaming agent.
- Fibers can also use to increases the strength of the concrete.
- Air entering agents with artificial light weight aggregate can be used to achieve desire density and strength of the concrete.

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