IJMTST is UGC Approved Journal with Journal Id: 43137

International Journal for Modern Trends in Science and Technology, 8(S01):58-65, 2022

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST08S0109
Available online at: https://www.ijmtst.com/vol8si01.html

An Experimental Study on Effect on Engineering Properties of M30 Grade Concrete with Partial Utilization of Red Soil as Fine Agreegate

M.Rudra Sai Ram[1] | B.Jaswanth[1] | D.Papaiah[1] | N.Jaya Chitti Vamsi[1] | A.Sai Kumar[2] | Dr. D.Venkateswarlu[3]

[1]B-Tech. Student, Civil Engineering, Godavari Institute of Engineering and Technology(A),Affiliated to JNTUK, Kakinada, Rajahmundry, A.P, India.
[2]Assistant Professor, Department of Civil Engineering, Godavari Institute of Engineering and Technology (A) , Affiliated to JNTUK, Kakinada, Rajahmundry, A.P, India.
[3]Professor, Head of Department of Civil Engineering, Godavari Institute of Engineering and Technology (A) , Affiliated to JNTUK, Kakinada, Rajahmundry, A.P, India.

To Cite this Article
M.Rudra Sai Ram, B.Jaswanth, D.Papaiah, N.Jaya Chitti Vamsi, A.Sai Kumar and Dr. D.Venkateswarlu. An Experimental Study on Effect on Engineering Properties of M30 Grade Concrete with Partial Utilization of Red Soil as Fine Agreegate. International Journal for Modern Trends in Science and Technology 2022, 8(S01), pp. 58-65. https://doi.org/10.46501/IJMTST08S0109

Article Info
Received: 01 May 2022; Accepted: 26 May 2022; Published: 30 May 2022.

ABSTRACT

Construction industry is the second largest industry next to agriculture with an annual turnover of Rs.3,84,000 crores. Concrete is vital in construction industry. In India, the conventional concrete is mostly produced by using natural sand obtained from the river beds as fine aggregate. River sand deposits are being used up excessively causing serious threat to environment as well as the society. Rapid extraction of sand from river bed causes so many problems like losing water retaining soil strata, deepening of the river beds and causing bank slides, loss of vegetation on the bank of rivers, disturbs the aquatic life. One of the cheapest and the easiest ways of getting substitute for natural sand is locally available soil. The use of locally available soil will conserve the natural sand for sustainable development of the concrete in construction industry. Hence the practices of replacing fine aggregate with manufactured sand and locally available soil are taking a tremendous growth.

In the present investigation fine aggregate is replaced by blending the river sand with locally available soil (red soil). Blended fine aggregate is prepared by mixing natural river sand which is retained on 600μ sieve and locally available soil which is passing through 600μ sieve in the percentage of 40% and 60% respectively so that the blended mixture belongs to zone-II (IS: 383 – 1980). The experimental investigation consists of checking the properties of materials, casting of specimens of grade M30. Workability of fresh concrete and strength parameters of cured specimens are considered in this study. Workability includes slump cone and compaction factor tests, and strength parameters include testing of concrete cubes, cylinders and prisms for determining compressive, split tensile and flexural strengths of concrete at 1, 3, 7, 28, 56 and 91 days respectively. Young's modulus is also determined for cylinder specimens.

Keywords-.RiverSand, FineAggregate

INTRODUCTION

Construction industry is the second largest industry next to agriculture with an annual turnover of Rs.3,84,000 crores. Concrete is vital in construction industry. High cost of building materials are increasing the cost of concrete which is utilized in large quantities.

Ideally, low-cost housing must rely on locally available raw materials. Furthermore, such materials must be abundantly available and be renewable in nature. River sand is one of the major materials used for concrete and motor preparation. In India, there is a huge demand for the natural sand in order to satisfy the rapid infrastructure growth. Due to large utilization of river sand we are about to face shortage. River sand deposits are being used up and causing serious threat to environment as well as the society. Rapid extraction of sand from river bed causes so many problems like losing water retaining soil strata, deepening of the river beds and causing bank slides, loss of vegetation on the bank of rivers, disturbs the aquatic life. In order to face the shortage of sand, local materials are being researched as a replacement of natural sand. For conserving the natural resources and preservation of environment, there is an imperative need to develop alternative materials for replacing natural sand. Many alternative materials such as fly ash, bottom ash, granite powder, copper slag, wood waste, etc., are available to replace river sand but their availability at all places in adequate quantity is in doubt. So, use of soil as fine aggregate is explored local soil has always been the most widely used material for earthen construction in India. Approximately, 55 percent of Indian homes still use raw earth for wall constructions (Dinachandra Singh &Sarat Singh). This study looks into the effect of blending of the conventional fine aggregate sand with locally available soil.

RED SOIL

Soil found locally is the red soil. Red soil is a group of soils that develop in a warm, temperate, moist climate under deciduous or mixed forests and that have thin organic and organic-mineral layers overlying a yellowish-brown leached layer resting on an illuvial (see illuviation) red layer. Red soils generally derived from igneous rock. They are usually poor growing soils, low in nutrients and humus and difficult to cultivate because of its low water holding capacity. Red soils denote the second largest soil group of India covering an area of about 6.1 lakhs sq. km (18.6% of India's area)

These soils are found in large tracts of western Tamil Nadu, Karnataka, southern Maharashtra, Chhattisgarh, Telangana, Andhra Pradesh, Odisha and Chotanagpur plateau of Jharkhand.

The texture of red soils varies from sand to clay, the majority being loam. Their other characteristics include porous and friable structure, absence of lime, kankar and free carbonates, and small quantity of soluble salts. Their chemical composition include non-soluble material 90.47%, iron 3.61%, aluminum 2.92%, organic matter 1.01%, magnesium 0.70%, lime 0.56%, carbon-Di-oxide 0.30%, potash 0.24%, soda 0.12%, phosphorus 0.09% and nitrogen 0.08%.In general these soils are deficient in lime, magnesia, phosphates, nitrogen, humus and potash.

BLENDING OF FINE AGGREGATE

Sand required for the design concrete mix is tested for fineness modulus and it was found that it conforms to grading zone-III. Locally available soil is taken from a depth of 2 to 4 meters below the ground surface which belongs to zone-IV and more than 80% of soil is passing through 600µ sieve which is not recommended for concrete mix. The main objective of this study is to replace fine aggregate with locally available soil. But the replacement of fine aggregate cannot be done as the soil belongs to zone-IV. So there is a need to blend the soil with the river sand to obtain material conforming to zone-II which is suitable for mix design. Blended fine aggregate is prepared by mixing natural river sand which is retained on 600µ sieve and locally available soil which is passing through 600µ sieve in different proportions are tested for fineness modulus. It was observed that the blended fine aggregate with 30% natural sand and 70% soil conforms to grading zone III, 40% natural sand and 60% soil conforms to grading zone II, 50% natural sand and 50% soil conforms to grading zone II.

Table: Grading zones of blended fine aggregate according to IS: 383 – 1980

% of soil passing 600µ sieve	% of sand retained on 600µ sieve	Fineness modulus	Grading zone
70%	30%	2.22	Zone III
60%	40%	2.47	Zone II
50%	50%	2.62	Zone II

From above table, it is observed that blended fine aggregate with 40% Natural River sand which is retained on 600μ sieve and 60% locally available soil which is passing through 600μ sieve conforms to grading zone II and maximum percentage of locally available soil is used as fine aggregate in this proportion. Therefore, blended fine aggregate with 40% Natural River sand and 60% locally available soil is adopted in the present investigation.

OBJECTIVE

1.To study the properties of locally available soil and its comparison with natural river sand.
2.Blending of fine aggregate so that it conforms to grading zone II which is suitable for concrete mix.
3.To evaluate the workability characteristics in terms of compaction factor and slump cone test for M30 grade of concrete.
4.To evaluate the compressive, split tensile and flexural strengths of soil concrete mix and control mix at 1, 3, 7, 28, 56 and 91 days of curing for M30 design concrete mix.
5.To compare the compressive, split tensile and flexural strengths of soil concrete mix with control mix at different ages of curing.
6.To determine the stress strain behavior of soil concrete mix and control mix at 28 days of curing.

REVIEW OF LITERATURE

Natural river sand is to be transported from place where it is available to desired place which makes it expensive. Large scale depletion of natural river sand creates environmental problems. So locally available soil blended with natural soil is used as a substitute or replacement product for concrete industry. The existing literature shows various works done earlier for replacement of fine aggregate in concrete briefly.

Veera Reddy et al (2010) presented an investigation study to assess the suitability of stone dust and ceramic scrap in concrete making. In the laboratory stone dust has been tried as fine aggregate in place of sand and ceramic scrap has been used as partial/full substitute to conventional coarse aggregate in concrete making. Cubes, cylinders and prisms were cast and tested for compressive strength, split tensile strength and modulus of rupture after a curing period of 28 days. The results indicated effectiveness of stone dust as fine aggregate and partial replacement of conventional coarse aggregate by ceramic scrap up to 20 percent, without affecting the design strength.

Venu Malagavelli and Rao (2010) studied the high performance concrete with GGBS and ROBO sand. This paper presents the study of compressive strength and split tensile strength of M30 conventional concrete by replacing the 0 to 30% (5% increment) of sand with ROBO sand and 40 to 60% of cement with GGBS. Tests were conducted on concrete cubes and cylinders to study compressive and split tensile strengths. The results are compared with the normal conventional concrete. Through their studies it was concluded that compressive strength of concrete can be improved by using admixtures. From their results it is proved that, ROBO sand can be used as alternative material for the fine aggregate. Based on the results the compressive and split tensile strengths are increased as the percentage of ROBO sand increased. GGBS can be used as one of the alternative material for the cement. From the experimental results 50% of cement can be replaced with GGBS.

Bai et al (2011), studied the properties of mortar and concrete in which Crushed Rock Powder (CRP) is used as a partial and full replacement for natural sand. The use of such materials not only results in conservation of natural resources but also helps in maintaining good environmental conditions. For mortar, CRP is replaced at 20% 40%, 60%, 80% and 100%. The basic strength properties of concrete were investigated by replacing natural sand by CRP at replacement levels of 20%, 30% and 40%.

Mahzuz et al. (2011) have investigated on the use of stone powder in concrete as an alternative of sand using three concrete mix proportions, 1:1.5:3, 1:2:4 and 1:2.5:5. When the results of compressive strength were compared for these mixes between use of sand and stone powder, it was found that stone powder gives higher value than sand by about 14.76%, 4% and 10.44% respectively. In this study, the main concern is to find an alternative of sand. Substitution of normal sand by stone powder will serve both solid waste minimization and waste recovery. The study focuses to determine the relative performance of concrete by using powder sand. From laboratory experiments, it was revealed that concrete made of stone powder and stone chip gained about 15% higher strength than that of the concrete made of normal sand and brick chip. Concrete of stone powder and brick chip gained about 10% higher strength than that of the concrete normal sand and stone chip concrete. The highest compressive strength of mortar found from stone powder which is 33.02 MPa, shows that better mortar can be prepared by the stone powder. The compressive strength of concrete from stone powder shows 14.76% higher value than that of the concrete made of normal sand. On the other hand, concrete from brick chip and stone powder produce higher compressive value from that of brick chip and normal sand concrete.

Sathish Kumar (2012) carried out an experimental study on the properties of concrete made with alternate construction materials. The experimental investigations include the casting of cubes with various alternative construction materials such as rice husk ash, saw dust, recycled aggregate. The tests were conducted to study the various physical properties such as density, slump, 7 and 28 days compressive strength. A total of 168 specimens were cast and tested in the laboratory to evaluate their compressive strength. It was concluded that the compressive strength of rice husk ash concrete was found to be in the range of 70-80% of conventional concrete for a replacement of cement up to 20%. From the cost analysis it was found that the cost of RHA concrete was less compared to conventional concrete. Recycled aggregate posses relatively lower bulk density, crushing and impact values and higher water absorption as compared to natural aggregate. Wherever compressive strength is not a criteria, the concrete made with alternate construction materials can always be preferred.

MATERIALS

Cement: The cement used was ordinary Portland cement of 53 grade in accordance with IS: 12269-1987.The cement should be fresh and of uniform consistency. Where there is evidence of lumps or any foreign matter in the material, it should not be used. The cement should be stored under dry conditions and for as short duration as possible.

Fine Aggregate

(i)River sand: River sand conforming to grading zone - III was used as fine aggregate.

(ii)Locally available soil: Locally available Red soil conforming to grading zone-IV was used.

(iii)Coarse Aggregate: Crushed granite metal with 60% passing 20 mm and retained on 10 mm sieve and 40% passing 10mm and retained on 4.75 mm sieve was used.

(iv)Water: Potable fresh water, which is free from concentration of acid or organic substances, was used for mixing the concrete.

CONCRETE MIX DESIGN

Conventional concrete mix design according to IS: 10262 - 2009

In the present investigation mix proportioning is done using BIS method for M30 grade concrete. The resulting mixes are modified after conducting trials at laboratory by duly following the Indian standards guidelines to achieve following mix proportion by weight:

Design Requirements

Characteristic compressive strength (f_{ck})	- 30 N/mm²
Maximum size of aggregate	- 20 mm
Degree of workability	- 0.86 compacting factor
Degree of quality control	- Good
Type of exposure	- Severe

Test Data for Materials

Type of cement/ grade of cement	- OPC 53 grade
Specific gravity of cement	- 3.15
Specific gravity of fine aggregate	- 2.68
Specific gravity of coarse aggregate	- 2.74
Fineness modulus of fine aggregate	- 2.47
Grading zone of fine aggregate	- Zone II

MIXING, CASTING AND CURING

MIXING OF CONCRETE

Concrete was mixed in a tilting type concrete mixer. The mixer was hand loaded with coarse aggregate first, then with fine aggregate and with cement. During the rotation of the mixer, water was added to the ingredients inside. The rotation was continued up to 3 minutes. The mixer was tilted and the concrete was unloaded on a clean platform.

CASTING OF SPECIMENS

Casting is a manufacturing process by which concrete material is usually poured into a mould which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mould to complete the process.

CASTING OF CUBES

To study the compressive strength of concrete, cubes of (150 mm x 150 mm x 150 mm, 100 mm × 100 mm × 100 mm) size were cast for each batch of concrete mix. Oil was applied to the cube moulds and is filled with concrete. The concrete filled cube moulds were placed on table vibrator and are vibrated for 1 minute. After the compaction was completed, excess concrete was removed with trowel and the top surface is leveled.

CASTING OF CYLINDERS

To study the split tensile strength of concrete, cylinders of (l50 mm diameter and 300 mm height) size were cast for each batch of concrete mix. Oil was applied to the cylinder moulds and is filled with concrete. The concrete filled cylinder moulds were placed on table vibrator and are vibrated for 1 minute. After the compaction was completed, excess concrete was roemoved with trowel and the top surface is leveled.

CASTING OF PRISMS

To study the flexural strength of concrete, prisms of (100 mm x 100 mm x 500 mm) size were cast for each batch of concrete mix. Oil was applied to the prism moulds and is filled with concrete. The concrete filled prism moulds were placed on table vibrator and are vibrated for 1 minute. After the compaction was completed, excess concrete was removed with trowel and the top surface is leveled.

CURING OF SPECIMENS

Curing is the process of controlling the rate and extent of moisture loss from concrete to ensure an uninterrupted hydration of Portland cement after concrete has been placed and finished in its final position.

TESTS ON HARDENED CONCRETE

CUBE COMPRESSIVE STRENGTH: According to **IS: 516 - 1959**

Compression test on the cubes is conducted on the 300 T compression testing machine. The cube was placed in the compression testing machine and the load on the cube is applied at a constant rate up to the failure of the specimen and the ultimate load is noted. The cube compressive strength of the concrete mix is then computed. This test has been carried out on cube specimens after 1, 3, 7, 28, 56 and 91 days of curing.

SPLIT TENSILE STRENGTH: According to **IS 5816 - 1999**

This test is conducted on 300 T compression testing machine.The cylinders prepared for testing are 150 mm in diameter and 300 mm height. After noting the weight of the cylinder, diametrical lines are drawn on the two ends, such that they are in the same axial plane. Then the cylinder is placed on the bottom compression plate of the testing machine and is aligned such that the lines marked on the ends of the specimen are vertical. Then the top compression plate is brought into contact at the top of the cylinder. The load is applied at uniform rate, until the cylinder fails and the load is recorded. From this load, the splitting tensile strength is calculated for each specimen. In the present work this test has been conducted on cylinder specimens after 1, 3, 7, 28, 56 and 91 days of curing.

YOUNG'S MODULUS OF M30 CONCRETE (E):

Concrete is not a perfectly elastic material. The modulus of elasticity was determined as per IS: 516 –1959, subjecting the cylinder to uni- axial compression and measuring the deformations by means of dial gauges fixed between the certain gauge length. The stress–strain curve was established from the readings. The modulus of elasticity was calculated from the stress–strain curve.

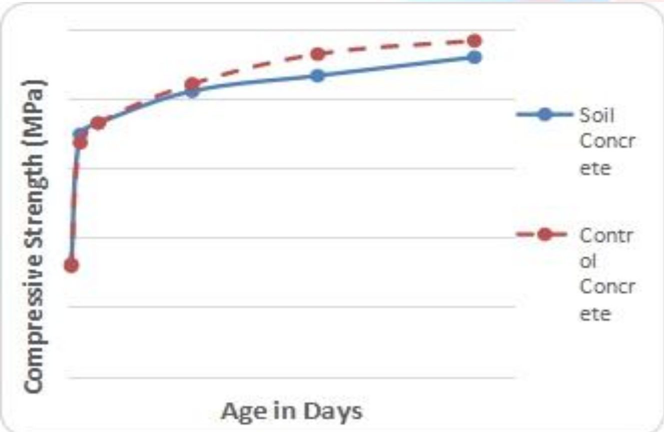
FLEXURAL STRENGTH TEST: According to **IS: 516 - 1959**

This test is conducted on 10 T Universal Testing machine. The loading arrangement to test the concrete beam specimens for flexure. The beam element is simply supported on two steel rollers of 38 mm in diameter these rollers should be so mounted that the distance from Centre to Centre is 400 mm for l0.0 cm specimens. The load is applied through two similar rollers mounted at the third points of the supporting span, which is spaced 13.3 cm centre to centre. The load is divided equally between the two loading rollers and all rollers are mounted in such a manner that the load is applied axially and without subjecting specimen to any torsional stresses. The specimen is placed in the machine in such a manner that the load is applied to the upper most surface as cast in the mould, along two lines spaced 13.3 cm apart. The axis of the specimen is carefully aligned with the axis of the loading device. No packing is used between the bearing surfaces of the specimen and the rollers. The load is applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at a rate of 180 kg/min for the 10.0 cm specimens. The load is increased until the specimen fails, and the maximum load applied to the specimen during the test is recorded. Also the distance between the line of fracture and the nearer support is measured. In the present investigation this test has been conducted on beam specimens after 1, 3, 7, 28, 56 and 91 days of curing.

TEST RESULTS AND DISCUSSIONS

Compressive strength of 150 mm cube for soil concrete and control concrete mix

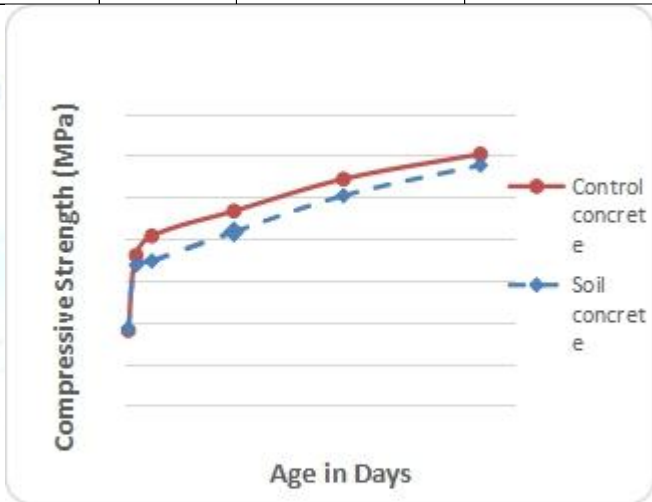
S.No	Age (Days)	Compressive strength for soil concrete (MPa)	Compressive strength for control concrete (MPa)
1.	1	16.15	15.85
2.	3	34.81	33.63
3.	7	36.44	36.44
4.	28	41.04	42.07
5.	56	43.26	46.37
6.	91	45.92	48.29



Comparison of compressive strength of 150 mm cube of soil concrete mix with control mix for different ages.

Compressive strength of 100 mm cube for soil concrete and control concrete mix

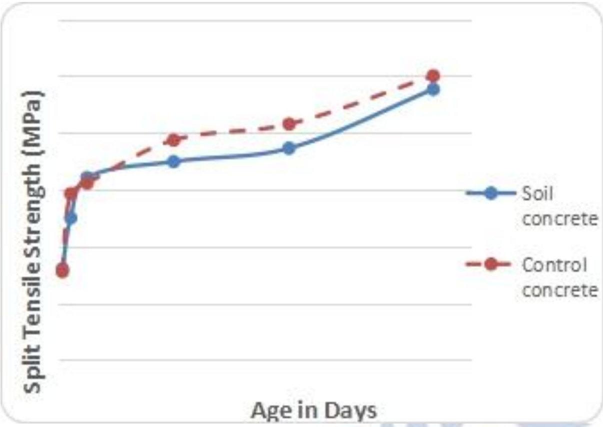
S.No	Age (Days)	Compressive strength for soil concrete (MPa)	Compressive strength for control concrete (MPa)
1.	1	18.33	18.00
2.	3	33.67	36.00
3.	7	34.67	40.67
4.	28	41.67	46.67
5.	56	50.33	54.33
6.	91	57.67	60.33



Comparison of compressive strength of 100 mm cube of soil concrete mix with control mix for different ages.

Split tensile strength of cylinder for soil concrete mix and control concrete mix

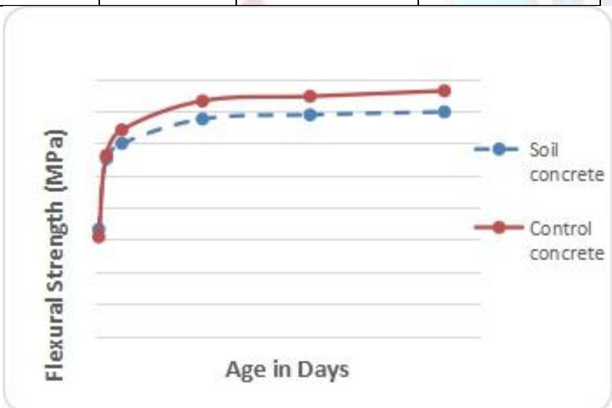
S.No	Age (Days)	Split tensile strength for soil concrete (MPa)	Split tensile strength for control concrete (MPa)
1.	1	1.60	1.56
2.	3	2.50	2.92
3.	7	3.21	3.11
4.	28	3.49	3.87
5.	56	3.73	4.15
6.	91	4.76	5.00



Comparison of split tensile strength of cylinder of soil concrete mix with control mix for different ages.

Flexural strength of prism for soil concrete and control concrete mix

S.No	Age (Days)	Flexural strength for soil concrete (MPa)	Flexural strength for control concrete (MPa)
1.	1	3.32	3.09
2.	3	5.52	5.62
3.	7	5.99	6.41
4.	28	6.75	7.31
5.	56	6.88	7.45
6.	91	6.97	7.62



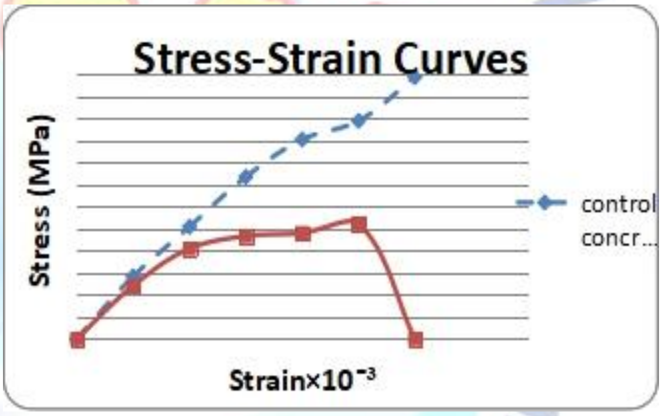
Comparison of flexural strength of prism of soil concrete mix with control mix for different ages.

Stress-Strain behavior of M30 control concrete

S. No	Description	Load (kN) (P)	Deformation (mm)	Stress (N/mm²) (P/A)	Strain (10^{-3})
1.	Control concrete	100	0.05	5.66	0.25
		180	0.10	10.18	0.5
		260	0.15	14.71	0.75
		320	0.20	18.11	1
		370	0.25	19.80	1.25
		420	0.30	23.77	1.5

Stress-Strain behavior of M30 Soil Concrete Mix

S.No	Description	Load (kN) (P)	Deformation (mm)	Stress (N/mm²) (P/A)	Strain (10^{-3})
1.	Soil concrete mix	85	0.05	4.81	0.25
		145	0.10	8.20	0.5
		165	0.15	9.34	0.75
		170	0.20	9.62	1
		185	0.25	10.47	1.25



Comparison of stress strain curves of control concrete with soil concrete mix

CONCLUSIONS

The following conclusions were derived from the results considering the workability, strength characteristics of concrete with replacement of natural sand with locally available red soil in different proportions for M30 grade.

1.Locally available soil is a good alternative for fine aggregate. But it cannot be used as a direct replacement because the soil conforming to zone IV. So there is a need to blend the soil with the river sand to obtain fine aggregate conforming to zone-II which is suitable for mix design.

2.The properties of blended fine aggregate (prepared by mixing natural river sand which is retained on 600μ sieve and locally available soil which is passing through

600μ sieve in the proportion of 40% and 60%) are good and the investigation has proved that it can be used as fine aggregate in the production of concrete as a substitute of river sand..

3.The workability of concrete measured by compaction factor test decreases for soil concrete mix with that of control concrete.

4.The compressive, split tensile and flexural strength for soil concrete mix are comparable with that of control concrete.

5.The compressive strength of soil concrete mix for 150 mm cube is more than that of control mix up to 3 days of curing while the compressive strength for soil concrete mix is 2% less than that of control mix at 28 days of curing.

6.The compressive strength of soil concrete mix for 100 mm cube is comparable at 1, 3 and 7 days of curing and attains nearly 100% strength with that of compressive strength of control concrete for 150 mm cube at 28 days of curing.

7.The split tensile strength of soil concrete mix is more than that of control mix at 1 and 7 days of curing while the split tensile strength for soil concrete mix is 10% less than that of control mix at 28 days of curing and attains 123%strength at 91 days of curing.

8.The flexural strength of soil concrete mix is more than that of control mix at 1 day of curing while the flexural strength for soil concrete mix is 8% less than that of control mix at 28 days of curing.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Akshay C. Sankh, Praveen M. Biradar, Naghathan. S. J and Manjunath B. Ishwargo, "Recent trends in replacement of natural sand with different alternatives", IOSR journal of mechanical and civil engineering (IOSR-JMCE), pp: 59-66.

[2] Anitha selva sofia S.D, Gayathri. R, Swathi.G, Prince arulraj. G, "Experimental investigation on quarry dust concrete with chemical admixture",International journal of latest research in science and technology, volume 2, issue 2, pp: 91-94, march - april (2013).

[3] Ansu John and Elson John, "Study on the partial replacement of fine aggregate using induction furnace slag", American journal of engineering research (AJER), Volume-4, pp: 01-05.

[4] Bai, H. Sharada. "Use of crushed rock powder as replacement of fine aggregate in mortar and concrete." Indian Journal of Science and Technology 4.8 (2011): 917-922.

[5] Bharathi Ganesh, Sharada Bai. H, Nagendra.R, Narendra.B.K, "Characterization of pond ash as fine aggregate in concrete", International conference on advances in architecture and civil engineering (AARCV 2012), 21st – 23rd June 2012.

[6] Eknath P.Salokhe, Desai.D.B, "Application of foundry waste sand in manufacture of concrete",IOSR journal of mechanical and civil engineering (IOSR-JMCE), pp: 43-48.

[7] Elavenil.S and Vijaya.B, "Manufactured sand, a solution and an alternative to river sand and in concrete manufacturing",Journal of engineering, computers & applied sciences (JEC&AS), February 2013.

[8] Ettu.L.O, Ibearugbulem.O.M, Ezen.J.C, Anya.U.C, "The suitability of using laterite as sole fine aggregate in structural concrete", International journal of scientific & engineering research, Volume 4, Issue 5, May-2013.

[9] Gaurav Kantibhai Patel and Jayeshkumar Pitroda, "Effect of pond ash and used foundry sand on the mechanical properties of concrete", Journal of international academic research for multidisciplinary, Volume 2, Issue 3, April 2014.

[10] Lavanya M.R, Sugumaran.B, Pradeep.T, "An experimental study on the compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash",International journal of engineering inventions, Volume 1, Issue 11, pp: 01-04.