EXPERIMENTAL AND ANALYTICAL STUDIES OF BOND STRENGTH BETWEEN CONCRETE AND STEEL BARS IN DIFFERENT TYPES OF CONCRETE

A PROJECT REPORT

Submitted in partial fulfillment of the requirements for the award of the Degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

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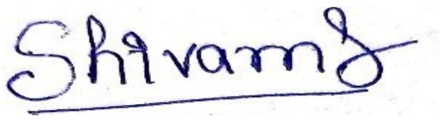
STUDENT'S DECLARATION

We hereby declare that the work presented in the Project report entitled **"EXPERIMENTAL AND ANALYTICAL STUDIES OF BOND STRENGTH BETWEEN CONCRETE AND STEEL BARS IN DIFFERENT TYPES OF CONCRETE"** submitted in partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of our work carried out under the supervision of **Mr. Kaushal Kumar.** This work has not been submitted elsewhere for the reward of any other degree/diploma.

Ria Thakur (161684)



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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"EXPERIMENTAL AND ANALYTICAL STUDIES OF BOND STRENGTH BETWEEN CONCRETE AND STEEL BARS IN DIFFERENT TYPES OF CONCRETE"**submitted in partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Ria Thakur,Shivam Sharma and Anirudh Guleria under the supervision of Mr.Kaushal Kumar, Assistant Professor Department of Civil Engineering, Jaypee University of Information Technology,Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: June 2020

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ABSTRACT

Concrete is a widely used construction material. But when reinforcement is put into it, its power increases. Bond strength among reinforcement and concrete is the strength preventing the separation of concrete and mud from steel reinforcement caused by factors such as adhesion,longitudinal and longitudinal shearing between joint concrete by bar distortion. Reinforcement goes a lot to concrete construction, even though it relies on facts and many other things. Initially testing of specimens were done using ABAQUS applying different load conditions followed by the working samples placed into Universal Testing Machine (UTM) to get the result and make one bond strength test with the results for analysis and evaluation.

This study is based on reliability related to the concrete type.

Goal is to find a formula that is empirical in nature that can present an excellent presentation of the power of different concrete types. First step is to analyze ABAQUS. A pull-out load has been taken out of the concrete and reinforcement at various water-cement ratios and then are examined.

Keywords: Pull-Out Test; Universal Testing Machine; Reinforcement; Concrete; Water Cement Ratios.

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Abbreviations	Full Form
OPC	Ordinary Portland Cement
FGB	Functionally Graded Beam
HVFAC	High-Volume Flyash Concrete
IS	Indian Standard
HVFA	High-Volume Flyash
MS	Micro Silica
NS	Nano Silica
W/C	Water Cement Ratio
UTM	Universal Testing Machine
CTM	Compression Testing Machine
PP	Polypropylene
SPO	Single Pull Out
DPO	Double Pull Out
NSC	Normal Strength Concrete
HSC	High Strength Concrete
NCC	Normal Cement Concrete
SCC	Self Cement Concrete

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Widely used building material in the world is Concrete. Construction of Concrete has not undergone any major change over time though it has been in operation since ages. Therefore, a conclusion can be drawn that, with its large use and small variations that have existed over the years, the making of concrete should be well established to create complete structures. However, as we can see in the practical case that damage occurrence and cracks are common in the concrete structures and their deterioration often make them compelled to destroy them or abandon their use.

Figure 1.1 Cement(OPC 43)

In **figure 1.1** Ordinary Portland Cement of Grade 43 is shown which was used as a major material for preparation of specimens.

It is necessary to have knowledge about the dynamics of the stacks between the sub-concrete and the concrete to recover. The inconsistency of the deviations between the concretes of different ages leads to the coarsening of the coupling connections, especially different shrinkage creation. In many cases where there is a need for concrete or steel transition, the transfer of effort between concrete and steel and these materials interference guaranteed to adhere between these components are essential for reinforced concrete structure performance.

The strength of bond between concrete and hardness comes mainly by adhesion and gravity and is affected by metal properties such as those of relative and concrete displacement due to volume variations. Loss of adhesion may occur at the interface between two different concerts, between two different age concrete, or in the connection between the concrete and steel bar. This condition may be very dangerous and may result in poor performance in the building. Thus experimental studies have shown the effectiveness and beauty of specific therapeutic modes for making the interface in concrete, as well as between concrete and steel, to achieve adequate adhesion between reinforcement and these materials.

1.2 BOND STRENGTH

It can be defined as a measure of the effectiveness of a bond between steel and concrete and there is no specific definition of a bond. In experimental tests on transparent bars, the total load usually indicates the strength of bond that can be enhanced between concrete and steel. Bond energy is generated by mechanical interaction, without chemical reaction. To achieve unimaginable results a number of experiments have been performed. The test analyzes performance under extreme strength, shearing and a combination of pressure and tension. The most trusted test is a pull test, however errors may occur in the sub concrete, interface or recovery layer.

1.2.1 BOND STRENGTH BETWEEN CONCRETE AND REINFORCEMENT

The strength of the bond among steel and concrete is equally important as the compressive strength of concrete in a structure or reinforced structure. The coupling between concrete and steel is of particular importance in the lieu of structural behavior with respect to cracks, due to cracks and thermal effects in the first stage. It is common for the bond strength separation into three categories, such as mechanical bonding, thinning and bonding. This distinction is based on siege v/s discrimination.

Figure 1.2 Reinforcement embedded in cubical mould

Figure 1.2 shows a steel bar embedded in a cubical concrete block(specimen) used for finding bond strength with the help of pull out test.

Though, the separation of bond strengths into these three components is often proven due to the inability of each test. This is followed by the fact that even a seemingly smooth metal line can provide mechanical adhesion, based on the surface hardness caused by the rust and the manufacturing processes that can create highways. The main factors affecting the strength of the beam are the type of concrete used, loading parameters and Geometry of steel bars.

1.2.2 REINFORCEMENT BARS DIAMETER VARIATION

The standard sizes of Reinforcing Steel Bar are available in length 9m or 12 m. Diameter of the metal used is different and the weight varies accordingly. Various metal bars and their theoretical instruments are listed below:

Modified steel bar Range: A615, BS4449, GB1499.2-2007

Steel Items:HRB400, GR60, HRB335, HRB400E, G500B, HRB500, G460G

Width: 12 m, 9 m

Table 1.1 Steel Bars Theoretical Weight

Diameter of steel bars	Hypothetical weight(Kg/m)
6 mm	0.222
8 mm	0.395
10 mm	0.62
12 mm	0.89
14 mm	1.21
16mm	1.58
18 mm	2
20 mm	2.47
22 mm	2.98
25 mm	3.85
28 mm	4.83
32 mm	6.31
40 mm	9.87

1.2.3. GRADE OF CONCRETE CHANGE

Usually, the durability of the concrete used in the field is less as cement is the only material that binds to concrete and because of its constant price, researchers have been looking for replacement. For economic purposes, development of power and anti-corrosion functionally graded beam (FGB) took place.

According to IS456:2000, the different concrete grades can be divided in M5, M7.5, M15, M25 etc., where M stands for Mix and the number after M represents the strength of the concrete in N/mm2 @28 days on inspection a 15 cm × 15 cm × 15 cm cube for testing direct sensing.

1.2.4 ADMIXTURES ADDING UP

These are natural or synthetic chemicals that are applied to the concrete before or during the mixing process. They are agents that include water softener, air, accelerators and water pressure reduction.

They are used to provide special properties to hardened or new concrete. They can increase the durability, performance or durability of a given concrete mix. They can overcome unfavorable construction conditions such as cold or hot weather,low cement requirements or pumping requirements.

1.3 PROJECT OBJECTIVES

1. The main objective is to check the variation in concrete bond strength and reinforcing steel corresponding to various concrete types.
2. To make a comparison between the experimental analysis and the analysis performed on ABAQUS varying the properties of concrete.
3. Ultimately, we want to derive an empirical formula of bond strength, concrete properties being the main factor.
4. To be able to make a comprehensive examination of what importance a particular concrete carry for a certain work.

CHAPTER 2

LITERATURE REVIEW

Purpose of the review is to provide detailed information on the strength of bonds and the different involving factors.

2.1 PREVIOUS STUDIES

Brother and Upadhye (2015) in their experiment studies the effect of bond strength on the strength (tensile test) of polymer fibers made of polymer in concrete. The fraction volume of the metal decreases by 0 to 7% during the explosion of 1% fiber and the SBR latex polymer of 15% volume refined by cement weight. In this test, a sample of size 150mm * 150mm * 150mm with a 16 mm high damaged bar of 650 mm is placed at the center of the 150 mm of concrete and the cube. Pull-out tests on the specimens were done to the universal test machine.Because of the results of the test work, the observations which were made during testing and casting of the models, and the results of reinforced concrete and concrete behavior, the mentioned **conclusions** are drawn:

1. Fibers are extremely effective in making stiffness difficult.

2. Tensile strength increases with increasing fiber content.

3. Increase in fiber content and mode of failure, when subjected to bending and pressure.

2.2 PREVIOUS STUDIES

Annaporna (2017) studied the performance of bonds between steel and concrete characterized with the development of fragile cracks as chemical bonding was lost due to mechanical affinity. When FRC is applied the behavioral development of the bond is recognized as the presence of fibers against the crack opening. In this study the bond behavior and bond strength of 150 mm vegetation was considered by the variations in their matrix characteristics, bar characteristics and confinement. Three different diameters of 16mm, 20mm and 25 mm were used. Concrete strength M30 and M20 were used. Matrix closure varied by blocking it with the addition of 1% iron wire and mild steel. Bond strength varies between 7.32 MPa and 19.50 MPa in various variations. It was discovered that Bond strength increased with concrete age and attractive strength, decreased with increasing rebar diameter. The strength of bond of the assimen attached to the gentle metal helix exceeds those with an additional 1% iron content. The installation of steel fibers did not affect the strength but improved the fracture behavior of the models. bend increases with decreasing bond strength. **Conclusions** drawn are:

1. With output failure, all types of tests failed.

2. The FRC did not contribute significantly to the strength of the bond but the fracture functionality of the transcript was corrected.

3. Bond strength increases with decreasing centimeters and increases in compressive strength.

4. With increasing bond strength slip decreases .

2.3 PREVIOUS STUDIES

Chung and Xuli (1995) added latex (20% by weight of concrete) or methylcellulose (0.4% by weight of cement) to cement gave a higher increase in shear bond strength among cement paste and stainless steel, however the lower concentration of methylcellulose was compared. and latex. The addition of methylcellulose did not affect the electrical return of the interaction between fiber and cement, and the addition of latex increased this overlap. Thus, in terms of low cost and low contact regeneration, methylcellulose has been favored in latex. In terms of cement-bonded structure, the bond strength increases directly through the contact layer.The **conclusions** drawn are:

1. Addition of methylcellulose did not alter the electrical re-connection among the fiber and the adhesive, and the addition of latex increases this establishment.

2. With low contact regeneration and low cost recovery, methylcellulose is favored in latex.

3. According to the cement-bonded structure, bond strength increases directly through electrical re-connection.

2.4 PREVIOUS STUDIES

Muhammadh and Suhoothi(2017) made two modes of welding length and height of 6.425m X 6.050m were studied in accordance with BS 8110-1: 1997. When concrete was emptied, load due to the concrete and independence of steel bars shall be replaced by framework. With the curation in concrete, the slide begins taking on every load, the reinforcing bars will initially take over concrete over reinforcement bars when the concrete begins to cure. The analysis is performed during the hardening period to determine the effective cover distribution pattern, which limits the amount of cover deviation within the tolerance value.Model can provide non-conservative effects, as model need to be refined to look at the deterioration of the interface such as the reduction and occuring angular deviation changes. The model can provide non-conservative effects.

Paper presented an analytical model of 1D for solid-phase reinforcement reactions. The model is an extension of the 1D bond-slip model provided in CEB-FIP Model Code 1990. The model is effective in structural analysis.

The strength of the model was evaluated by comparing the results of experiment with the results from the high-dimensional 3D object model.

In the study, **conclusions** reached are:

1. The observed results, depending on the slip-slip curves, the magnitude of bond loss and length of time required to hold the sales force, give the correct response compared to experiment.

2. Proposed model provides results that are on the safe side in most cases. With the large corrosion penetration and no small or small reinforcement fluctuations, maximum height set may not be to the safe side.

2.5 PREVIOUS STUDIES

Cheng et al. and Guohua (2009) studied the bonding behavior among the surrounding concrete and the reinforcing line, six types of groups in total that release stainless steel bars and two types of strands with missing metal bars, which serve as a reference, are being investigated and presented. The main experimental parameters for this investigation may include embedding length,bar width and reinforcement line type. In particular, the beam method for reinforcing stainless steel bars on the surrounding concrete was analyzed by comparing six group samples with an aluminum alloy bar. The results showed that the bond pressure obtained by the vertical bars is much lower than that of the broken bars given the same characteristics and details. On average, the open bars appear to only increase 18.3% of the bond stress of the broken bars.

The following **conclusions** are reached:

1. With the detection of a pull-out sample, the free end is defective at the start of loading when the empty bag section is attached. The free end skiing started to increase with the added speed of the upward loading, then the vertical barrier was quickly drawn, and the pilot test was damaged by the reinforcement bar was removed.

2. At the embedded inner depth, with a stronger reinforcement diameter, the strength of the beam of soft bars is reduced, while the Al-alloy of the elastic has less significant change.

3. Bond strength of a visible bar is formed by the density and adhesion and is largely dependent on the tension. However, the bond strength of the Al-alloy simply is formed by the adhesion pressure, which ranges from 0.21 to 0.56 MPa as 1/10 that of the horizontal bars.

2.6 PREVIOUS STUDIES

Deng et al. and Yang (2012)investigated the chloride-bonded bond-slip characteristics of chloride deposited with various standards of applied reinforced concrete (RCA). A Pullout test was performed to evaluate the binding and elastic modes of embedded rebar that meet different corrosion rates. Both the upper and lower concrete are facing down. Bond-slip curls were recorded to determine the reduction of rebar saturation rates and RCA return on bond strength and deterioration of signal strength. Experimental results show that increased rebar corrosion gradually increases the strength of the reinforced concrete sliding reinforced concrete (RAC) without a small degree of elasticity and the rate of deterioration of the final strength decreases with a decrease of 0.5% rebar corrosion. The results also indicate that the final strength of the reinforced RAC decreases slightly with the increase of the RCA insertion. However, the relative strength of the bond between the unstructured rebar and the RAC is less affected by the RCA content, while it decreases with the increase of the RCA insertion in the specimens that rises significantly after the degradation. The decreasing power between the damaged rebar and the RAC is found to decrease with the increase in the rebar Corrosion rate and with the increase in the RAC content.

The assessment scenarios here may differ somewhat from those in other contexts. Part of the mix with different materials may vary and will affect the results. As our research represents common experimental parameters for concrete reinforcement adjustment at different RCA levels, the authors believe any concrete variations, pull test procedure, and others will challenge the refinement of this test and will not cause significant variations or distortions.

1. High-strength RAC tends to crack at a small rate due to its low strength. RAC filler products with small strength can pull strongly at the will of those large panels and cause a large range of cracks in the concrete.

2. Minimum adjustment to the reinforced RAC first increases the tensile strength of the rebar, and then, with the increase of rebar rust, the final tensile strength decreases, while the rate of deformation increases with a decrease of compressive strength at 0.5. % Rebar corrosion but decreases to the point where the corrosion rate increases to 1.5% and 2.5%. In addition, the increasing corrosion rate gradually weakens the strengthened RAC mobility.

3. The final strength of the reinforced RAC decreases gradually with the increase of RCA replacement. However, the relative strength of the bond between the unstructured rebar and the RAC is less affected by the RCA content, while it decreases with the increase of RCA incorporation into the high-energy samples after rebar dissolution.

4. The gravitational force obtained decreases with increasing rebar corrosion rate and increases with increasing RCA content; however, this type of climbing disappears when the concrete containing the RCA is embedded in transparent rebars.

2.7 PREVIOUS STUDIES

Aryanto and Shinohara(1998) concluded that bonding is one of the key keys for assessing the performance of concrete structure (RC)) In this paper, bond performance including bond compression, streamlining, compression gaps and rigidity of RC members of the finishing element have been explored under certain levels of corrosion steel. Seven types of cylinder with a diameter of 19mm and 2.8 cover across the width of the bar were prepared and inspected under the damaged area. The rust rate ranged from 0% to 4% in weight loss. At low corrosion rates up to 1% of the corrosion rate, bond pressure increases resulting in a decrease in the rate of corrosion rate. At higher corrosion rates the decrease in rate of cracking is due to the weakening of the concrete strength which is caused by the cracks around the damaged bar. A simple analytical method was proposed to predict the fracture space of the fracture joints of the damaged cone.

The following **conclusions** are reached:

1. Damage of reinforcement bars to RC members influences bond stress, fracture gaps and tensile strength. The results of the evaluation of the members of the corrupted RC model indicate that with a low degree of corrosion it shows an increase in the local bond pressure.

2. It also shows a decrease in the rate of deformity of the scale with an increase in corrosion rates. This decrease in the average crack is caused by an increase in bond pressure at low

corrosion up to 1% and a slight decrease in concrete strength caused by cracks around the corrosion barriers of high corrosion.

3. The longitudinal / splitting die also plays a major rule in reducing bond stress and the intensity of conflict.

4. From the test, it is expected that there is a subtle decrease in the yield strength of the molded RC members in the bottom rust.

2.8 PREVIOUS STUDIES

Barbosa and Filho (2011) took a number of international standards to regulate the use of high strength concrete, which may not have been generally accepted without regard to the differences that could be made between materials in different countries. This paper presents the results of a pilot study involving the casting of Brazilian steel tests, with five different strengths of concrete, 20, 40, 60, 80 and 100 MPa, and three different steel diameters, 16,0, 20,0 and -25.0 mm. The test results of the bond disappearance relationship are compared with the CEB provisions and other materials found in the literature. A single statistical analysis was performed.

Following **conclusions** are drawn from the test results:

1. Updated the bond between concrete and steel made. The test results achieved when issuing tests on Brazilian steel in relation to bond behavior are used to compare with other results of the specific theoretical model found in the literature.

2. The bonding study between reinforcement and concrete is not easy. The behavior of the reinforced concrete elements is affected by the smoothness of the steel bars embedded in the concrete matrix. The effect of the intensity of the friction and the emergence of the cracking occurs from the onset of the melt; therefore, the evaluation of those items requires the introduction of a bond bond model.

3. This paper introduces specific numerical models and the victimization methodology that affects the structural performance of Brazilian materials.

2.9 PREVIOUS STUDIES

Laura and steffen et al.(2014) studied the effectiveness of bond strength among steel and concrete reinforcement is a very important requirement for reinforced concrete as composite materials. Thus, bond quality is influenced by a wide range of parameters. The focus is on the presented paper on the effects of compressive stresses acting directly on the hardness of the reinforced bar bars, as can be found on the reinforced reinforced concrete wall under increasing pressure.

The influence of the differences is determined by means of tests that are issued with separate concrete covers. Compared to the standard construction material, the concrete covers on the walls of the containers are expected to be much larger. The strength of the concrete cover is an important factor in the bond failure mode. For the results of the proposed tests the dependence of the bond strength under the fluctuating argument on the expected bond damage is shown. The following **conclusions** are reached:

1. The structural behavior of reinforced concrete and reinforced concrete materials is strongly influenced by the reinforced beam structures. Bonding characteristics are also directly related to the loading conditions of the material. In the event of a heavy biaxial load, e.g. on the walls of the container, deterioration of bond structures may occur, which may affect the cracking and the behavior of the catalyst structure.

2. For pull-out tests of different concrete the influence of the bond behavior differences between steel reinforcement and concrete. The results indicate that the impact of the collision affects the bond failure mode and consequently the high bond pressure fluctuations. In addition, the bond stress relationships that can be removed experimentally can be implemented into an FE model with a logical model for the deformation behavior of reinforced and pre-built concrete structures.

SUMMARY OF LITERATURE REVIEW:

The general behaviors observed after reading various papers on the subject were as follows:

1. Fibers are very effective in making stiffness difficult.

2. The tensile strength increases with increasing fiber content.

3. The loss of tensile strength increases as temperatures increase.

4. The binding strength gives more strength to withstand the increased temperature of the silica fiber mixture compared to the concrete M60.

5. Slip decreases with increasing bond strength.

6. With low contact recovery and low cost recovery, methylcellulose prefers latex.

7. The positive coupling is also among the maximum output strength of all three types of compressive strength of concrete which exerts a strong influence on bond behavior.

8. Good concrete types of high strength fail in the form of dissolution, and fractions fail abruptly to form small cracks.

9. As the interval length increases, the bond strength decreases and the corresponding slip increases. Absolute sample loss is 30% of the final bond strength strength.

10. The contamination of the greasy metal bars does not affect bond strength if the length of the metal bar attachment is increased and diameter of the bar is reduced.

11. Generally, when the bar degradation rate increases, the loss in bond strength increases.

12. The observed results, depending on the slip-slip curves, the magnitude of the bond loss and the length of time required to hold the sales force, give the correct answer compared to the experiment; i.e. the results are consistent with physical behavior.

13. Corrosion deterioration effects include a reduction in cross-sectional area of reinforcement, shrinking length of reinforced concrete due to excessive product deformation and decreased bonding between steel and concrete. Among other things, the reduction of the rigid area plays a very important role. Ignoring the other two effects of rust on price estimates has no material effect on these predictions.

14. Current corrosion varied considerably between the sample and at different times in the same syllabus although the applied magnetic field was constant.

15. For pull-out signals, the free end is defective at the start of loading when the empty bag section is attached. The free end skiing started to increase with the added speed of the upward loading, then the vertical barrier was quickly drawn, and the pilot test was damaged by the reinforcement bar was removed.

16. Rac-strength RAC tends to deteriorate to a lesser extent due to its higher strength. RAC filler products with small strength can pull strongly at the will of those large panels and cause a large range of cracks in the concrete.

CHAPTER 3

MATERIALS & METHODS

3.1 CONCRETE

Composite material that is concrete is made of fine total blended in with (concrete glue) that is strong - by and large a concrete mortar, for example, lime clay, yet once in a while with water driven strings, for example, calcium aluminum or Portland concrete to assemble Portland concrete solid (much like Portland stone) .Many different kinds of non-concrete cement are accessible in different methods of holding, incorporating black-top cement with a thick layer. regularly utilized in street surfaces, with polymer cements that utilization polymers as a connector.

At the point when the material is blended in with dry Portland concrete and water, the blend shapes a promptly transferable fluid grease framed and formed. The concrete blends in with water and different fixings to shape an intricate grid that joins components together into a strong material, for example, the most regularly utilized stones, added substances, (for example, pozzolans or superplasticizer) are added to the blend to improve the physical properties of the wet or last blend. Most concrete is poured with fortified materials, (for example, rebar) that are introduced to give less quality, creating strengthened cement.

Concrete is among the most utilized materials. Its overall use, ton by ton, is twice as much as wood, steel, plastic and aluminum consolidated. All around, the instant solid industry, the biggest fragment in the solid market, is relied upon to surpass $ 600 billion by 2025.

3.1.1 Concrete Grading

The level of cement demonstrates its quality required for development. For instance, the M30 territory demonstrates that the compressive quality required for development is 30MPa. The primary book in grade "M" is a blend and 30 is the necessary quality of MPa.

In light of different lab tests, the solid evaluation is introduced in Mix Proportions. For instance, in the M30 territory, the blending proportion is around 1: 1: 2, where 1 is concrete, 1 is the sand proportion and 2 is the unit mass dependent on the size or weight of the materials.

The quality is estimated by the solid 3D shape or chambers made by structural specialists at building destinations. 3D shape or chambers are made during throwing of auxiliary individuals and after adjustment is restored for 28 days. At that point the force gain test is performed.

Standard solid imprints are M15, M20, M25 and so on. For light solid works, M15 is commonly utilized. For solid development to be made utilizing at any rate M20 evaluation of cement.

MIX PROPORTION AFTER ADJUSTMENTS FOR DRY AGGREGATE

Table 3.1 Mix design consideration for M40

Material	**Quantity**
Cement	547.42 kg/m3
Water (added)	208.72 kg/m3
Fine aggregates (Dry)	562 kg/m3
Coarse aggregates (Dry)	1061.5 kg/m3
Free w-c ratio	0.36

Self Compacting Concrete

Oneself compacting concrete is a kind of solid that streams intensely and spreads through the structure without the need to vibrate. The solid you use is a fair solid set by its weight. The significance of the solid you work for is that you keep up all the strength and solid qualities, meeting the normal execution prerequisites.

At times superplasticizers and consistency modifiers are added to the blend, decreasing draining and partition. In solid isolates it loses its quality and results in territories that have apiaries close to the structure. A very much made SCC blend isn't troublesome, it has a high nail and fantastic strength qualities

3.2 REINFORCED CEMENT CONCRETE

Reinforced cement concrete (R.C.C) is a blend for standard reinforced concrete for maximizing its compressive strength and strength to a large degree.
Concrete is the modern structural material that is made by mixing a good-balanced amount of cement, crushed rock or rock,sand and water.
Used from sub structure to roofs, highways, motorways, and power stations, canals, and other portable buildings.

3.2.1 Role of Reinforcement in Concrete.

As we realize that, solid has high quality, yet low quality.

In this way, when just the substantial burdens chip away at the solid surface, at that point there is no compelling reason to apply fortification to it.

Yet, where heavier powers are additionally included, as in, pillars and pieces, there is a high danger of disappointment when clear cement is utilized.

Steel, in any case, as we probably am aware, has next to no quality (and has great compressive quality).

Along these lines, when the two materials (cement and steel) are joined, a structure material can withstand every one of the three sorts of vitality that might be dynamic in the structure, e.g., compressive burdens, compressive anxieties, and shear powers. Such materials are known as Reinforced Cement Concrete.

The materials used by us are given below:

Figure 3.1 Coarse aggregates(20mm)

Figure 3.2 Coarse aggregates(10mm)

In **figure 3.1** and **figure 3.2** Coarse aggregates of 10mm and 20mmare shown which were available in the lab and were used in casting M40 samples and hence increased workability.

Figure 3.3 Sand Zone(ii)

Figure 3.4 Sand Zone(iv)

In **figure 3.3** and **figure 3.4**, Fine aggregates are shown zone-2 and zone-4 sand they were rough and fine respectively and were mainly used to fill up void spaces in coarse aggregates and were used in M40 mix design.

Figure 3.5 OPC 43 Cement

In **figure 3.5** Ordinary Portland Cement of 43 grade is shown that was used by us while working .Cement was the most important material used for preparing specimens,it was bought by a nearby retailer.

Figure 3.6 Cubical Mould

Figure 3.7 Oiled Cubical Mould

In **figure 3.6 and figure 3.7** Cubical moulds of 150*150*150mm are shown that are used for casting of specimens; the dimensions selected are such that the minimum dimension will exhibit the same strength as that for any other dimension at the actual site.

Figure 3.8 Tamping Rod

In **figure 3.8** Tamping rod is used in Cube Molds to compact concrete. The rod is made out of steel. It has a size of 16 mm, a length of 60 mm and is flattened or shaped at one end.

Figure 3.9 Trowels

In **figure 3.9** Trowel is shown that is a small hand tool used for removing air entrapped as well as having a homogeneous mix and then can be used to transfer concrete paste from mixing tray to cubical moulds and giving a smooth surface.

Figure 3.10 Mixing Tray

In **figure 3.10** Mixing Tray is shown that is used for mixing of aggregates(fine and coarse) and cement and then making homogeneous concrete paste without any difficulty it has a plain and smooth surface and is very durable.Hand mixing or with a trowel can easily be done on it.

3.3 METHODOLOGY

Throughout the years, a few distinct forms of the draw out have been made. They all have regular highlights that the strengthening bar is driven into the solid bar, the support bar is pulled out by putting the pressure load on the fortification bar, and the solid square is kept from moving by the steel plate acting against the strain load. Be that as it may, a few subtleties of the test arrangement fluctuate starting with one test then onto the next. As can be found in the table, the distinctions in test arrangement mostly comprise of two variables, to be specific: test type structure and load utilization.

To study the effects of boundary conditions on the appearance of steel concrete, a three-factor analysis of the experimental setup was compiled. The aggregate component of the reinforcement line has a length of 150 of the 75 channels used for analysis. In the analysis, a drag load of 100 kN was applied to the reinforcement line and all the materials are considered to be directly coupled to the structures as listed in the figure, for the purpose of illustration.

3.3.1 Experimental Setup

Portland standard cement (OPC) was used for concrete. The Blain endpoint is rated as 354 m2 215 / kg.Aqueous solubility of the solid and composite fines is rated as 1.89% 219 and 1.37%, respectively, the moisture value of the aggregate 220 is measured to be 1.04% and 0.79%..

Since we require a variety of concrete structures, we used two different types of concrete, namely Self compacting concrete and M40,discussed earlier.

3.3.2 Testing of Materials

CEMENT

1. Consistency Test – It was done in accordance to the IS 4031 (Part 4): 1988 [54].Cement adhesion is defined as the viscosity that would allow a Vicat planter to have a diameter of 10 mm and 50 mm to penetrate 5- 7 mm amid bottom of the wall.IST & FST, energy efficiency,water content and power can be determined using this test.

Figure 3.11 Vicat Apparatus

In **figure 3.11** The Vicat Apparatus with adjustable stainless steel wing and 300g needle assembly is shown. It is used to determine the consistency and start / end times of a set of ropes and mud concrete.

2. Initial and Final Setting Time Test – Following IS 4031 (CHAPTER 5): 1988 [55]. The first placement time is the duration between the time when water is put to the cement and the time the 1 mm square pin does not penetrate the cement paste, placed on a Vicat 5 - 7 mm wood from the bottom of the wall. The final setup time is the median time when water is poured to the cement and the time when the 1 mm pin makes it appear to attach to the mold but the 5 mm attachment is less effective. The water added to this test must be "0.85 P" per cement weight, where "P" standard consistency is obtained from the consistency test.

Figure 3.12 Cement testing

In **figure 3.12** Cement testing can be seen by filling up of cement paste in Vicat mould 60/70 dia. X 40mm for further testing of initial and final setting time test by Standard Vicat apparatus

3. Soundness Test – It was performed according to IS 4031 (Part 3): 1988 [56]. The soundness of cement implies the ability to withstand volume increase. The increase in volume on the concrete wall or concrete floor is due to the presence of durable concrete,burned MgO and CaSO4. The existence of only immature lime was found by the Le-chatelier method. The water poured to the test should be "0.78 P" by cement weight, where "P" is the basic consistency of cement.

4. Fineness Test –.Following IS 4031 (ARTICLE 1): 1988 [57]. The fineness is calculated by rotating around a standard beam.The amount of cement whose grain size is larger than the general mesh size (90 micron) is calculated. An increment in concrete corrosion (greater than 10%) increases concrete immersion, thereby creating cracks in the structures.

Figure 3.13 90 micron sieve

In **figure 3.13** Sieve of 90 micron is shown. Cement fineness is measured by wrapping cement in a standard sieve. Part of the cement where the particle size of cement is greater than 90 micron is determined.

5) Specific Gravity Test – It was performed as per IS 4031 (Part 11): 1988 [58]. Cement specific gravity is the ratio of the volume of cement provided and the weight of the equivalent water at 4 ° C. This test was done using a Le Chatelier pot.OPC should have a gravity of around 3.15.

Figure 3.14 Le-Chatelier bottle

In **figure 3.14** Le-Chatelier's Flask is shown that is used to obtain specific hydraulic cement strength. Made of Borosilicate glass. The flask is 243mm in total height, with a maximum of 90mm 250mml capacity.

Fine Aggregate Testing

1. Fineness Modulus Test – Fine aggregates fineness modulus is calculated using the sieve analysis. FM test provides stability of the sand surface. FM is obtained by adding the combined percentage of the joint mass to one of the standard allowances from 10 mm to 150 µ and dividing this amount by 100.

2. Specific Gravity Test – It was performed in accordance with IS 2720 (Part 3): 1980 [59] using a bottle(pycnometer).

Testing of Coarse Aggregate

1. Fineness Modulus Test – It was done same as that of the other aggregate. The only contrast is that here, the sieve size ranges from 80 mm-150 µ.

Figure 3.15 Aggregates Sieving

In **figure 3.15** the sieves are arranged in descending order with the largest filter at the top. Then pour the sample through the top filter and close it, then hold the two top layers and kick it in and out, straight and straight. After a while touch the 3rd and 4th sieves and finally the block.

2. Specific Gravity Test – This was made in accordance to IS 2386 (Part 3): 1963 [60] using wired baskets.It is performed to measure the quality or strength of the aggregates used. Low-weight aggregate is likely to be frail than those with more pulling rates.

3.4 PULL-OUT TEST

3.4.1 Apparatus

All pull tests will need to be performed using an MTS test machine with a load of 250 kN. The image of the test machine and the test set are presented in Figure.3.16 and the 3.17 bond length of the bond set is 75 mm (150m beam height), the total load expected to be 75 kN, which was expected to be 20% of the test machine's strength. . From the output load failure measured by the test machine, the bond strength will be calculated as the failure load divided by the surface area of the reinforcement diameter, according to the following equation []: $\tau = F / \pi dl$

where τ = bond strength,

F = failure load,

d = width of the toolbar,

l = the combined length of reinforcement bar.

The test case will be mounted on the right test machine in such a way that the bar is pulled horizontally from the cube. The end of the bar at the pull will serve to be the highlight of the new face of the cube as it is cut. With regard to the execution of the types of tests, the emphasis bar is cast on the concrete surface of some of the test methods in the vertical position and other test methods in the horizontal position. In addition, the reinforcement bar is attached to the concrete block in the middle of the concrete slab for other test methods but closer to or far from the stack (connector 111 concrete-plastic steel) or to the entire length for installation of other test methods, as shown in column 3 of Table 1. Finally, the location The visible 113 can be a molded area for some test methods or a soft spot for other test methods. These differences, however small, may have some effect on the test results because (i) the position of the tensing of the reinforcing bar may affect the quality of the joint surface above the reinforcement area, (ii) the binding of the reinforcement bar. in the concrete block area near the binding site may cause concrete failure, and (iii) the hardness of the available surface may cause an uneven distribution of contact pressure at the concrete contact point.

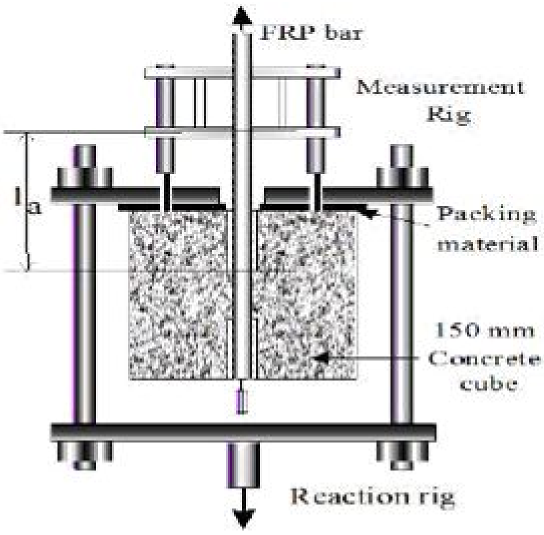


Figure 3.16 Pull-out Test set up

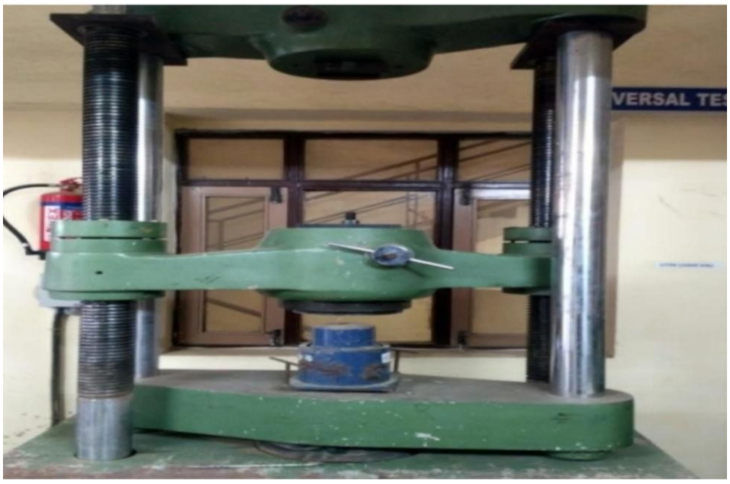


Figure 3.17 (UTM) Universal Testing Machine

Mold will be water soaked. Water can be achieved by using jointed joints, or by adding a composite element to the assembly area after the assembly. The molds will be designed to hold the bars firmly in place and will allow for easy removal without the hassle of installed bars.

3.4.2. Test Specimen Preparation

- **Rust and Bars scales-**They will be for all time expelled from the bars by wire brushing and examination bars to guarantee that they are liberated from oil, paint, or different covers that may influence their authority. Fitting arrangements may likewise be utilized, if essential, to clean the oil or oil. The main fortification bars on which the dial-size trunk will be set on the test, ought to be the outside of the standard ordinary perfection that is in the hands of the tomahawks.
- **Measurements of the Testimen Test -** The test types will have solid sections of size given underneath, with a solitary strengthening bar appended legitimately to the focal pivot at each start. The bar will slide down around 10 rom from the base of the 3D shape face as it is cut, and will climb upwards from the surface any separation expected to give enough line bar to broaden the conveying squares and bolster the test machine and give enough length to be held for gear use. At the collecting of the test instrument in the example of the separation between the outside of the solid and the point toward the finish of the hindrance that fixes when the estimating device is in. It is gotten, it will be painstakingly estimated with the goal that the tallness of the bar is over this separation; it very well may be determined and attracted to the deliberate point.
- **Concrete Connecting -** notwithstanding those tests where the solid blending strategy is a controlled variable, the solid will be blended as per the pertinent necessities for the technique for rewarding and rewarding solid test insights in the lab portrayed in IS:516 · 1959 *.
- **Embellishment and Curing Techniques -** notwithstanding those tests where the solid position strategy is controlled, the symbols will be formed and restored by the prerequisites for the solid and solid relieving process (lab manual) determined in IS: 516 · 1959 ·. After the front layer is appended, the surface will be splashed and secured with a clammy bar to forestall vanishing.

- **Number of testimen-** At least three pointers of the harmed bar submitted to the test and three kinds of examinations of the physical barrels of one practical zone comparing to the harmed bars under investigation, will be arranged and tried.
- **Test Conditioning -** The outside of the 3D shape, which is a transporter on the draw test, will be covered with a meager layer of fine concrete glue at any rate 24 h before testing, or a dainty layer of high quality gypsum mortar will be applied at any rate 2 h before testing.

Figure 3.18 Testimens for testing

In **Figure 3.18** Specimen for Pull-out test is shown. After the curing period the sample is tested in Universal Testing Machine to find out the bond strength between the steel bar and the concrete.

The mentioned details shall be recorded:

- The strength of concrete cracking by age corresponding to the material age at the time of performing pull tests, the age.
- Load scale 0-025 mm at free end.
- Average load of 0-25 nun at the free end.
- Slides are free and downloads keep up with occasional uploads.
- The ultimate burden is failure and the nature of failure.

CHAPTER 4

SOFTWARE ANALYSIS

4.1 ANALYSIS ON ABAQUS PART

We started by designing a solid tridimensional and deformed body. We did this by further sketching the two core (square), and cylinder profiles. When constructing an object, ABAQUS / CAE automatically invokes Sketcher.

We have also produced data plans for developing model assembly

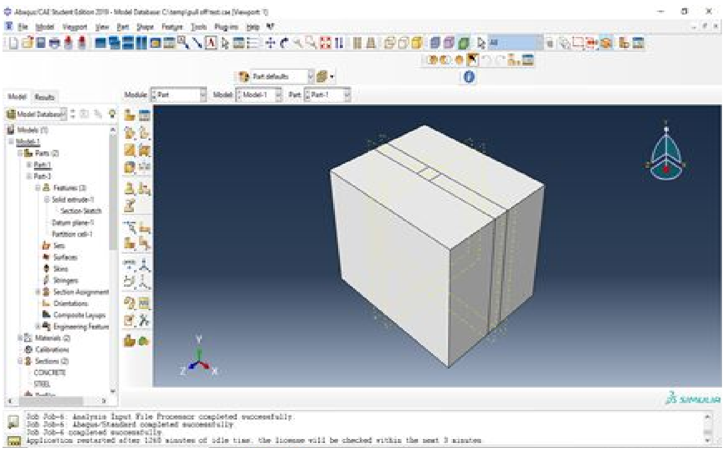


Figure 4.1 3D modelling of square block using PART Module

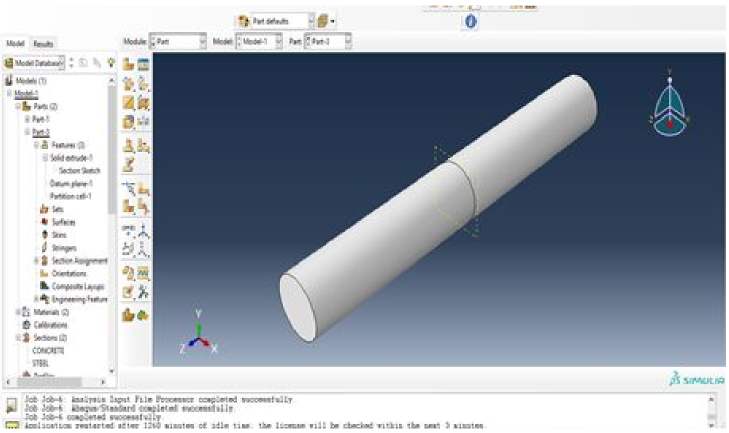


Figure 4.2 3D modelling of cylindrical block using PART Module

4.2. PROPERTY

We use Module Property to build assets and define their properties. The following properties are used for the research of this section. There are two types of materials used.

Table 4.1 Material Properties

S.No	Properties	Concrete	Steel
1	Young Modulus	25000 N /mm	20000 N /mm
2	UCS	25 mPa	415 mPa
3	Density	2400 kg /m	7850 kg /m
4	Poisson Ratio	0.15	0.3

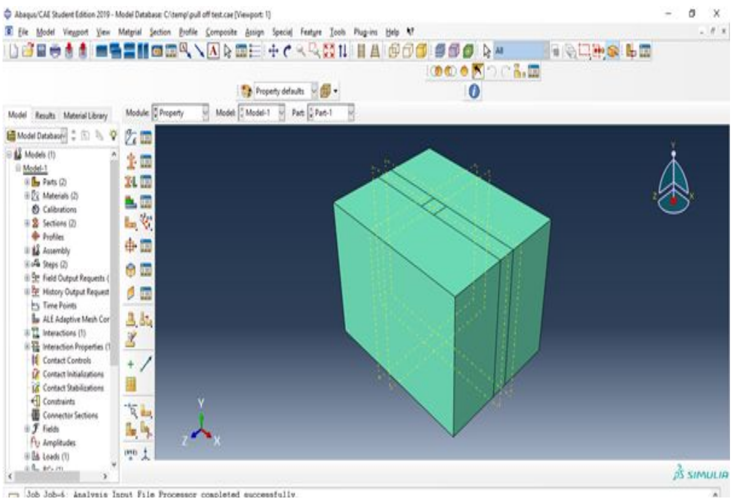


Figure 4.3 Creating concrete properties to square block using PROPERTY Module

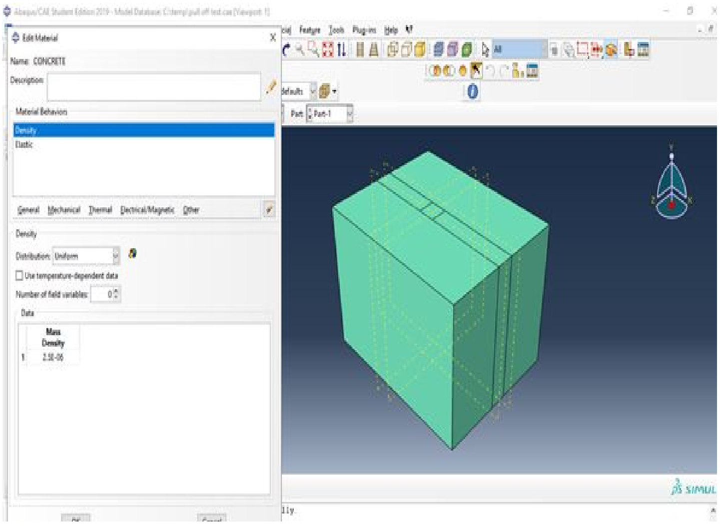


Figure 4.4 Creating material CONCRETE

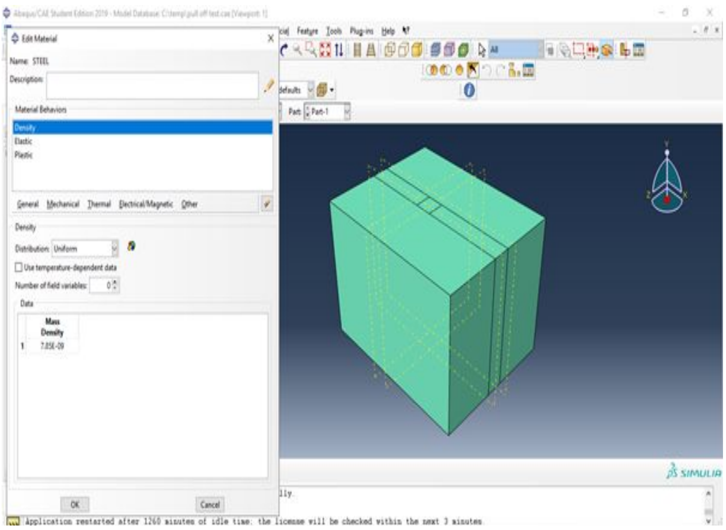


Figure 4.5 Assigning properties to the material CONCRETE

4.3. ASSEMBLY

Every part we build is focused on our coordinate system and is independent of other parts of the model. By creating component instances and then setting conditions that are related to each other in the global coordinate system, we use the Assembly module to define the state of the completed model, called the assembly. While the model can contain many components, it has only one assembly. We built one example of a concrete block, and another with a metal bar.

The figure displays the Assembly of the model:

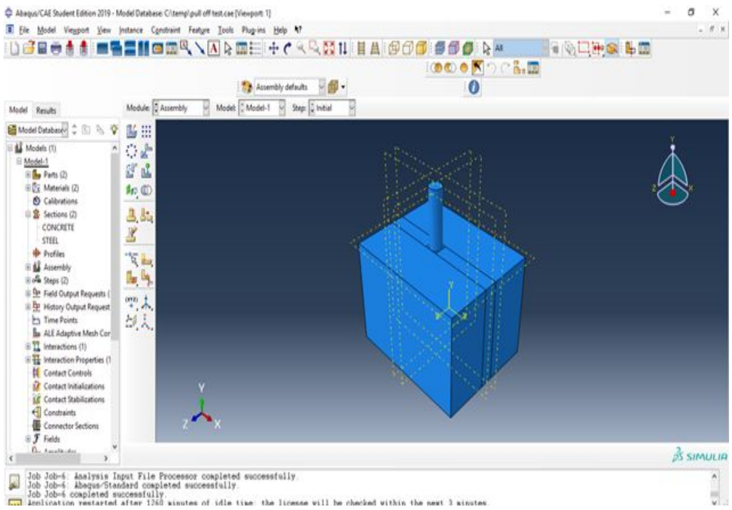


Figure 4.6 Assembling the 2 parts using the ASSEMBLY module

4.4. STEP

Since we have made our part, we can move to the Step module to characterize our means in examination. An underlying advance, where we will include a constraining condition that confines the solid square's development. ABAQUS/CAE consequently produces the underlying advance yet you have to utilize the Step module to make the progression of the examination yourself. You can likewise demand yield for any means in the examination through the Step module. So we made Step-1(Static, General) where the focus was on the power to use to pull the metal bar up.

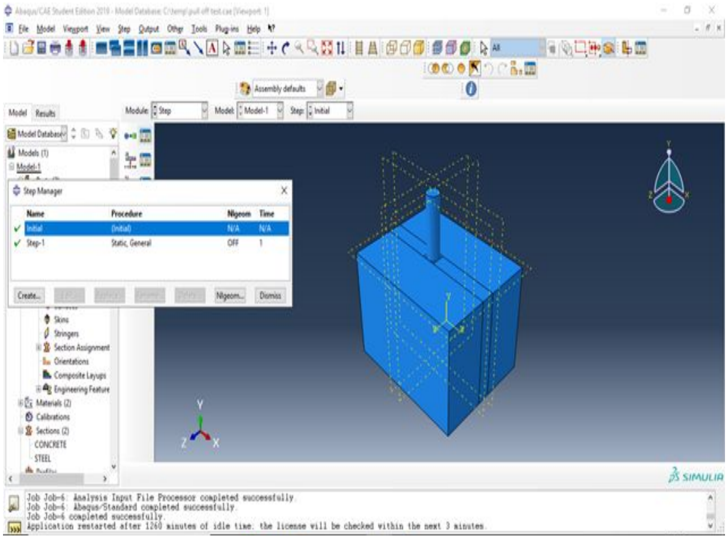


Figure 4.7 Creating step(STATIC, GENERAL) using STEP module

4.5. INTERACTION

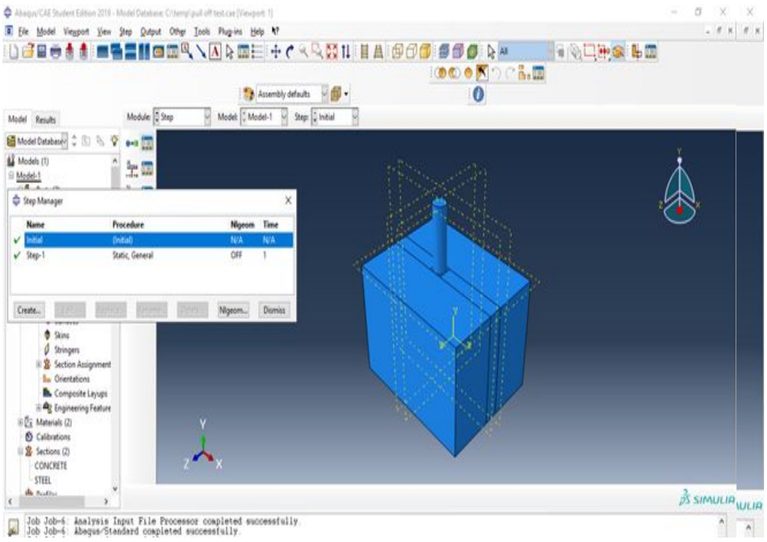


Figure 4.8 Assigning boundary conditions and creating an interaction using INTERACTION module

4.6. LOAD

Boundary conditions are applied to the 5 faces to prevent block movement in the opposite direction. To pull the cylinder, a 100 kN load is inserted into the slave position.

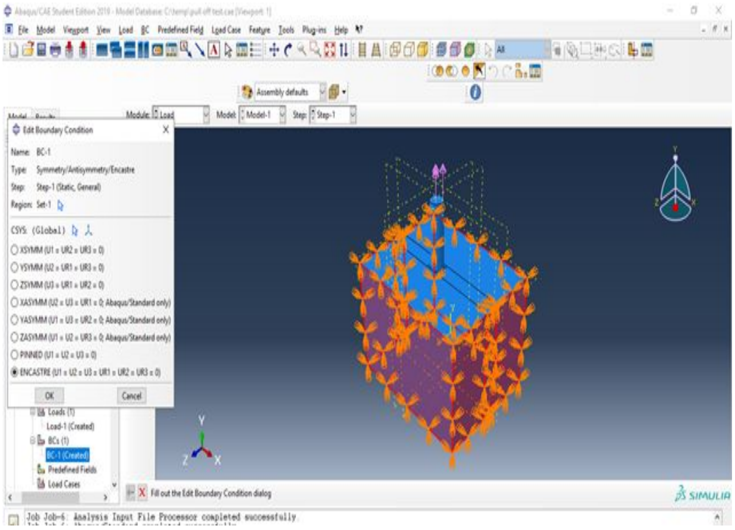


Figure 4.9 Assigning load using LOAD module under step 1

4.7. MESH

The grid of finite elements is generated by the use of the Mesh module. We will choose the meshing technique which is used by ABAQUS / CAE to create the mesh, the shape of the element and the type of element. ABAQUS/ CAE utilizes different meshing techniques. When we enter the Mesh module, the color of the model indicates the default meshing technique assigned to the model; if ABAQUS / CAE model is displayed in orange, it can not be meshed without our assistance.

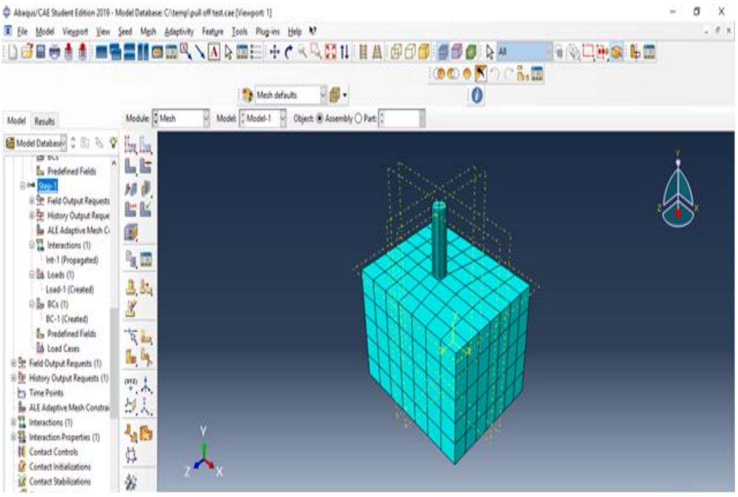


Figure 4.10 Creating mesh using MESH module

4.8. JOB

Since we've designed your examination, you 're going to move to the Job module to make an job identified with your model and present the activity for investigation. It is where the information and data are submitted and observed, and breaks down are finished with no blunder in pre-preparing. A Visualization apparatus helps see the tests after finish.

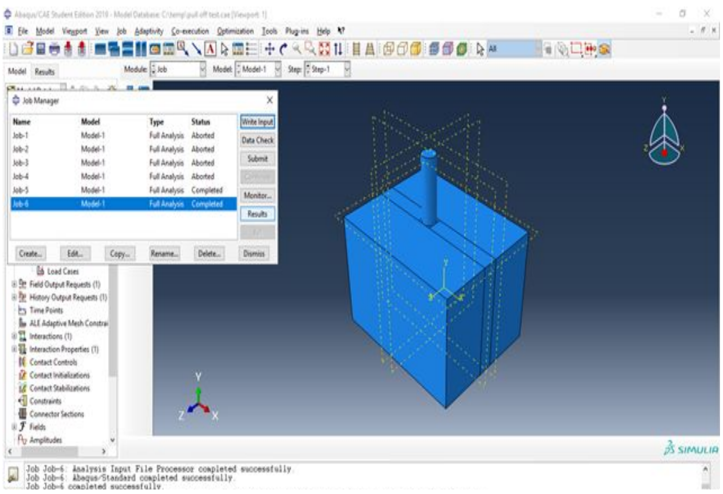


Figure 4.11 Job creation and submission using JOB module

4.9. VISUALIZATION

The stress distribution is shown for the given model:

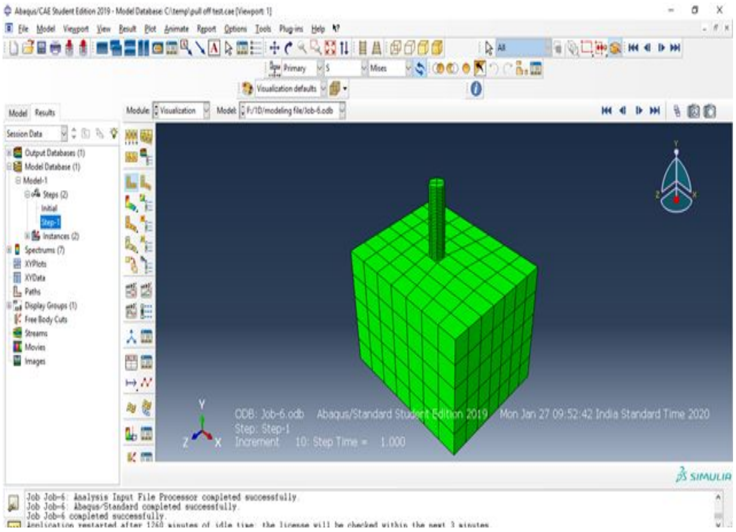


Figure 4.12 Stress Distribution

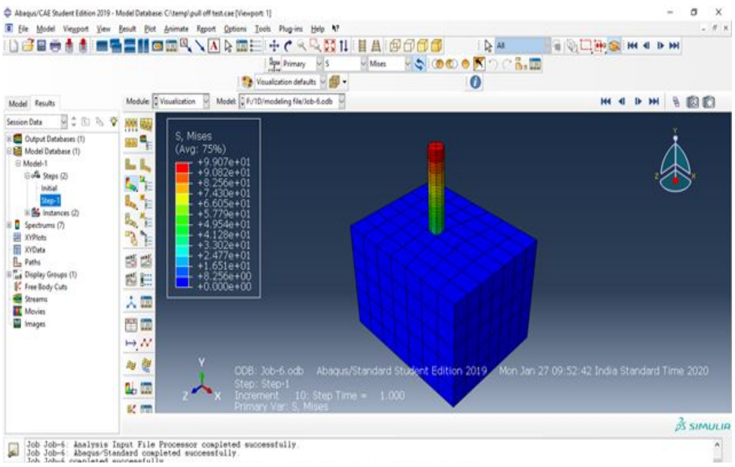


Figure 4.13 Stress Distribution of Modules

CHAPTER 5

RESULTS

5.1 CEMENT AND AGGREGATES TEST RESULTS

Table 5.1 Cement Test Results

Serial no	Test name	Results obtained	Theoretical value
1	Consistency	30%	26-33%
2	Initial setting time	90min	More than 30 min
3	Final setting time	260min	Less than 600 min
4	Soundness	7mm	Not more than 10mm
5	Fineness	3%	Less than 10%
6	Specific Gravity	3.15	3.15
7	Compressive strength	7days-27mPa 28 days-40.5mPa	43mPa

The above theoretical values are based on IS code 4031-1988,IS code 4031-1989,IS code 4031-1996 and IS code 8112-1982 respectively.

Table 5.2 Fine Aggregates Test Results

Serial no	Test name	Results obtained	Theoretical values
1	Fineness modulus	2.96	2-4
2	Specific gravity	2.65	2.5-3

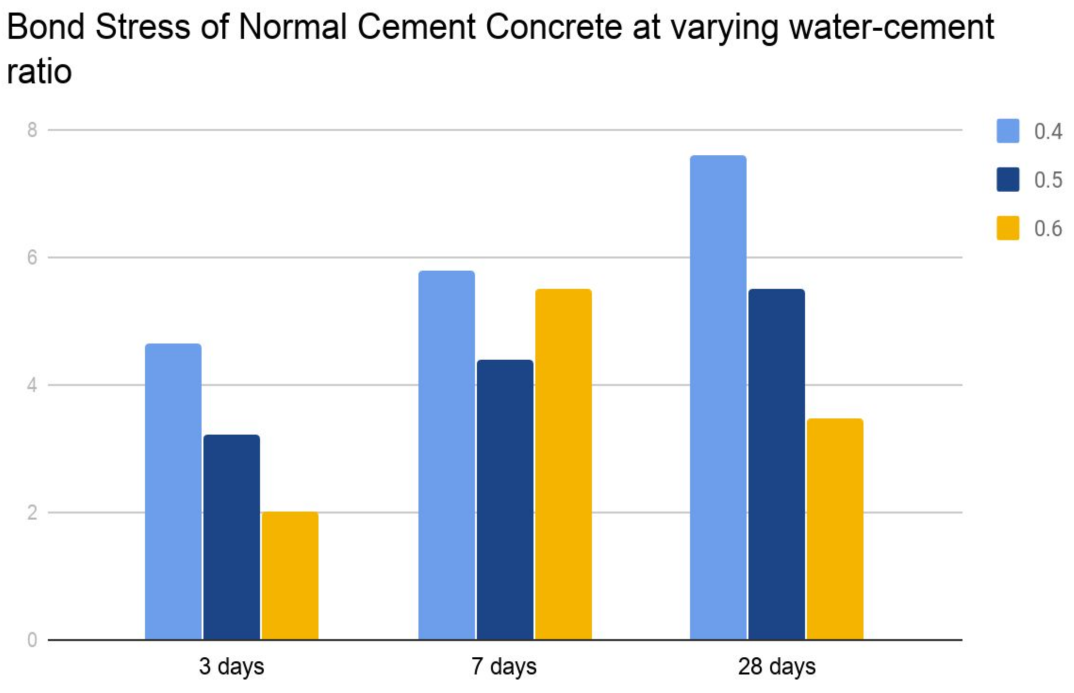
Table 5.3 Coarse Aggregates Test Results

Serial no	Test name	Results obtained	Theoretical values
1	Fineness modulus	7.2	6.9-7.5
2	Specific gravity	2.73	2.5-3

5.2 PULL-OUT TEST RESULTS

Table 5.4 Normal Concrete Bond Strength at varying W / C ratios

W/C Ratio	3days	7days	28days
0.4	4.657	5.79	7.59
0.5	3.235	4.38	5.49
0.6	2.005	2.63	3.48

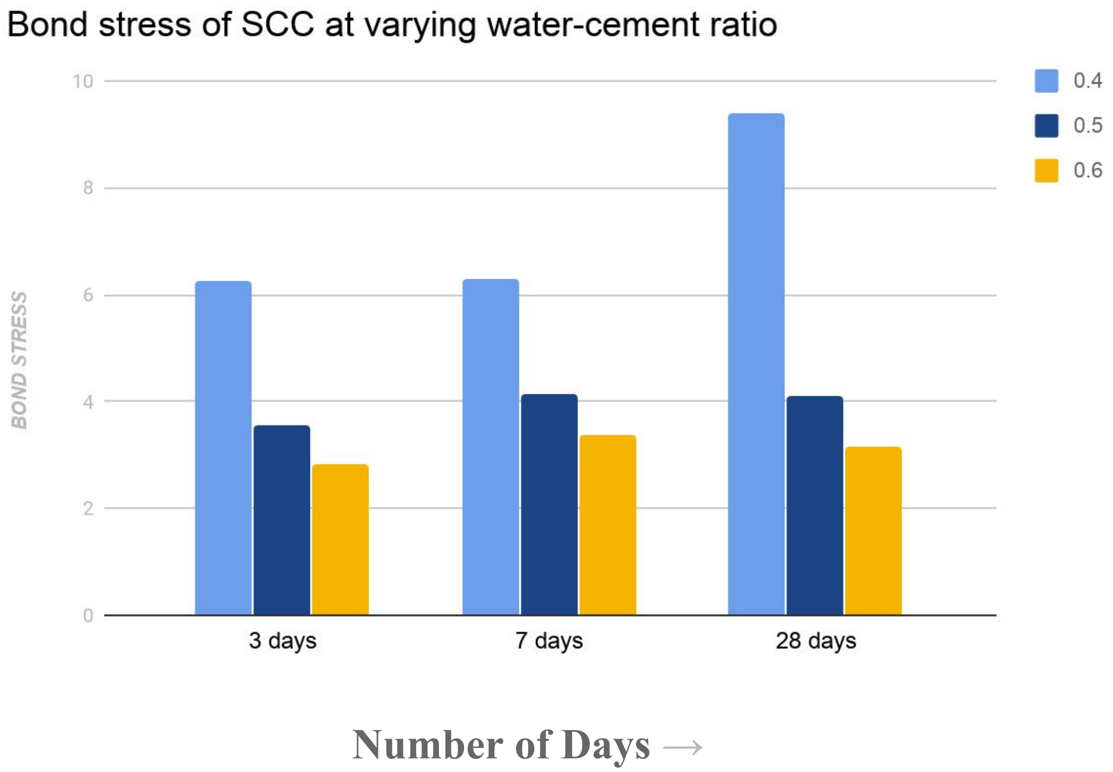


Number of Days →

Graph 5.1 Normal Cement Concrete Bond Strength

Table 5.5 Self Compacting Concrete Bond Strength at varying W / C ratios

W/C Ratio	3days	7days	28days
0.4	6.24	6.31	9.41
0.5	3.54	4.15	4.12
0.6	2.83	3.36	3.14



Graph 5.2 Bond Stress of SCC

5.3 SOFTWARE ANALYSIS

As software analysis was incomplete we could not compare the results obtained from the software to experimental results. We were only able to carry out analysis with one type of concrete that is only half the work done.

CHAPTER 6

CONCLUSIONS

Based on the study, conclusions are drawn afterwards:

1. The strength of bonds related to Regular Cement Concrete (NCC) was lower than that of Self Compacting Concrete (SCC) at 0.4, 0.5 and 0.6 cement water ratio(WCR).

2. Bond strength at NCC is highest at 3, 7 and 28 days at a rate of 0.4 W / C, while at SCC bond strength is at 3, 7 and 28 days on average 0,4 W / C.

3. Compared with the NCC, the bond strength of the SCC increases rapidly at a rate of 0.4 W/C and the bond strength in the SCC is approximately equal to the value of the bond strength with the NCC by 0.5 and 0.6 W / C 7 and 28 days.

4. Easily and economically viable, a modified Universal Testing Machine can be used to calculate bond tension.

6.1 FUTURE SCOPE

This work has critical essentialness in building works identified with strengthened concrete and material determination and their particular. The trials performed to quantify the bond quality of strengthening bars can be utilized to assess the possibility utilizing SCC rather than ordinary cement. Besides, there are a few other important basic exhibitions, yet more accentuation has been set on bond quality in this paper, and the expansion of configuration rules from Normal Cement Concrete (NCC) takes into consideration examination.

The following points can be considered for future consideration in this study:

Changing steel bar with different forms of reinforcements.

Usage of various forms of cement and see functionality depending on its composition.

Changing the specimen's shape from a cubical mould to a slab or various geometric shapes.

Temperature varying as this also influences the strength of the bond between concrete and reinforcement.

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