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Analysis and Modelling of Reinforced Concrete Beams

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Abstract: ***The work is to understanding the behaviour of structural components like beams and columns during loading is crucial for the development of efficient and safe structures. In this report, the reinforced concrete beam has been analyzed and modelled when subjected to two-point loads and single-point load conditions, using the Finite Element Analysis tool, popularly called ANSYS software. The analyzed and modelled beam has a dimension of 500mm × 100 mm × 100 mm with 2 numbers of 8mm diameter bars are main reinforced, and 2 numbers of 8 mm diameter are hanger bars. The behaviour of the analysed beam has been observed regarding the shear behavior, crack widths and displacement for various static loading. According to the analysis carriedout on the Reinforced Concrete beams using ANSYS, it is observed that results are more profound to reinforcement size, materials properties, load percentage increment, etc.***

Keywords**:** ***Concrete, Steel Fibers, Manufactured Concrete, Software.***

I. INTRODUCTION

1.1 Introduction To Ansys

The Ansys finite element solvers enable a breadth and depth of capabilities unmatched by anyone in the world of computer-aided simulation. Thermal, Structural, Acoustic, Piezoelectric, Electrostatic and Circuit Coupled Electromagnetics are just an example of what can be simulated. Regardless of the type of simulation, each model is represented by a powerful scripting language [2] the Ansys Parametric Design Language (APDL). APDL is the foundation for all sophisticated features, many of which are not exposed in the Workbench Mechanical user interface. It also offers many conveniences such as parameterization, macros, branching and looping, and complex math operations. All these benefits are accessible within the Ansys Mechanical APDL user interface. [5] ANSYS provides you with the ability to apply the technology at a level that is appropriate for the size of the problem, execute it on a full range of computing resources, based on what's appropriate and available, and finally the ability to deploy the technology within your company's user community. [4]

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ANSYS is a Mechanical finite element analysis software usedto simulate computer models of structures, electronics, or machine components for analysing strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes.

1.2 Introduction To Concrete

A cement is a binding material used for constructions that sets, hardens, and adheres other materials to bind them together. Cement was first developed by Joseph Aspdin, an enterprisingin 19th century British stonemason, who heated a mix of clayand limestone in his kitchen stove, then pulverized it into a fine powder.

[1] The hydraulic cement hardens when water is added. The Aspdin dubbed his creation Portland cement due to its similarity to a quarried stone on the Isle of Portland, off the British coast. In 1824, this brilliant craftsman obtained a patent for what would prove to be the world's most demanding building material, laying the foundation for present global Portland cement industry. Modeling an element for the performance of concrete is a challenging task. Concrete is aquatic brittle material by 8-15% of the compressive strength. The modulus of elasticity of concrete is considered as 27386MPa as per IS 456:2000. Poisson's ratio is 0.2. The shear transfer coefficient for open crack and closed crack are 0.3 and 0.95 respectively. Uniaxial tensile cracking stress is found using IS 456:2000 and is 3.834MPa.

1.3 Introduction To Materials

1.3.1 Cement:

The Indian cement industry are nearly 93 years old. The first plant was established in 1913 with an annual capacity of approximately 100t/a. The growth of cement industry in India have seen many a boom and slack period. The most drastic being the shift from the "control regime" to "free regime" in year 1989. The cement and concrete industry have witnessed both quantitative as well as qualitative growth in the free regime, which continues till now. The paper reviews the history of this growth in three sections namely;

(1) Cement industry: the growth from control to free regime,
(2) Energy materials intensive to efficient and sustainable cement manufacture,
(3) Preference of construction industry from high strength concrete to durable, high performance concrete.

Cement is rarely used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate to produces mortar for masonry, or with sand and gravel to produces concrete. Concrete is the most commonly used material at present and is next only to water as the planet's most-consumed resource.

1.3.2 Fine aggregate:

Fine aggregate is a coarse material composed of finely separated rock and mineral particles. Sand has many compositions but it is defined by its grain size. Sand grains are minor than gravel and coarser than silt. FA can also be denoted to a textural class of soil.

1.3.3 Coarse Aggregates: -

Coarse aggregates are uneven broken stones or naturally arising round gravels that are used to create concrete, coarse aggregates for structural concrete contains of broken stones of hard rock such as granite and limestone (angular aggregates) or river gravels (round aggregates). Aggregates bigger than 4.75mm in size will be termed as coarse aggregates. The aggregates are acquired from stone quarries and stone crushers, the size between 4.75mm to 60 mm. Constructional aggregate, or normal aggregate, is a extensive category of coarse to medium grained particulate material used in construction with sand, crushed stone, recycled concrete, slag, and geo-synthetic aggregates.

1.3.4 Steel:-

Steel was known in ancient times and was produced in bloomers & containers. The primary steel is produced in fragments of ironware mined from an archaeological site in Anatolia (Kaman-Kalehoyuk) and are approximately 4,000 years old, from about 1800 BC.

Steel is an alloy made up of iron with usually a few tenths of a percentage of carbon to progress its strength and fracture resistance related to other forms of iron. Stainless steel that are corrosion & oxidation resistant need typically a supplementary about 11.00% chromium.

II. LITERATURE REVIEW

1. Shaishav R. Viradiya, Tarak P. Vora have carried out the research work to simulating the behaviour different modeof failure for RC beams strengthened in flexure and twobeams were modelled by FEM software using Ansys. From the analysing the load vs. deflection relationships,crack pattern, first crack load and Ultimate failure load was obtained and compared with the experimental resultsobtainable in Literature survey. In experimental the beams were casted with grade M25of size 230X300mm with span length of 2000mm with reinforcement of 2-12mm at bottom and 2-10mm at top with 8mm stirups @ 250mm c/c.by the work it is determined that theultimate load carrying capacity of the SFRC beams higher compared to normal concrete beams. The final loads from the finite element analysis are higher than theultimate loads from the experimental results. Load vs. Deflection behavior is almost similar for experimentally& analytically.

2. Dr. E.K. Mohanraj and Bhuvaneswari. K have studiedthe partial replacement of fine aggregate by manufactured sand and conducted study on the load vs. deflection curve and stress vs. strain curve compared with Ansys software and also mechanicalproperties of concrete by fly ash and recycled coarse aggregate were partially replaced also compared. Five different concrete mixes having partial replacement of natural sand by m-sand wereprepared for compressive test, split tensile test and flexural test. The beams of sizes 1200 x 100 x 150 mm and 1200 x 150 x 230 mm were casted for 20% replacement of fine aggregate to M-Sand and their load deflection curve, their first cracking load and Ultimate Load were found by testing the specimensin UTM. They have concluded that the compressive strength, split tensile strength and flexural strength of concrete with replacement of natural sand by manufactured sand reveals higher strength. For both experimental and Ansys the load deflection charactertics value shows increasingly as percentageof M-sand is increased.

3. P.Jayajothi et al have worked on Non-linear finite elements analysis for the mode of failures I RC beams under flexure and shear for fiber reinforced concrete polymer laminates. In FEM software Ansys the modelling have been done for four beams. Out offour beam, two beams were casted without FRP that is convention concrete and other two beam are strengthened by (CFRP) carbon fiber reinforced polymer. The results obtained from software have been compared with the experimental results from the literature study. The load-deflection is plotted for quarter span for modelling by taking an advantage ofsymmetry of the beam. The behavior difference is observed for beams with and without CFRP. They have concluded that the ultimate load carrying capacity of strengthen beam is more compared to control beam. The CFRP for strengthen beam exibitsincrease in flexural strength by 18 to 20 percent andthe overall behavior of RC beams shows very near results by software compared with experimental work.

4. Osman M. Ramadan,Sayed M have worked on the nonlinear behavior of reinforced concrete beams canbe simulated by the three dimensional ANSYS modeling. The analysis of reinforced concrete members by finite elements method and ANSYS computer program could save a lot of money, time and effort and give a chance to study aspects whichwas hard to be conducted in the experimental studies. Based on the analysis of the experimental and theoretical results, the following remarks can bemade

5. S.P.Sangeetha and P. S. Aravind Raj have studied gives the development of new eco-friendly binding material in concrete. Use of industrial waste products protects the environment and safeguards natural resources. Recycle of the slag supports to protect the environment from pollution. It is detected that up to 50% partial replacement of Ordinary Portland Cement with GGBS gives optimum performance based on the above said parameters and economy. The experimental results were found that the analytical results were in good settlement with the experimental and compared with analytical results found by ANSYS analysis and it was flues.

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6. Dhiraj Ahiwale et al have studied on the mild steel cantilever beam with a length of 3m span, a width of 250mm and 200mm depth. The modal analysis of cantilever beam is performed by the analysis of the beam at 0.5m, 1m, 1.5m, 2m, and 2.5m from top, middle and bottom faces of the beam. The crack width and depth for the individual beams are determined and are validated with help of finite element analysis simulation software Ansys. The results of theoretical and experimental results are approximately same. The crack in beams suggest that the top and bottom of the beam crack decreases and crack in the middle of the beam remain constant. They have concluded that the crack varied based on mode of vibration. They also concluded that the crack shifts from fixed end to free end of the cantilever beam. So, the beam failure can be prevented by the information from this work

III. OBJECTIVES

The objectives considered on the bases of the literature papers we studied.

- To study the physical properties of the materials
- To study the compressive ,shear strength of concrete
- Comparative study of reinforced concrete beam with ansys software

IV. MATERIALS AND METHEDOLOGY

Table-1: Physical Properties of Cement

SL. No	Properties	Test Results	Permissible Limit
1	Normal consistency	33%	Less than 35%
2	Initial Setting Time	30min	Minimum of 30min
3	Final Setting Time	600min	Maximum of 600min
4	Specific Gravity	3.15	3.1 to 3.6

Table-2: Physical Properties of Fine aggregate

Sl. No	Properties	Test Results
1	Fineness modulus	2.94
2	Specific gravity	2.82

Table-3: Properties of Coarse aggregate

Sl. No	Item	Test Result	Permissible Limit
1	Specific Gravity	3	2.5 – 3.0
2	Water Absorption	1.14%	0.1 – 2%
3	Aggregate Impact Value	17.24%	10 -20% (Strong)

Table-4: Properties of Steel

Properties	Units
Diameter(mm)	8
Elastic Modulus(GPa)	210
Yield Strength(MPa)	240
Ultimate Strength(MPa)	385
%Elongation (%E)	15.56

V. MIX DESIGN

Concrete mix design is the practice of selecting appropriate constituents of concrete and determining their comparative amounts with the objective of producing a concrete of the required workability, strength and durability as economically as possible. The amount water required can be determined by referencing table 2 of IS 10262:2009. The water content have tabulated according to slump of about 25-50mm. the workability is the vital thing for determining the water content and cement content. The aggregates majorly depends on the water to cement ratio. [3] [6] According to the materials available during the work, the physical properties were determined and proper mix deign isprepared. The mix design of concrete M25 is done as per IS code IS 10262:2009.

Table-5: Mix Design Ratio for M25

ITEM	Kg	Ratio
Cement	419.14	1.00
Fine Aggregate	1161.01	2.77
Coarse aggregate	1592.73	3.80
Water	197.00	0.47

VI. RESULTS AND DISCUSSION

Table-6: Compression strength of concrete

Compressive Strength (N/mm^2)	
7 DAYS	28 DAYS
18.77	31.54
18.60	32.46
17.83	32.00

Figure 1: Beam setup for test

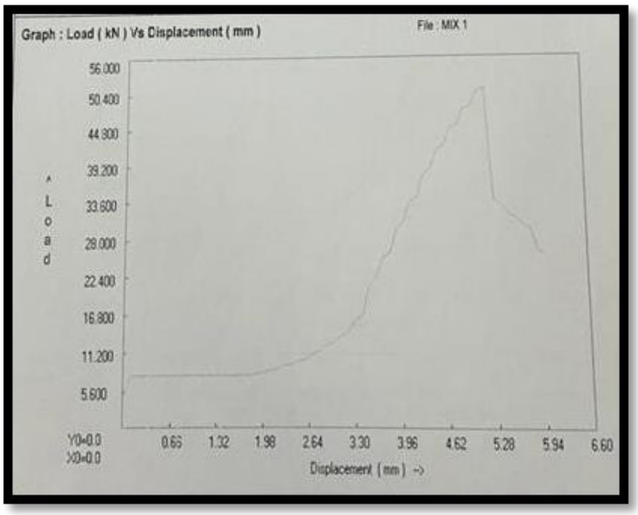

Figure 2: Load vs Deflection of Beam

Table-7: Shear strength of reinforced concrete

Days	Sample	Ultimate Load (KN)	Shear Strength(n\mm^2)
7 days	1	33	3.3
	2	32	3.2
	3	49	4.9
28 days	4	60	6
	5	49	4.9
	6	55	5.5

Table-8: Shear strength of reinforced concrete

Days	Sample	Ultimate Load (KN)	Shear Strength(n\mm^2)	Maximum Displacement(mm)
28 days	MIX 1	51.3	3.3	5.3
	MIX 2	47.85	3.2	3.3
	MIX 3	38.91	4.9	1.9
	MIX 4	48.08	4.8	3
	MIX 5	55.44	5.5	4.2
	MIX 6	38.76	3.8	1.8

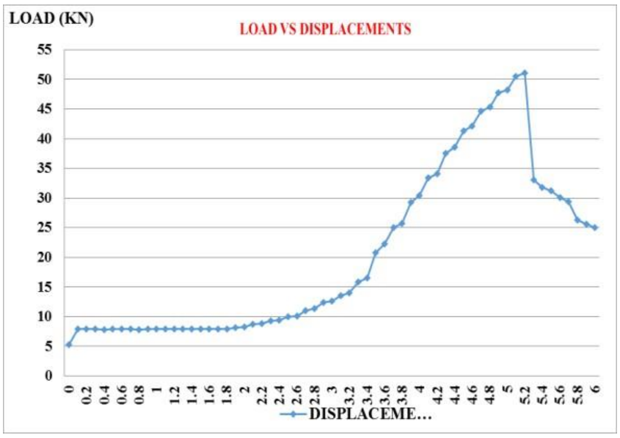

Figure 3: Load vs Deflection through software

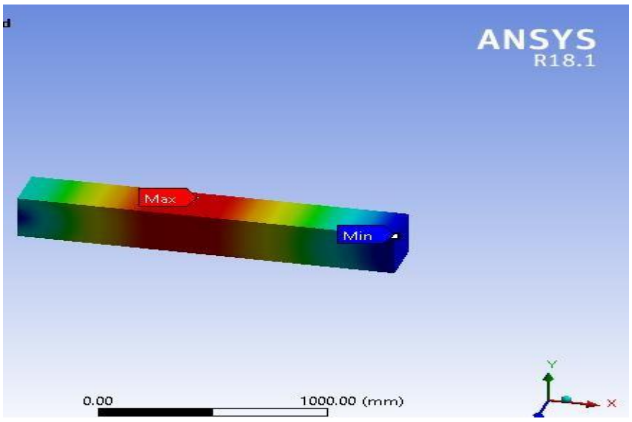

Figure. 4: Analysis of beam from software

Table-9: Final results using ansys

Sl. No	Property	Simply Supported Beam
1	Deformation (mm)	5.2
2	Ultimate load (kn)	51.06
3	Shear Strength (n\mm^2)	5.106

VII. CONCLUSION

1) By the work we conclude that the comparative study of experimentally and analytically results shows similar results.
2) The analytical results obtained shows the satisfactory results for different mixes compared with experimental results.
3) The experimental for single point load and two point loadnearly merge with analytical results.
4) Due to addition of reinforcement in prism loads to increase the strength of concrete and tends to fail in shear

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Mr. Pradeep Kumar Reddy is Currently working in faculty of engineering and technology in sharnbasva university Kalaburagi as assistant professor with teaching experience of 8 years with one year of field experience. Have pursed B. E, MTech in civil engineering from Visvesvaraya technological University. Presently research work been undergoing in Visvesvaraya technological University on steel fiber reinforced concrete. Have undergone research work on steel fiber reinforced concrete. Have published various national and international papers and conferences on steel fiber reinforced concrete. Further he is doing his research work on steel fiber reinforced concrete for various parameters. He is also the reviewer of JERR.

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