

“EXPERIMENTAL INVESTIGATION ON PRECAST TEE BEAM USING LECA”

Submitted in partial fulfillment of the requirements for the award of
Master of Engineering Degree in Structural Engineering

by

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INSTITUTE OF SCIENCE AND TECHNOLOGY
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **D DEEPAK KISHORE (39380004)** who carried out the project entitled “**EXPERIMENTAL INVESTIGATION ON PRECASTTEE BEAM USING LECA**” under my supervision from November 2020 to April 2021

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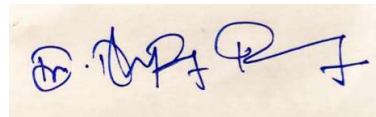
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DECLARATION

I **D DEEPAK KISHORE** hereby declare that the Project Report entitled “**EXPERIMENTAL INVESTIGATION ON PRECASTTEE BEAM USING LECA**” done by me under the guidance of **Mr. J. VANJINATHAN** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in partial fulfillment of the requirements for the award of Masters of Engineering degree in Structural Engineering.

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ABSTRACT

Light-weight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving additional qualities like lessened the dead weight. It's lighter than the conventional concrete .The Structural light weight concrete as we call is a concrete whose density varies from 1400 to 2000 kg/m³ . Light expanded clay aggregate concrete to reduce the density of structural concrete member . It reduces the weight of concrete , cost of concrete by reducing the aggregate cost and produces economic infrastructure system . Lightweight concrete cubes, cylinders are casted and tested for determining compressive strength, split tensile strength, and obtain the results are compared with the control specimens. LECA Aggregates LECA means Light Expanded Clay Aggregate. LECA consists of small, lightweight, bloated particles of burnt clay. Air-filled cavities in LECA give its strength and thermal insulation properties.

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CHAPTER- 1

INTRODUCTION

1.1 GENERAL

1.1.1 Beam

Pillar is a primary component that is equipped for withstanding load. Shafts for the most part convey vertical gravitational powers, however can likewise be utilized to convey even loads. The twisting power initiated into the material of the pillar because of the outer burdens, own weight, range and outside responses to these heaps is known as a bowing second. Bars are portrayed by their profile (state of cross-area), their length, and their material. Most pillars in supported solid structures have rectangular cross areas, however a more proficient cross segment for a shaft is an I or H segment which is regularly found in steel development.

1.1.2 Flexural Behaviour of Reinforced Concrete Beams

Consider an essentially upheld pillar exposed to continuously expanding load. In the beginning phases of stacking, the applied second is not exactly the breaking second M_{cr} and the most extreme malleable pressure in the solid is not as much as its flexural elasticity f_{cr} . This stage is the uncracked stage (Fig. 1), wherein the whole area is successful in opposing the second and is under pressure.

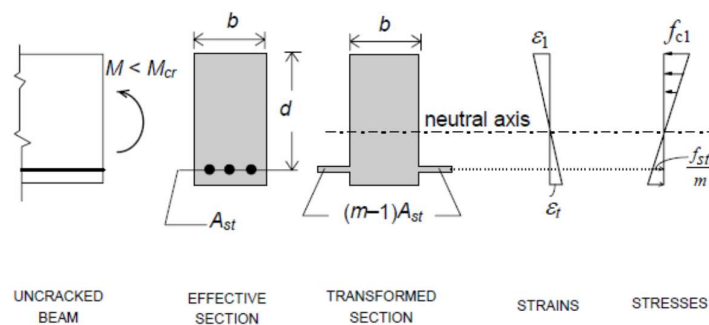


Fig. 1.1 Uncracked phase (Source: Pillai et al 2003)

As the applied second surpasses M_{cr} , the most extreme ductile pressure in concrete surpasses the flexural elasticity of concrete and the segment starts to break on the strain side. The breaks are started in the base (malleable) filaments of the bar, and with expanding stacking, extend and proliferate steadily towards the nonpartisan pivot. As the broke part of the solid is presently delivered insufficient in opposing tractable burdens, the viable solid area is diminished (Fig. 2). The strain opposed by the solid only before breaking is moved to the building up steel at the broke segment of the shaft.

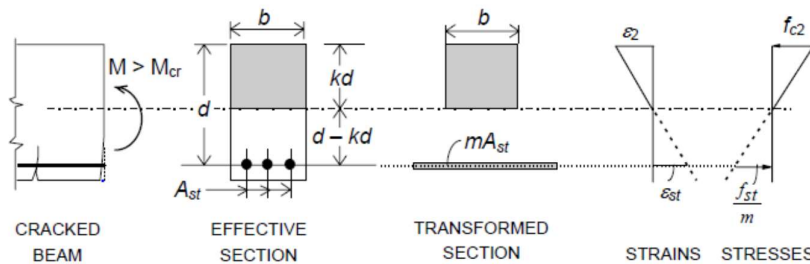


Fig. 1.2 Cracked phase (Source: Pillai et al 2003)

On the off chance that the steel substance of the segment is little, the steel will arrive at the yield strength f_y before the solid arrives at its most extreme limit. As the heap is expanded it causes enormous plastic lengthening of the steel across the flexural breaks, bringing about wide breaking and huge expansion in the resist the limit pressure fiber of the solid. With this increment in strain, the conveyance of compressive pressure in the solid gets nonlinear; bringing about an increment in the mean pressure in the compressive pressure block and, to keep up balance of the inner powers, a decrease in the unbiased pivot profundity happens. The decrease in the nonpartisan hub profundity causes a slight expansion in the switch arm, subsequently at the time of obstruction. Consequently accomplishment of the yield point in the steel decides the conveying limit of the supported pillars. Such yield disappointment is steady and is gone before by noticeable indications of pain, like the extending and stretching of breaks and the checked expansion in redirection. This kind of disappointment is alluded to as pressure disappointment.

Then again, if the steel substance of the part is enormous, the compressive strength of the solid might be depleted before the steel begins yielding. Concrete comes up short by squashing when strains become so enormous that they disturb the uprightness of the solid. Pressure disappointment through pulverizing of the solid is unexpected, and happens abruptly. Therefore, the shafts ought to be dimensioned in such a way that in the event that they over-burden, disappointment would be started by yielding of the steel instead of by squashing of the solid.

1.1.3 Stresses in Beams

Inside, transmits experience compressive, manageable and shear stresses as a result of the stacks applied to them. Shear stresses are ordinarily acting at the assistance of the bar. Routinely, under gravity stacks, the primary length of the shaft is possibly diminished to encase a more unassuming breadth roundabout fragment at the most elevated place of the column, achieving pressure, while a comparable novel bar length at the lower some portion of the bar is fairly stretched out to encase a greater range bend, as is under strain. A comparable interesting length of the focal point of the bar, generally somewhere close to the top and base, is identical to the extended bend of winding, in this way it is feeling the squeeze nor strain, and describes the unprejudiced turn. Absurd, the bar is introduced to shear pressure.

Bending Of Beams

Supported solid pillars are non homogenous in that they are made of two completely different materials. The strategy utilized in the examination of supported concrete radiates are consequently not quite the same as those utilized in the plan of bars made out of steel or some other primary material. The principles included are as per the following.

At any cross area there exist inside powers that can be settled into two segments ordinary and distracting to the part. Those segments that are ordinary to the part are the bowing anxieties and their function is to oppose the bowing second at the segment. The unrelated parts are known as the shear focuses on promotion they oppose the shear powers.

Fundamental assumptions relating to flexure and flexure shear are as follows:

- 1) A cross section that was plane before loading stays plane under load.
- 2) The bending pressure anywhere relies upon the endure that point in a manner given by the pressure strain chart of the material.
- 3) The dispersion of the shear stresses about the profundity of the segment relies upon the state of the cross area and of the pressure strain graph. These shear stresses are at biggest at the impartial pivot and equivalent to zero at the external filaments.
- 4) Owing to the joined activity of shear stresses and flexure stresses, anywhere in a shaft there are slanted burdens of pressure and pressure, the of which from a point of 90 degree with one another.
- 5) Since the flat and vertical shearing stresses are equivalent and the flexural stresses are zero at the neutral sheet, the slanted elastic and compressive burdens anywhere in that plane structure a point of 45 degree with the even, the power of each being equivalent to the unit shear at the point.
- 6) When the burdens in the external strands are more modest than as far as possible, the pillar acts flexibly.

There are two modes failure modes of RC beams.

- (i) Flexural failure
- (ii) Shear failure

1.1.5.1 Causes for the Failure in RC Beams

Built up solid pillar regularly go through underlying adjustment and improvement of their exhibition during their administration life. The commitment factors liable for this change territory, change of use, absence of legitimate development practice, plan principles and details and so on Every one of these components render existing construction lacking in their heap conveying limit and lead to disappointment of designs.

1.1.5.2 Flexure Failure

Flexural disappointment of a shaft is malleable in nature. It happens slowly withenormous avoidances and breaking which give an admonition of beginning disappointment.



Fig 1.3 Flexural failure

1.1.5.3 Shear Failure

Shear disappointment is fragile in nature and doesn't permit generous reallocation of burdens and it happens with no earlier notice and is regularly calamitous.

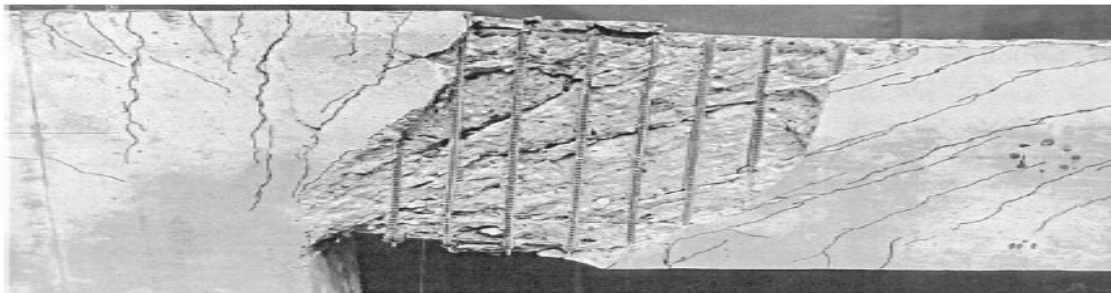


Fig 1.4 Shear failure

1.1 BACKGROUND

There is a huge and developing requirement for the fortifying of existing supported cement (RC) structures. The prerequisite to fortify a current solid construction may emerge for an assortment of reasons. Underlying decay may have occurred, an adjustment being used could bring about more colossal stacking, or

plan necessities in building regulations may change. There is a requirement for strategies that can give financially savvy answers for both the plan and execution of reinforcing measures. The different reinforcing strategies being broadly followed to retrofit different underlying components are segment broadening, fortified steel plating, outside post-tensioning, FRP composites wrapping, jacketing, holding FRP plates, holding with pre-assembled RC plate, ferro concrete jacketing. The current methodology have certain natural negative imprints, as huge cost, inconvenience in execution, decline in headroom, loss of elegant worth, development in self-weight, wary surface game plan, unexpected de-holding dissatisfaction, etc To beat all the above disservices, the strategy of external help was from the outset concentrated by a gathering of researchers headed by Cairns by keeping the external bars by the sides and at the level of the ebb and flow strengthened bars (1995, 1997, 2002, 2003-a, 2003-b). In any case this procedure has a couple of shortcomings, similar to disappointment of the external bars to acknowledge the twisted profile as that of the bar under redirection, necessities of diverters for light emanations length/significance extents to avoid the abatement in effective significance of outside bars as redirection extends, strengthening of end zones blueprints by projecting in extra help at the terminations to go against the concentrated weight from the weights. To conquer the above inadequacies a specialized headway was given by Kothandaraman and Vasudevan (2010) to impact the fortifying framework by keeping the outside support at the soffit of the bar without the utilization of redirectors. The other specialized benefits are that these outer bars will at the same time achieve the curve while the pillar is exposed to flexural powers. The bars will be kept simply contacting the outside of the pillar soffit. After the underlying avoidance, the strain on the outside bars would be constrained by the frictional holding created along the contact surface. This holding would be expanding as redirections increment. Along these lines the degree of benefit (extreme strength) that could be accomplished out of this technique would be higher than that could be accomplished by the old strategy. In spite of the fact that this strategy has various benefits, the conduct of the remotely built up pillar isn't contrasted and a bar in which whole support is implanted. The proposed study is basically to look at the flexural conduct of remotely built up bar and the traditional pillar with whole support implanted.

Physical and mechanical properties of light-weight underlying high-strength solid utilizing LECA, in precast portions, Floors and parcel dividers, was considered. The littlest scope of LECA 15 mm was utilized. The sand utilized was either 0-5 mm normal or tempest sand. Admixtures utilized were CNT(carbon nano tubes). Tee beam,cubes and tube shaped examples were made for testing following 7 and 28 days of relieving in bath.In T-segments, the heaviness of each portion was diminished around 30% plan. At long last, the diversion of precast chunks under a uniform burden was tried and controlled agreeably.

1.2 OBJECTIVE

- To make use of eco-friendly light weight concrete for a faster construction.
- To reduce the self-weight of concrete.
- To achieve strength as per nominal concrete.
- To reduce water permeability.
- To study a behaviour of double tee slab experimentally.
- To Break down the solid in new state also in solidified state and assess physical and mechanical properties of cement

1.4 SCOPE

- Double Tee slabs are casted for a scale ratio of 1:10.
- Light weight concrete using LECA is used for casting.
- Carbon nano-tubes is used for achieving strength.
- LECA is highly impermeable material which is used for reducing water permeability and self weight.
- Replacement of total by LECA of thickness like 1996kg/m³ - 2597kg/m³ .
- Reduces the greatness of concrete, cost of concrete by diminishing the all out cost produces traditionalist system.

1.5 NEED FOR STUDY

- Self weight of the structural elements are reduced.
- Strength of the element is improved.
- Either Partial or fully replacement of aggregate.
- Cost of construction is minimized.
- Faster construction.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

In this part examines dependent on trial examinations to fortify built up solid section by unbonded outer support are checked on and introduced.

2.2 REVIEW OF WORK DONE BY EARLIER INVESTIGATORS

Cairns and Zhao (1993) have portrayed the progressions in underlying conduct because of uncovered support dependent on the standards of harmony of powers and similarity of misshapenings. They announced the aftereffects of 19 actual tests and of mathematical demonstrating of shafts with fortified and with uncovered support. Four distinctive disappointment modes specifically flexure, shear, pulverizing of cement on the strain face close to the closures of the uncovered length of bar and end dock were addressed in the examination. They saw that the shear disappointments didn't happen inside the uncovered length. A half misfortune in strength was found for a shaft with 1.5% support, uncovered more than 90% of the range, however there was no misfortune in strength for a pillar with 0.5% support uncovered over comparative extent of length. Mathematical model was additionally evolved to foresee the strain conduct, disappointment loads with explicit guides to assess loss of solidarity on openness of support and to assess the length of bar which might be uncovered without misfortune

Cairns (1995) have considered the appraisal of shear strength of bars with a piece of the longitudinal help uncovered over portions of the reach. A strategy for investigation, in light of existing semi-observational standards in BS 8110, was proposed to assess a commitment from uncovered bars. The investigation proposed that shear strength is expanded when support is uncovered in everything except the most gently built up areas. He has announced the subtleties of a progression of research facility tests and was shown that outcomes are sensible and at times moderate gauge of solidarity. Taking everything into account he has expressed that the support may give a critical commitment to the strength of built up solid bars, in

spite of being debonded from the part, given the finish of the bars are sufficiently moored. Materialness of the strategy is limited to radiates in which close to a large portion of the longitudinal pressure bars are uncovered. His discoveries offered expected investment funds by giving a more exact strategy to evaluation of the heap conveying limit of supported solid bars debilitated by the evacuation of cement around the pressure support while under underlying fix.

Cairns and Rafeeqi (1997) have examined the conduct of built up solid bars fortified by remotely unbonded support. They performed scientific investigation utilizing the typical harmony conditions (power and second balance) and similarity conditions over the length of the pillar. Limited component study has been directed on just upheld radiates with two-point stacking (four-point bowing). Their exploratory examination included the lead of 21 tests, in which 6 tests were taken to disappointment. Three arrangements of shaft examples with each set containing two examples were projected. Inside each set, the primary pillar filled in as a source of perspective example, and was routinely supported with fortified support. The second light emission set was ostensibly indistinguishable from the first, however was tried with extra unbonded outer support moored uniquely toward the finish of the bar. All pillars were definite to guarantee flexural mode disappointment. Their examination showed that arrangement of extra unbonded outside support builds the flexural limit of up to 85%. Higher the level of fortified support, lower is the increment in strength. In spite of the fact that malleability was decreased in radiates, underlying breaking gave adequate admonition of primary misery. They have shown that, contingent on different elements including mathematical proportion of support and type of stacking, it could be possible to twofold a definitive strength of a pillar by giving outside unbonded support.

Cairns and Rafeeqi (2002) have portrayed a technique for fortifying solid pillars by outside unbonded support. The outer bars of same evaluation as that of conventional bars are delicately tensioned to beat droop, and are not prestressed. „Deflectors“ were fitted along the reach to ensure that external bars follow the redirected profile of the shaft, and in this route keep up the effective significance of external bars. They have given the essential direct of bars braced with unbonded outside help using a lot of seven lab tests, maintained by numerical model. The results were differentiated and two reference.

Models. Despite the way that the flexural strength of the developed strong shaft got extended, taking into account the deficit of composite correspondence between outside bars and the bar region, the flexural strength had never outperformed that possible with a comparative proportion of help clung to the part. It was additionally added that the expansion in extreme flexural strength relied upon the first space of support. They have expressed that great efficiencies can be accomplished when fortifying delicately supported pillar areas, yet with all the more vigorously built up segments just restricted strength improvements are achievable. Trial results showed semi-arbitrary nature of breaking in solid in this way showing unassuming improvement in functionality. A mathematical model for radiates retrofitted with outside unbounded had been created, in light of displaying direction introduced in CEB-FIP Model code 90. The model anticipated upgrades in extreme strength precisely, yet was less effective in the forecast of redirection.

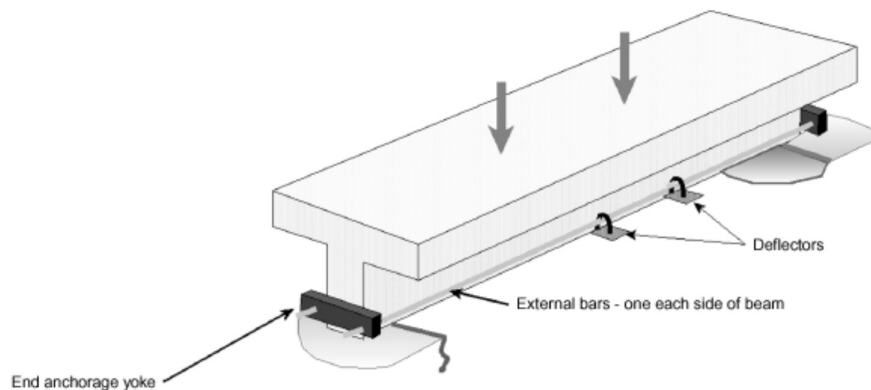


Fig. 2.1 Strengthening of RC beam with external reinforcement with deflectors (Source: Cairns 1995)

Cairns and Rafeeqi (2003) have given an overall depiction of underlying conduct of bars fortified utilizing the procedure of outside support. Consequences of 27 actual tests on fortified supported solid shafts were accounted for and contrasted and eight reference examples. Their previous paper depicted the utilization of diverters all together that the outside bars to follow the arch of the first pillar and the outcomes are accounted for. This paper portrayed crafted by actual testing and related demonstrating to additionally investigate the abilities of the procedure and to decide the conditions under which redirectors ought to be introduced with an intend to administer the utilization of diverters. Of the 27 reinforced examples, six examples were tried with redirectors fitted, and the rest of without. They expressed that when

diverters are not fitted, powerful profundity of outside bars diminished as diversion expanded. All in all they revealed that the normal increase in firmness for redirector examples was 18% marginally more noteworthy than the 15% improvement acquired from buddy examples not fitted with diverters. They have shown that the strategy can give more noteworthy strength upgrade to softly built up segments and that arrangement of redirectors improves proficiency. The threat of abrupt breakdown was discovered to be no more prominent than that for comparable expectedly supported bars.

Cairns and Rafeeqi (2003) built up a mathematical technique dependent on segment examination, fusing non-straight material conduct and non-direct mathematical impacts. The model was first approved against trial results involving 35 actual tests on research center examples [8], at that point used to enhance the exploratory investigation by investigating boundaries which couldn't get sufficient test inclusion. Impacts of the state of the bowing second outline and range/profundity proportion were accounted for. Redirectors were regularly determined to doubly reinforce at more limited range/profundity proportions; the advantages were more noteworthy with higher proportions.

In view of the mathematical examination they come to the accompanying end results:

- The mathematical model anticipated a definitive strength precisely, yet was less effective in the forecast of diversion.
- Failures are begun in after three particular habits (a) when external bars show up at yield (material strength outperformed); (b) when strong beginnings crush (material strength outperformed); and (c) when effects of the speed of development in redirection on switch arm of outside bars moves toward the effects of the speed of extension in external bar power. All the above frustrations are joined by crushing of concrete in the pressing factor zone. By virtue of delicately upheld fragments and fortresses with low adaptability, it is moreover possible that mistake could begin through break of built up help. The mathematical model has been utilized to explain the impact of the state of the bowing second

graph on strength improvement.

- The stress-strain qualities of cement don't impact the strength upgrade where redirectors are fitted, yet may do as such in their nonattendance.
- The extra advantage given by diverters shifts, however as they are of light development and establishment is clear their utilization will be worthwhile in most of the circumstances.

Kothandaraman and Vasudevan (2010) have examined the flexural conduct of RC radiates fortified by outside support at soffit. A sum of twenty shaft examples were cast of which six bars were reference radiates with flexural and shear building up steel and without outside supporting steel and the other fourteen pillars were fortified by outer supporting bars, and tried for four point stacking. They presumed that,

The moment carrying capacity can be substantially improved by their proposed technique.

- In instance of under built up areas the increment in second conveying limit might be upgraded as high as 70%.
- Initial breaking second is expanded from 19% to 64 %.
- The second at yielding of inside steel is expanded from 24 % to 131 %.
- The extreme second limit with respect to the retrofitted radiates is expanded from a day and a half to 140 %.
- The redirection malleability expanded to a limit of 19 %.
- The proposed technique for fortifying the R.C. radiates is discovered to be viable and benefits mulling over of burden conveying limit, pliable conduct, break control and conservative contemplations. This method is attainable for reasonable application.

Vasudevan.G and Kothandaraman.S (2013) introduced the extensive exploratory examination on the utilization of non-prestressed outside supporting bars at soffit of the RC radiates for upgrading the flexural strength. The revealed procedure proposed by them utilizes outside supporting bars at the soffit, which disposes of the need of diverters, and the mooring was finished by embracing an exceptionally

basic method, which takes out the utilization of mechanical securing gadgets. The outside support strategy proposed by the creators has benefits like speed and effortlessness of establishment; insignificant interruption to use during establishment; utilization of practical materials; negligible surface planning of solid substrate; no de-holding request overlay disappointment issues as knowledgeable about fortified plates and FRP covers. Likewise, this strategy holds a large number of the benefits of outside unbonded pre-focused on ligaments, yet disposes of the tedious focusing on activities.

It was noted from the starter examination by the creators that, at the hour of fixing the outer bars, little trouble was knowledgeable about legitimate fixing of bars at the finishes because of the twist curve of the outside bars. This minor disadvantage was dispensed with in this investigation by making a little oval molded score at the highest point of the opening utilizing the boring machine. Furthermore, the slackness in the outside bars as experienced during the primer test examination was nearly killed by making an oval molded notch at the twist segment of the end jetties the length and profundity of the depression was kept as almost 50 and 25 mm.

The result observed by the authors

- a. It was seen that the greatest break width for the reference radiates at extreme burden levels came to 4.0–5.0 mm while for the shafts retrofitted with extra outer bars it was just 1.0–1.5 mm.
- b. During the exploratory testing of shafts with extra outside bars at the soffit, just better breaks were noted during different phases of stacking. For the retrofitted bar examples just dainty noticeable makes were seen laugh uncontrollably to almost 80 % of a definitive burdens and the breaks were out of nowhere enlarged to 1.0–1.5 mm while arriving at a definitive disappointment. Consequently by the arrangement of extra outside building up bars at the soffit, the widths of the flexural breaks were fundamentally diminished at the assistance load levels. Breaks were likewise noted at the securing areas of outer bars at a definitive disappointment of the shafts.
- c. The safe haven disappointment, may even in specific cases control the limit of the shafts with outer bars. The mooring disappointment could be disposed

of by giving extra harbor poles at appropriate stretches or by some other reinforcing technique. A definitive second limit of the retrofitted radiates expanded from a day and a half 140 % by the arrangement of outer bars at the soffit. The rate expansion in extreme limit likewise shifts as for evaluation of solid, level of interior bars and outside bar to inner proportion. It is additionally noticed that, the rate expansion in extreme second limit is more for radiates with lesser level of inside support.

Based on the results of the experimental investigation, the following conclusions are arrived.

- Cracks are slender and firmly divided for remotely supported shafts when contrasted with the reference radiates.
- Initial breaking second is expanded from 19 to 64 %by the arrangement of extra outside bars at the soffit.
- The greatest break width at a definitive stage is in the scope of 1.0–1.5 mm for the remotely built up radiates when contrasted with 4.0–5.0 mm
- The second at yielding of inner steel is expanded from 24 to 131 % by the arrangement extra outside bars.
- The rate acquire in steel yielding second limit continuously decreases as the level of interior support increments.
- a definitive second limit with respect to the retrofitted radiates is expanded from a day and a half 140 %by the arrangement of outside bars absent a lot of loss of malleability.
- This method could be abused to the most extreme degree on account of pillar individuals with daintily (under) built up radiates. Lesser the space of inserted Steel more will be the specialized benefit.

2.3 SUMMARY OF THE LITERATURE

Retrofitting a construction broadens the life expectancy of the design, decrease the utilization of crude materials, and lessen the effect on a worldwide temperature alteration issues. The different retrofitting methods being generally followed to retrofit different underlying components are area amplification, reinforced steel plating, outside post-tensioning, FRP composites wrapping, jacketing, holding FRP plates, holding with pre-assembled RC plate, ferro concrete jacketing. The current strategies have certain inherent awful checks, as tremendous cost, inconvenience

in execution, decline in headroom, loss of sharp worth, development in self-weight, careful surface plan, surprising de-holding disillusionment, etc .To defeat all the above disadvantages, the method of outside support was at first concentrated by a group of scientists headed by Cairns (1995, 1997, 2002, 2003-a, 2003-b) by keeping the outer bars by the sides and at the level of the current fortified bars. Anyway this strategy has a few weaknesses, like powerlessness of the outer bars to accept the bended profile as that of the shaft under diversion, prerequisites of diverters for light emissions range/profundity proportions to stay away from the decrease in successful profundity of outside bars as redirection builds, fortifying of end zones courses of action by projecting in additional support at the closures to oppose the concentrated burden from the burdens. To beat the above deficiencies a specialized headway was given by Kothandaraman and Vasudevan (2010) to impact the fortifying framework by keeping the outer support at the soffit of the shaft without the utilization of redirectors. The other specialized benefits are that these outer poles will at the same time achieve the curve while the bar is exposed to flexural powers. The bars will be kept just reaching the outside of the bar soffit. After the basic redirection, the strain on the external bars would be compelled by the frictional holding made along the contact surface. This holding would grow as redirections increase. Consequently the level of advantage (outrageous strength) that could be cultivated out of this methodology would be higher than that could be refined by the old procedure. Despite the fact that this procedure has various benefits, the conduct of the remotely supported pillar isn't contrasted and a shaft in which whole support is inserted. The proposed study is basically to analyze the flexural conduct of remotely supported shaft and the customary pillar with whole support implanted.

CHAPTER- 3

MATERIAL PROPERTY

3.1 Cement

Concrete has different properties and traits which depend on their compound sytheses. By changing in fineness of beating, oxide sytheses concrete has show different properties and unmistakable kind of cement. The use of added substances, changing manufactured association, and use of different unrefined materials have come about the openness of various kinds of cements. Concrete used in the preliminary work is ORDINARY PORTLAND CEMENT of 43 assessments acclimating to IS: 8112/1989. **Specific gravity= IS 4031 part 11:1988 - Reaffirmed 2014**

(Le-chatelier flask)

- Consistency = IS 4031 part 4:1988 - Reaffirmed 2014
- Initial & Final setting time= IS 4031 part 5:1988 - Reaffirmed 2014
- Fineness = IS 4031 part 1:1988 - Reaffirmed 2016

The results of the tests on sample are listed

Table 3.1 Tests on cement

1.	Specific gravity	3.15
2.	Standard consistency	32%
3.	Setting time	
	(i) Initial setting time	345 minutes
	(ii) Final setting time	510 minutes
4.	Fineness	3%

3.2 Aggregates

Totals are the significant constituents in concrete. They offer body to the solid, lessen shrinkage and impact economy. The way that the totals involve 70-80 present of volume of solid, it somely affects different attributes and properties of cement. Prior, totals were considered as artificially dormant material however now it has been perceived that a portion of the total are synthetic dynamic and furthermore certain totals ere display substance bond at the interface of total and glue.

3.2.1 Coarse Aggregates

Squashed rock of 10mm and 20mm size are utilized as coarse total. In the current examination, locally accessible squashed blue rock stone total of size 20mm and down, is utilized and the different tests, completed on the total are given beneath. The accompanying tests are directed as per IS norms.

Sieve analysis = IS 383:2016

- Specific gravity = IS 2386 part 3: 1963 - Reaffirmed 2016
- Water absorption = IS 2386 part 3: 1963 - Reaffirmed 2016

The results of tests on coarse aggregate is given in table

Table3.2 Tests on Coarse aggregate

1.	Fineness modulus	7.12
2.	Specific gravity	2.85
3.	Water absorption	0.3%

3.2.2 Fine Aggregates

Fine total which fulfilled the necessary properties for trial work and adjusts to zone according to the particular of IS: 383-1970. It is bought from a close by smasher. The particles meeting the prerequisites of the details with explicit gravity 2.54 is utilized as fine total. The accompanying tests are directed as per IS principles.

- Sieve analysis = IS 383:2016
- Specific gravity = IS 2386 part 3: 1963 - Reaffirmed 2016
- Water absorption = IS 2386 part 3: 1963 - Reaffirmed 2016

The aftereffects of tests on fine total are given in table

1.	Specific gravity	2.54
2.	Fineness modulus	2.636
3.	Water absorption	2.62
4.	Bulk density	
	(i) Loose state	1537.96 Kg/m ³
	(ii) Rodded state	1778.609 Kg/m ³

Table3.3 Tests on fine aggregate

3.3 PROPERTIES OF LECA

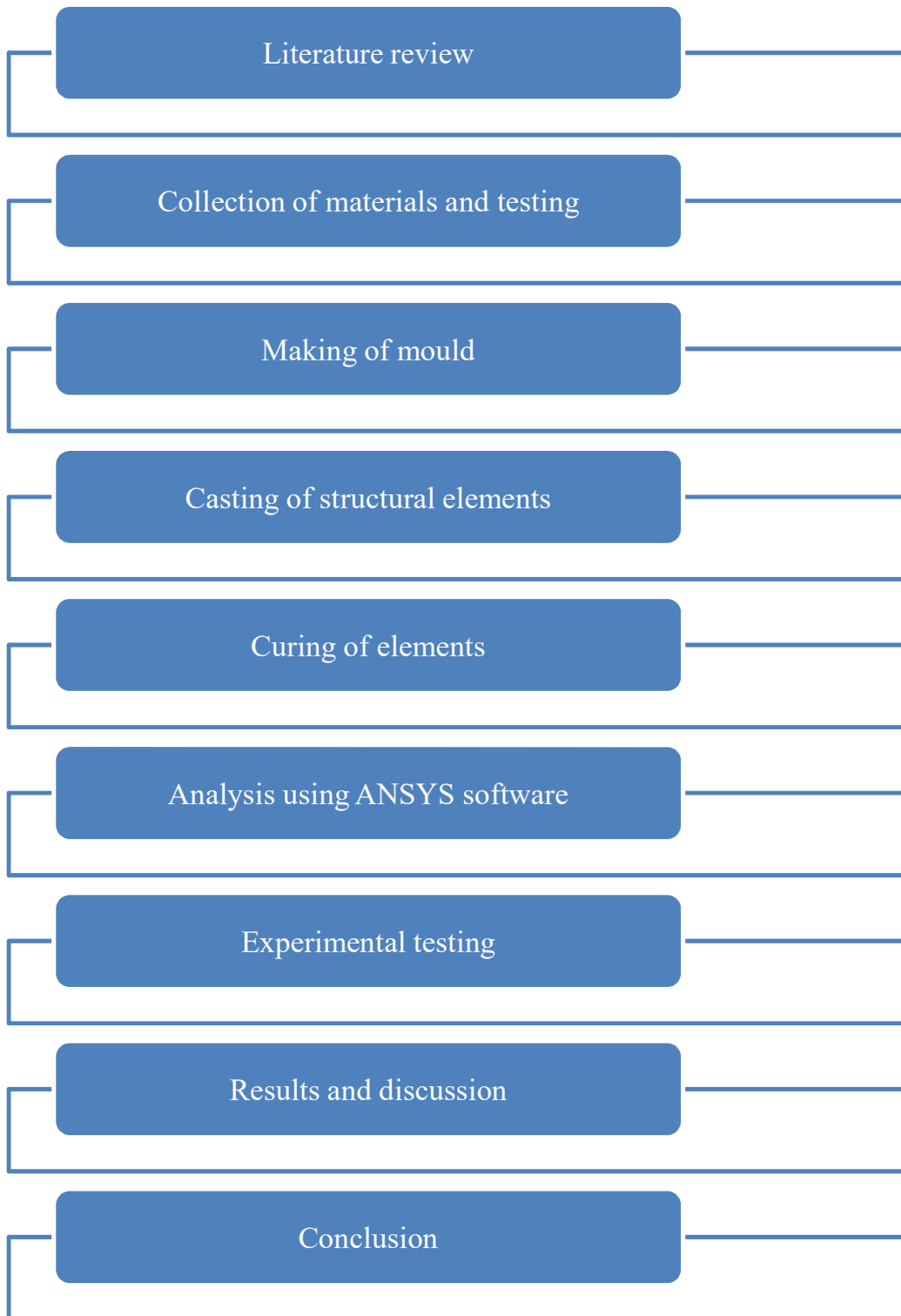
- Relative thickness lower than typical totals.
- LECA utilized in underlying and geotechnical applications.
- Reduce dead loads and sidelong powers by the greater part in establishments over structures and those with delicate soils.
- Eco-accommodating nature-based side-effect that joins similar advantages as block tiles.
- It is indestructible, non-burnable, and invulnerable to attack by dry-rot, wet-rot and frightening little creatures.



3.4 Water

Clean consumable water was utilized for blending, restoring and curing of cement

3.5 Methodology



3.6 Mix Procedure

Uniform blending of cement ought to be guaranteed to get right test aftereffects of the example. For conventional cement, at first the coarse total is weighed for required amount per blend proportioning and poured in blender; at that point Sand is gauged and filled the blender, which is totally dry. Concrete is gauged and consistently spread on the outside of sand and uniform blending is guaranteed. Dry blending is completed, later water blended in with the dry blend, blending is guaranteed up to at least 5 minutes until uniform shade of cement is seen. At that point concrete is set in molds according to system.

Stipulation for Proportion:

Grade designation =M25

Type of cement = Ordinary Portland Cement 43grade

Max nominal size of the aggregate =20mm

Min Cement content = 300kg/cum

Max W/C ratio =0.5

Exposure condition =Moderate

Type of aggregate = Crushed angular

Aspect Ratio= $l/d = 25/0.5 = 50$

Test Data:

Cement-Portland Cement 43grade

Specific Gravity of cement =2.7

Specific Gravity of coarse aggregates=2.7

specific Gravity of fine aggregate =2.6

Sand confirming to zone-III

From Sieve Analysis of 1000g of sand:

Table:3.4 Fineness Modulus and Gradation

Size	Wt. retained	PercentageWt. Retained	Cum. Percentage Wt. retained	Percentage Passing
10	0.00	0.00	0.00	100
4.75	0.00	0.00	0.00	100
2.36	110.5	11.05	11.05	88.95
1.18	129.3	12.93	23.98	76.02
0.6	149.4	14.94	38.92	61.08
0.3	411.2	41.12	80.04	19.96
0.15	199.6	19.96	100	0.00

Fineness Modulus= Cumulative % Wt. Retained/100= 253.99/100= 2.53

When FM is matched with limits of FM for Fine Aggregates, we come to know it is a fine sand. And when Percentage Passing is matched with the data given in IS: 383 for gradation of fine aggregate, we come to know it is of Zone III

Target mean strength for blend extent is given by $f_{ck} = f_{ck} + 1.65 \cdot S$
 $= 25 + 1.65 \cdot 4$ (esteem is as per IS 10262:2009)
 $= 31.6 \text{ N/mm}^2$

From Table 2 of IS 10262:2009, to decide the most extreme water content. Ostensible size of total is 20mm so water content comparing to it is 186 liters. Assessed water content for 100mm droop is $1.06 \cdot 186 = 197.16$ literi.e.197L.

Concrete substance will be $197/0.5 = 394 \text{ Kg/m}^3$.

From Table 5 of IS 456 least concrete substance for moderate openness condition is $300 \text{ Kg/m}^3 < 394 \text{ Kg/m}^3$.

Consequently OK.

From Table 3 of IS 10262:2009,

Ostensible most extreme size of aggregate=20 mm

Zone of fine aggregate= Zone III

Along these lines,

Volume of Coarse Aggregate per Unit Volume of Total Aggregate=
 $0.64A$ Volume of Coarse Aggregate per Unit Volume of Total
 Aggregate= $0.36A$

3.7 Mix Calculation

Volume of concrete = 1 m^3

Volume of cement = Mass of concrete/Specific
 Gravity $\times 1/1000$ = $394/2.7 \times 1/1000 = 0.146 \text{ cu.m}$

Volume of water = Mass of water/Specific Gravity $\times 1/1000$
 $= 197/1 \times 1/1000 = 0.197 \text{ cu.m}$

Volume of aggregates = $a - (b + c) = 1 - (0.146 + 0.197) = 0.657 \text{ cu. m}$

Mass of coarse aggregate= $d \times \text{Volume of coarse total} \times \text{Specific gravity of coarse total} \times 1000$
 $= 0.657 \times 0.64 \times 2.7 \times 1000 = 1135.3 \text{ Kg}$

$$\begin{aligned}\text{Mass of fine aggregate} &= d \times \text{Volume of fine total} \times \\ &\quad \text{Specific gravity of fine total} \times 1000 \\ &= 0.657 \times 0.36 \times 2.6 \times 1000 = 615 \text{ Kg}\end{aligned}$$

Table:3.5 Proportions

Cement= 394 Kg/m ³
Water= 197 Kg/m ³
Fine Aggregate= 615 Kg
Coarse Aggregate= 1135.3 Kg
W/C ratio= 0.5

CHAPTER-4

EXPERIMENTAL TESTING

4.1 EXPERIMENTAL INVESTIGATION

This section presents the subtleties of exploratory examinations completed on the test examples to contemplate the strength qualities of FRC in various mixes. The trial is led on FRC test examples to find out the usefulness and strength related properties, for example, 3D square compressive strength, chamber split rigidity and crystal flexural strength of different blends. Three examples are tried, and the normal is accounted for each blend for each test. Every one of the tests are led according to Indian principles. In light of the strength test aftereffects of shape and chambers the ideal rate is shown up. At that point the precast solid boards are casted. After 7, 14 & 28 days restoring, the boards are tried for compressive, Tensile and flexural strength.

4.2 PREPARATION OF SPECIMEN

The strong hang test Slump Test (ASTM C 143M-00) is a test that activities the handiness of new concrete. Even more expressly, it appraises the consistency of the strong in that specific bundle. This test is performed to check the consistency of recently made concrete. Consistency is a term solidly related to usefulness. It is a term which depicts the state of new concrete. It suggests the straightforwardness with which the strong streams. It is used to show the degree of wetness. Usefulness of concrete is basically impacted by consistency for instance wetter mixes will be more helpful than drier mixes, yet concrete of a comparative consistency may change in handiness. It is similarly used to choose consistency between solitary gatherings.

Concrete is set up according to blend plan. The newly arranged cement is filled in a spotless droop cone in four progressive layers. 25 packing is given for each layer appropriately prior to adding another layer. Unnecessary cement is hit of with scoop from the highest point of the shape after the last layer has been packed. The cone is eliminated quickly by raising it gradually and cautiously the vertical way. The settlement or subsidence (droop) (for example distinction between the stature of the droop shape and the most noteworthy mark of the financed solid cone.) in cone estimated when it arrives at stop.

4.3 CASTING:

4.3.1 CUBE:

The concrete cube specimens are casted by the consideration of following steps
Cube Mould:

The 3D shape Molds of required size a 150 x 150 x 150 metric straight unit for ostensible size of total not extraordinary 38 mm. Shape Molds will be provided with a base plate and they will be according to IS:10262-2009. Cement= 394 Kg/m³
27

Packing Rod :

According to IS:10262-2009, the packing bar will be 16±0.5 mm breadth and 600±2 mm long with an adjusted working end and will be made of gentle steel.

Projecting Process :

The 3D shape Mold plates should be taken out, appropriately clean amassed and each one the bolts should be totally close. A thin layer of oil at that point will be applied on every one of the essences of the Mold. It's important that solid shape viewpoint appearances ought to be equal. In the wake of taking solid examples and blend them, the shapes will be strong as presently as could really be expected. The solid example will be packed into the 3D square Molds in layers roughly 5 cm profound. In embeddings each scoop of concrete, the news will be influenced round the excellent edge of the Mold in light of the fact that the solid slides from it, to ensure a balanced conveyance of the solid with inside the Mold. each layer will be compacted either by hand or by the vibration as portray underneath. Compaction by Hand

Each layer of the solid stuffed inside the Mold will be compacted by not however 35 strokes by apparatus. The strokes will be infiltrating into the hidden layer and furthermore the base layer will be rodded thought its profundity. any place voids are left by the instrument the edges of the Mold will be abroach to close the voids.

4.3.2 CYLINDER:

The material properties of cement must be appropriately assessed if test examples are made and restored by principles. Solid chambers are normally made to assess the compressive strength of the solid just as Spilt elasticity.

Chamber Mold:

Metal 150 x 300 mm chamber Molds are utilized for projecting solid test examples in the field. Prior to filling, they ought to be put on a smooth, firm, level

surface.

Packing Rod:

Accepting 150mm distance across Molds are used, it ought to be full in three identical layers and each layer rodded reliably on various occasions with a sixteenmillimeter estimation x 450 - 600-millimeter long hemi circularly tipped steel bar.

Projecting Process

The strokes will be flowed reliably silly sectional of the Mold. The base layer will be rodded all through its significance. for each higher layer, the bar will enter as for 25 mm into the central layer. If voids are left by the bar, the edges of the Mold ought to be tapped to close voids preceding adding the Ext layer of material.

4.3.3 PRISM:

As indicated by principles Concrete crystal are casted to assess the flexural strength of the solid. The projecting and testing methodology to be adhered to as Indian standard code IS 10262-2009.

Crystal Mold:

The Mold standard size will be 100 x 100 x500 made out of metal. The pressing bar will be a steel bar weighing 2kg, 40 cm long and will have a crushing face 25 mm square. The test model will be made when practicable in the wake of Mixing and in such way as to convey full compaction of concrete while neither detachment nor extreme laitance.

Projecting Process:

The compaction will be coursed reliably over the piece of the Mold. The base layer will be rodded all through its significance. For each upper layer, the shaft will enter around 25 mm into the key layer. In case voids are left by the shaft, the sides of the Mold should be tapped to close voids before adding the accompanying layer of material.



FIG 4.1 MOULD FOR CASTING OF SPECIMENS



FIG 4.2 CASTING OF CUBE, CYLINDER & PRISM

4.3.4 RC BEAM:

As per guidelines Concrete pillar are casted to assess the flexural strength of the solid. The projecting and testing system to be kept as Indian standard code IS 10262-2009.

Bar Mold:

The Mold size is 230 x 230 x 1500 made out of wood. The pressing bar will be a steel bar weighing 2kg, 40 cm long and will have a crushing face 25 mm square. The test model will be made when practicable resulting to Mixing and in such way as to convey full compaction of concrete while neither segregation nor extravagant laitance.

Projecting Process:

The compaction will be passed on reliably over the portion of the Mold. The base layer will be rodded all through its significance. For each upper layer, the bar will enter around 25 mm into the essential layer. In the occasion that voids are left

by the bar, the sides of the Mold should be tapped to close voids before adding the accompanying layer of material.



FIG 4.3 REINFORCEMENT FOR CASTING OF BEAM



FIG 4.4 CASTING OF BEAM

4.4 DEMOULDING AND CURING:

4.4.1 DEMOULDING:

Test solid investigate examples should be demoulded somewhere in the range of sixteen and 24 hours when they have been made. In the event that when this space of your time the solid has not accomplished sufficient solidarity to adjust demoulding while not harming the examples then the demoulding ought to be deferred for an extra 24 hours. once eliminating the solid examples from the Mold, dismantle the Mold completely. be careful to not mischief the examples on the grounds that, if any breaking is caused, the all-strength boundaries could likewise

be decreased. While demoulding, each investigate solid examples should be set apart with a reasonable ID on the most noteworthy or base utilizing a waterproof colored pencil or ink. The Mold ought to be altogether perfect while demoulding. ensure that oil or earth doesn't gather between the essences of the ribs, in any case the 2 parts will not match along as expected and there'll be surge through the joint Associate in Nursing an on a sporadic premise shaped could result.



FIG 4.5 DEMOULDING OF CUBE, CYLINDER & PRISM

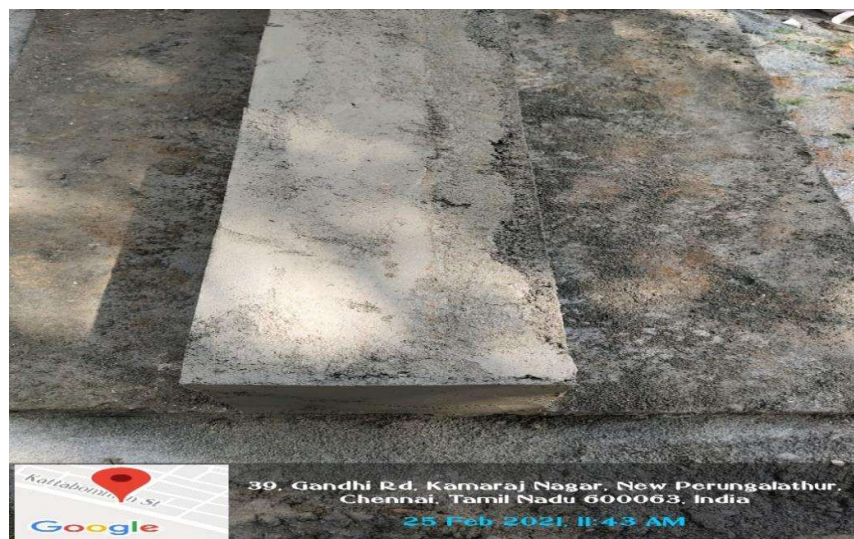


FIG 4.6 DEMOULDING OF BEAM

4.4.2 CURING:

Restoring assumes a significant part with respect to solid strength improvement and solidness. Relieving of Concrete might be a procedure by that the solid is secured against loss of dampness required for affiliation and whole inside the proposed temperature differ. Restoring can expand the strength and diminish the Perme ableness of solidified cement. Restoring is also helping in alleviating

warm and plastic breaks, which may seriously affect toughness of designs.

Relieving follow includes keeping the solid soggy or wet till the relationship of cement is finished and strength is procured. common interaction of cement should start by and by after introductory setting season of cement. According to IS 456 – 2000 cement shouldn't be restored yet seven days for standard Portland Cement, and it ought to be at least ten days for concrete with mineral admixtures or incorporated concrete are utilized. simply in the event of environmental condition and very dry temperature conditions, the characteristic cycle shouldn't be nevertheless ten Days for OPC and fourteen days for concrete with incorporated concrete and mineral admixtures.

4.5 CUBE COMPRESSIVE STRENGTH TEST

The solid shape compressive strength test is completed on 3D square examples of size 150mm x 150mm x 150mm. All examples are tried in soaked surface dry condition, subsequent to clearing out the surface dampness. For each blend mix, three indistinguishable examples are tried at the period of 7,14&28 days 21Qusing pressure testing machine. Stacking was proceeded till the example had fizzled. The perusing right then and there of inversion gives a definitive burden. The test arrangement is appeared.



FIG 4.7 CUBE COMPRESSIVE STRENGTH TEST

4.6 CYLINDER SPLIT TENSILE STRENGTH TEST

This is a roundabout test to decide the elasticity of barrel shaped examples. Parting elasticity test is completed at 28 years old days for the solid chamber example of size 150mm distance across and 300mm length utilizing widespread

testing machine. The heap is applied steadily till the example split and the readings are noted. The test arrangement is show in fig. 5.4. The parting elasticity has been assessed utilizing the relationship

$$f = 2P/\pi dl$$

Where, f = Splitting tensile strength of concrete in MPa.

P = Load at failure in Newton

d = Diameter of cylinder = 150mm

l = Length of cylinder = 300mm



FIG 4.8 CYLINDER SPLIT TENSILE STRENGTH TEST

4.7 FLEXURAL STRENGTH TEST

To decide the parallel burden opposition, the crystals are tried for flexure. As shown in Fig. 5.5. the crystal (100mm x 100mm x500mm) were set on a level plane and tried for flexural strength as per third point stacking. The underlying disappointment area was noticed and tracked down that the disappointment area of all crystal was inside the center third. The third point stacking was utilized to decide the pressure at disappointment.

$$R = PI/bd^2$$

Where,

R – Bending stress

P – Maximum applied load in N

l – Span length in mm

b – Average width of the specimen in mm

d – Average thickness of the specimen in mm



FIG 4.9 FLEXURAL STRENGTH TEST

4.8 RC Beam Test:

A bar with a compelling range of 1500 mm are tried under two-point stacking by utilizing water powered jack with the distance between the stacking focuses as 570 mm following 28 days of restoring utilizing wet gunny packs at surrounding temperature. LVDT is fixed to gauge mid-range avoidance.

CHAPTER-5

ANALYSIS USING ANSYS SOFTWARE

5.1 GENERAL

Today the Finite Element Method (FEM) is considered as one of the well - set up and beneficial strategy for the PC plan of complex issues in different fields of planning: underlying planning, mechanical planning, nuclear planning, biomedical planning, hydrodynamics, heat conduction, geo-mechanics, etc From inverse side, FEM can be examined as a helpful resource for the harsh course of action of differential conditions portraying assorted genuine cycles.

This stunning arrangement instrument has basically improved both the standard of planning plans and the way of thinking of the arrangement cycle in various present day applications the generally tangibility of the FEM makes it an unbelievable and comprehensive gadget for a wide extent of issues. Thusly different PC program groups have been delivered for the game plan of a collection of essential and solid mechanics issues.

5.2 ANSYS WORKBENCH

The ANSYS Workbench environment is a characteristic ahead of time restricted segment assessment instrument that is used identified with CAD systems just as Design Modeler. ANSYS Workbench is an item environment for performing fundamental, warm, and electromagnetic examinations. The class bases on estimation creation and improvement, associating existing math, setting up the restricted part model, tending to, and investigating results. The class will portray how to use the code similarly as fundamental restricted part reenactment thoughts and results interpretation.

ANSYS is a generally valuable programming, used to mirror coordinated efforts of all sets of material science, basic, vibration, fluid components, heat move and electromagnetic for engineers.

ANSYS can import CAD data and besides engages to create

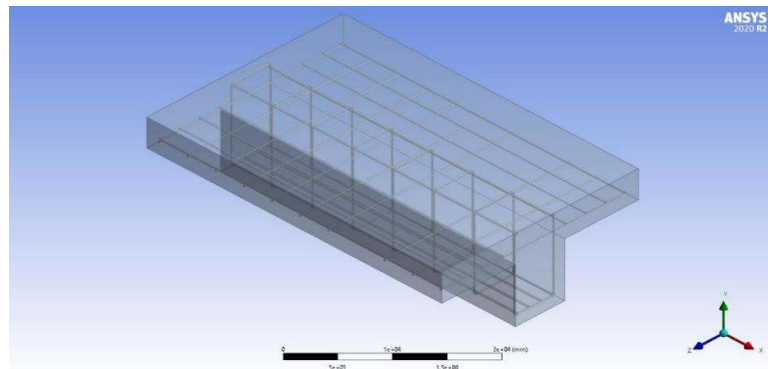
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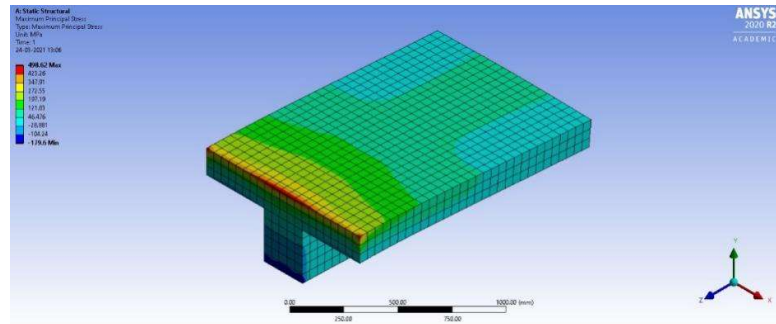
estimation creation and improvement, associating existing math, setting up the restricted part model, tending to, and investigating results. The class will portray how to use the code similarly as fundamental restricted part reenactment thoughts and results interpretation.

ANSYS is a generally valuable programming, used to mirror coordinated efforts of all sets of material science, basic, vibration, fluid components, heat move and electromagnetic for engineers.

ANSYS can import CAD data and besides engages to create

5.3 ANSYS ANALYSIS



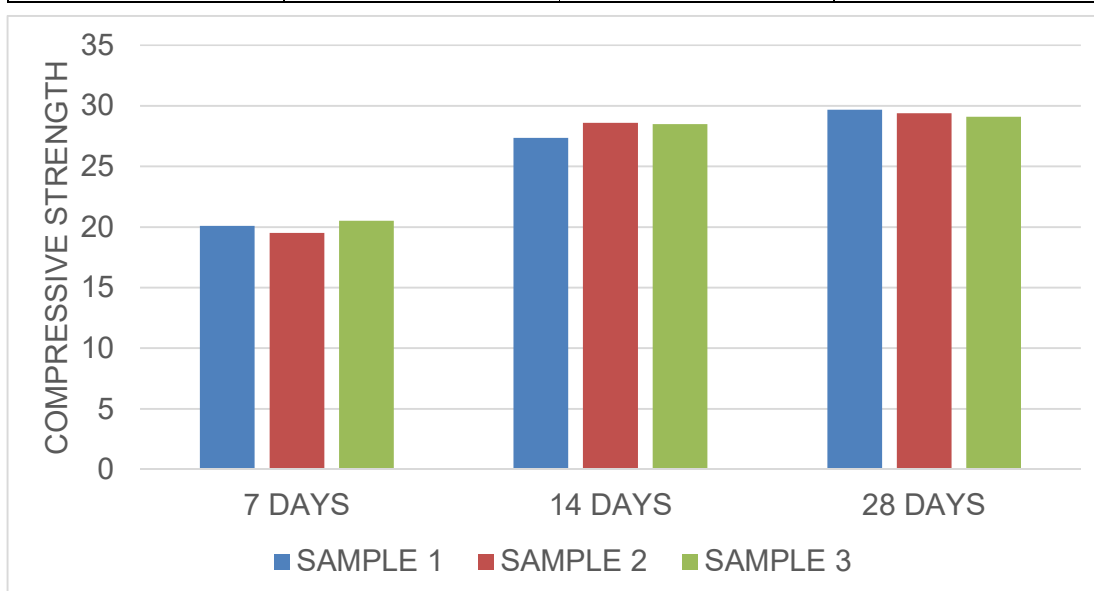


CHAPTER 6

RESULTS

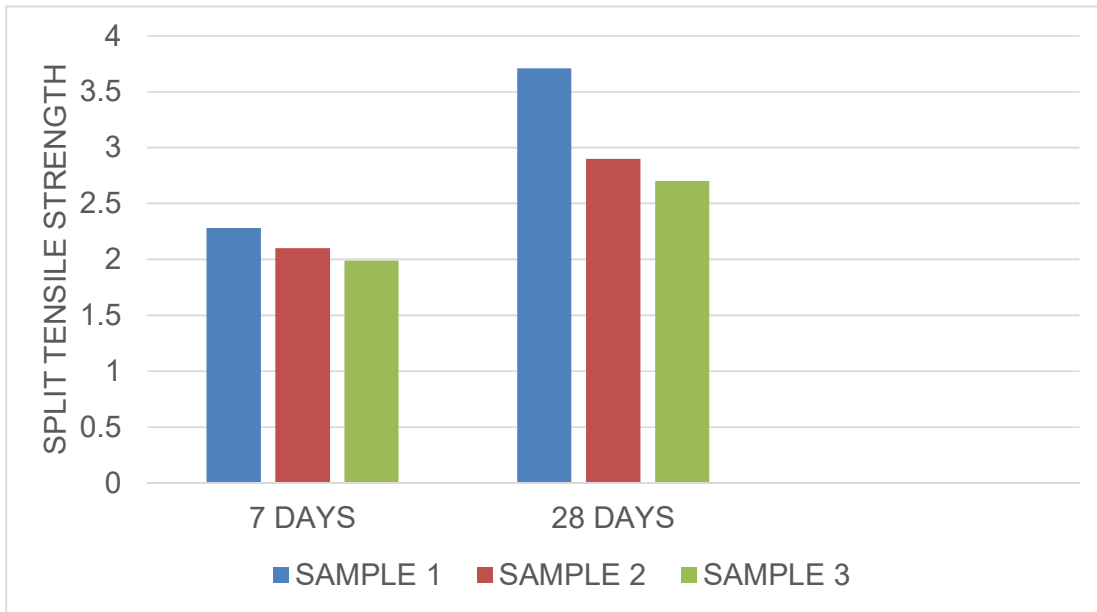
6.1 COMPRESSIVE STRENGTH TEST RESULTS

CUBE	7 DAYS	14 DAYS	28 DAYS
SAMPLE 1	20.1	27.35	29.7
SAMPLE 2	19.52	28.6	29.4
SAMPLE 3	20.5	28.5	29.1



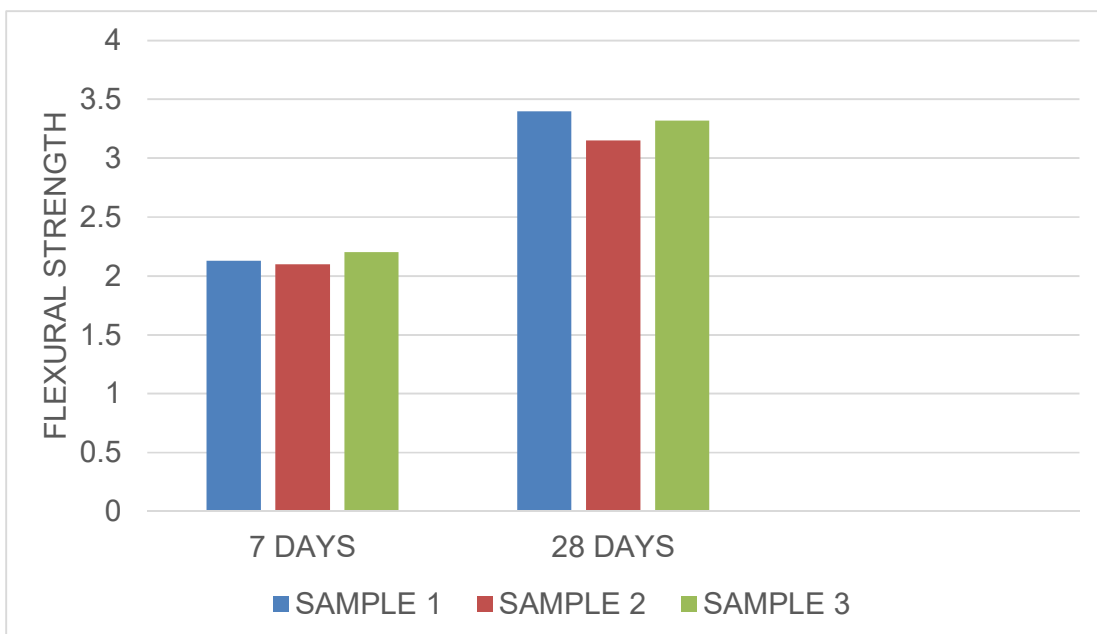
6.2 SPLIT TENSILE STRENGTH TEST RESULTS

CYLINDER	7 DAYS	28 DAYS
SAMPLE 1	2.28	3.71
SAMPLE 2	2.1	2.9
SAMPLE 3	1.99	2.7



6.3 FLEXURAL STRENGTH TEST RESULTS

PRISM	7 DAYS	28 DAYS
SAMPLE 1	2.13	3.4
SAMPLE 2	2.1	3.15
SAMPLE 3	2.2	3.32

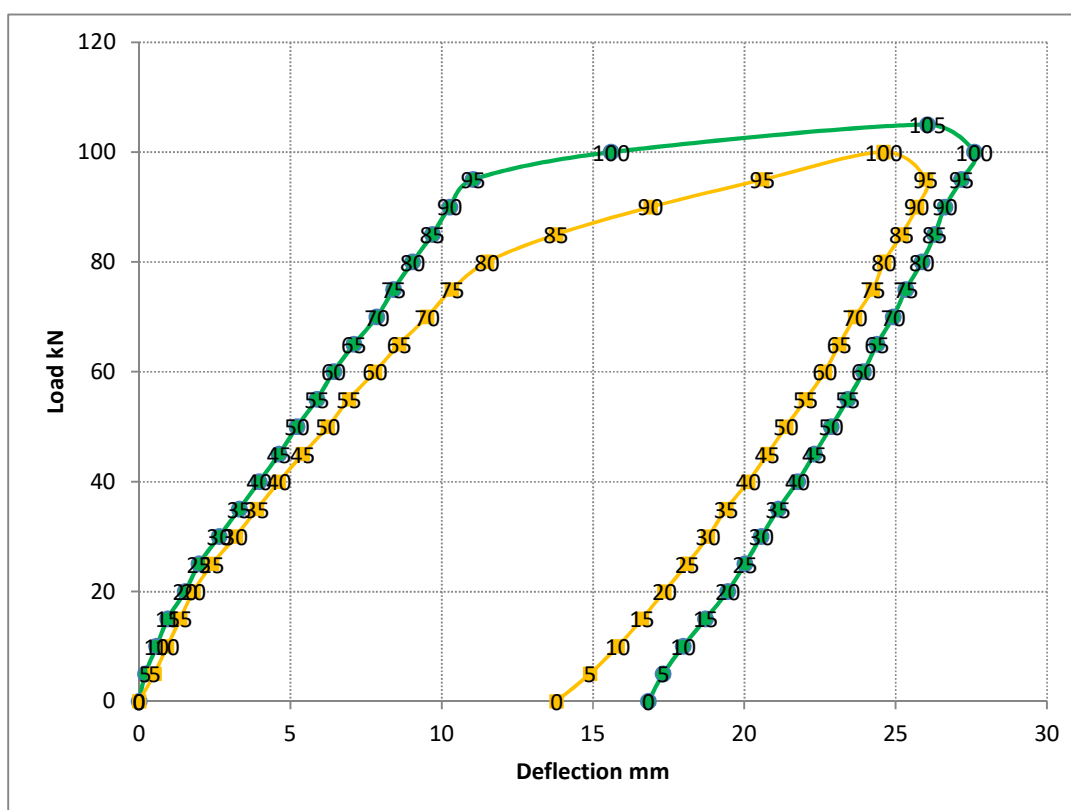


6.4 BEAM RESULTS

Load-Deflection values

PR LECA		FR LECA	
Load (kN)	Deflection (mm)	Load (kN)	Deflection (mm)
0	0	0	0
5	0.21	5	0.51
10	0.58	10	0.93
15	0.95	15	1.36
20	1.52	20	1.8
25	1.98	25	2.42
30	2.65	30	3.19
35	3.31	35	3.9
40	3.97	40	4.62
45	4.63	45	5.41
50	5.22	50	6.24
55	5.88	55	6.94
60	6.43	60	7.8
65	7.1	65	8.6
70	7.86	70	9.52
75	8.41	75	10.34
80	9.04	80	11.5
85	9.69	85	13.78
90	10.27	90	16.9
95	11.04	95	20.6
100	15.6	100	24.6
105	26.05	95	26
100	27.6	90	25.7
95	27.18	85	25.2
90	26.63	80	24.62
85	26.29	75	24.25
80	25.87	70	23.66
75	25.34	65	23.14
70	24.92	60	22.66
65	24.38	55	22.03
60	23.94	50	21.38
55	23.42	45	20.76
50	22.87	40	20.13
45	22.32	35	19.4
40	21.76	30	18.8
35	21.12	25	18.11
30	20.56	20	17.36
25	20.02	15	16.62
20	19.45	10	15.82
15	18.72	5	14.9
10	17.98	0	13.8
5	17.32		
0	16.83		

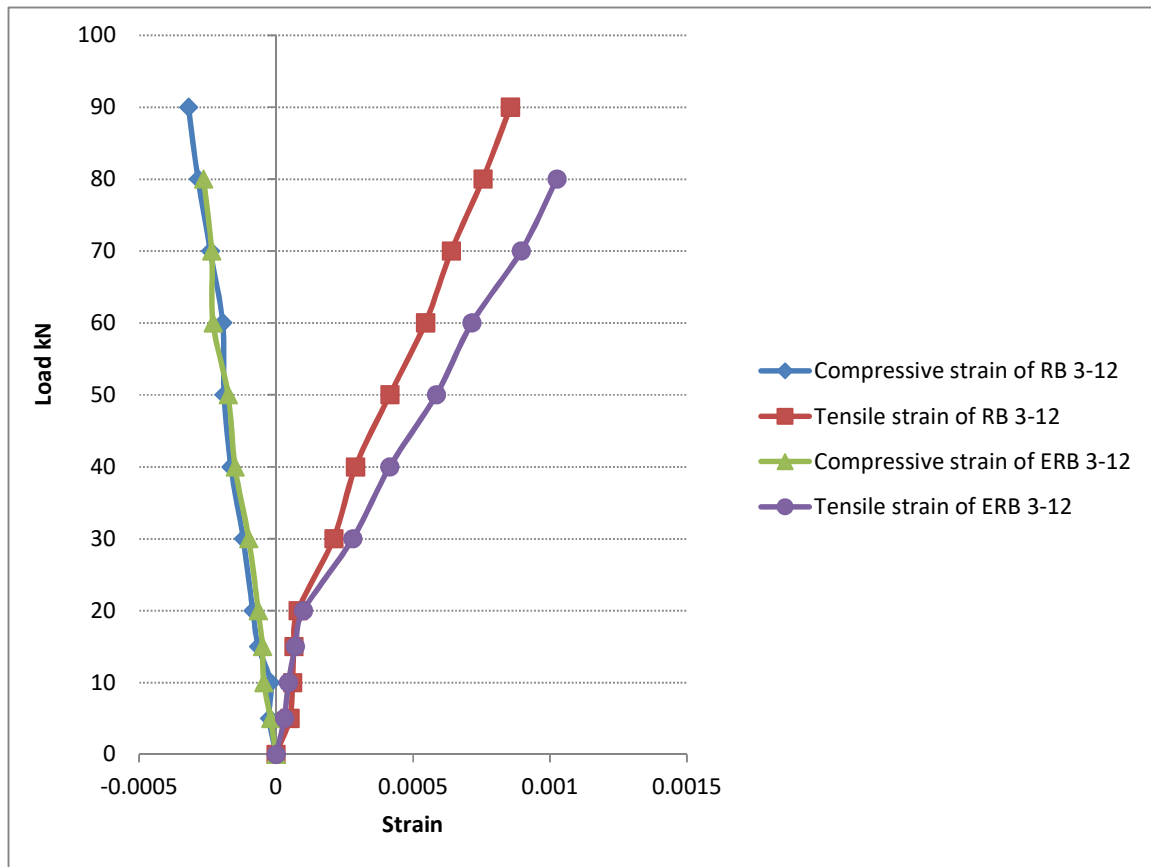
Load versus mid-span deflection curve



Load-Strain values

Partial Replacement of LECA			Fully Replacement of LECA		
Load (kN)	Compressive strain	Tensile strain	Load (kN)	Compressive strain	Tensile strain
0	0	0	0	0	0
5	-0.000025	0.000005	5	-2E-05	0.000003
10	-2E-05	0.000006	10	-4.5E-05	0.0000045
15	-0.000065	0.000065	15	-5E-05	0.000007
20	-0.000085	8E-05	20	-6.5E-05	0.00001
30	-0.00012	0.00021	30	-0.0001	0.00028
40	-0.000165	0.00029	40	-0.00015	0.000415
50	-0.00019	0.000415	50	-0.000175	0.000585
60	-0.000195	0.000545	60	-0.00023	0.000715
70	-0.00024	0.00064	70	-0.000235	0.000895
80	-0.000285	0.000755	80	-0.000265	0.001025
90	-0.00032	0.000855			

Load versus concrete surface strain curve



CHAPTER 7

CONCLUSION

From the trial examination on flexural fortifying of precast TEE radiates by outside bars at soffit the accompanying ends are drawn:

- The tee-pillar with outer bars at the soffit shows comparable execution concerning starting breaking conduct and burden at extreme stage.
- Both reference and remotely built up radiates bombed because of flexure.
- In dislike of oppressing the remotely built up radiates more redirection than that of
- reference radiates, for a similar burden, the degree of recuperation of diversion was more.
- The remotely built up radiates recuperated almost 45% of the diversion, while gradually delivering the heap, subsequent to achieving the disappointment state.
- The remotely supported bar showed greater pliability when contrasted with the reference pillar.
- Anchoring the outer support without slackness is fundamental to bring the outside support right into it when the heap comes right into it.
- The proposed technique is savvy and easy to embrace for flexural retrofitting of RC radiates.
- The proposed technique for fortifying the RC radiates is discovered to be viable and profitable mulling over of the heap conveying limit, bendable conduct, break control and its conservative perspectives.

CHAPTER-8

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