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Institute of Graduate Studies

Civil Engineering

ASSESSMENT AND SIMULATION THE IMPACT OF CONCRETE STRENGTH ON THE STRUCTURAL PERFORMANCE OF BEAMS

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Master's Thesis

Supervisor

Prof. Dr. Zeki HASGÜR

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Yasir ALHAREERI

Signature

DEDICATION

Firstly, I want to thank My Father for everything he did for me in my life.

Mother, you deserve many words of thanks, thanks very much.

My Wife, you are the one who helped me because without supporting me I would not have succeeded.

My Daughter and Lovely Rose, you are the one who lit the path of success for me.

So, words cannot express how grateful to you, you are the light my way, the main supporter in my life, and I'm every day I realize how much you love me, so I will never forget your favor for the rest of my life, Words of thanks don't give you your right.

ABSTRACT

ASSESSMENT AND SIMULATION THE IMPACT OF CONCRETE STRENGTH ON THE STRUCTURAL PERFORMANCE OF BEAMS

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The tensile strength of concrete as it in less ability to resist the tension stress formed by the external loading, the increasing of the concrete strength can enhance the capability of the tension zone in the cross section to handle the effect of the tension stress for more upper limits without reaching the cracking section state. The study aimed to build effective analysis of the scope of increasing the strength of concrete to rise the internal strength of the tension region. The study took the effect of the width of beam, the height of the beam, and the reinforcement area into account then evaluated each parameter percent of impact. The height of the section showed the bigger impact percent so that the study derived equations based of the effect of the height F(h) on the strength index which referred to the compressive strength of concrete divided by the square of the load for concentrated load case and by the square of the distributed loading for uniform loading case. The study then modified the equation for various width of beam values to get F(h), b then for various span length values to get F(h),b,h. the study used the two cases loading (concentrated load and uniform loading to examine the possibility of the derived equation for each case to show the close to actual state of cracked load and cracked uniform loading based on various heights and widths of the RC beam. The strength index for the two cases was examined after the processing the

equation by building many charts including curve fitting techniques. The strength of concrete was examined fro range 30 to 50 MPa, the study explained the results by the derived formulas and by the working stress steps with low differences indicating the applicability of the new equations to improve the decision making for increasing the strength of the concrete under specific conditions of the RC dimensions. The study built 3d images simulation using ANSYS program. The stress on the cross section for Fc in the mentioned range was investigated according the safety factor values

Keywords: Concrete Strength, Structural Performance, Performance of Beams.

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ABBREVIATIONS

Fc	:	Compressive strength of Concrete
Ec	:	Modulus of Elasticity of Concrete
E	:	Modulus of Elasticity of Steel
Fct	:	Tensile Strength of Concrete
Fy	:	Tensile Strength of Steel
As	:	Area of Steel

LIST OF SYMBOLS

ε : Strain in beam

σ : Stress in beam

L : Length of beam

W : The applied load

b : Width of beam

d : Effective depth

1. INTRODUCTION

1.1 INTRODUCTION

Among ancient people, cement was perhaps the most frequently used bond formation substance. Concrete is differentiated by the aggregate and cement used, the specific qualities it possesses, or perhaps the methods used it to option it[1]. The water-to-cement ratio greatly influences the appearance of ordinary structural concrete. If everything else is equal, the less water content, the greater the concrete. This very same mixture must include just enough water to ensure that each accumulated particle is totally surrounded by cementations material, that the areas between the aggregate particles are filled, and also that the concrete is fluid enough to be pumped as well as spread effectively [2]. The quantity of cement being used relation to aggregate (conveyed as a three-part proportion to fine gather to coarse aggregate) is another factor affecting durability. There will be less aggregate where an especially strong torso of concrete is needed[3].

1.2 PERSPECTIVE FOR CONCRETE STRENGTH

For many decades, housing developers and construction groups have experimented with concrete bodies due to their strength. Nowadays, the use of ready mix body of concrete has become popular in the construction industry because building companies can now rely on actual concrete suppliers to provide better widely accessible body of concrete mixes. The concrete is a solid material that can withstand ductile and compressive stresses without deforming. A well-graded concrete mixture is much more solid than just a poorly-graded concrete [4]. Concrete's power has made it important in the construction of buildings, foundations, water systems, factories, large manufacturing sectors, and a variety of other structures. This same concrete's strength can be adjusted to meet the needs of the construction project. The strength is changed by making changes in the mixture, such as increasing or decreasing the amount of water, cement, and crushed stone ratio. Furthermore, concrete has the ability to strengthen over time [5].
The compressive strength of the body of concrete is determined by a variety of factors, including the water-cement ratio, cement strength, the quality of the concrete material used, validity control during the manufacturing process, and so on. Compressive strength is measured either above a cube or a cylinder. For the test, various approved codes recommend a concrete cylinder or concrete cube of the standard specimen [6].

Concrete strength is measured in pounds per square inch or kilograms per square centimeter of force required to crush a sample of a given age or hardness. The strength of concrete is affected by environmental factors, particularly heat and moisture. If it is allowed to dry prematurely, it can experience unequal tensile applied stresses that cannot be resisted in an imperfectly hardened state. Curing procedures involve keeping the concrete damp for a period of time after it has been poured in order to slow the shrinkage that occurs as it hardens. Low temperatures also have a negative impact on its strength. To compensate, an additive such as calcium chloride is mixed into the cement. This speeds up the setting process, which generates enough heat to compensate for moderately low temperatures. In freezing temperatures, large bodies of concrete forms that cannot be adequately covered are not poured [7].

1.3 DURABILITY OF CONCRETE

The compressive strength of the body of concrete is determined by a variety of factors, including the water-cement ratio, cement strength, the quality of the concrete material used, validity control during the manufacturing process, and so on. Compressive strength is measured either above a cube or a cylinder. For the test, various approved codes recommend a concrete cylinder or concrete cube of the standard specimen [6]. Concrete strength is measured in kilograms per square centimeter of force required to crush a sample of a given age or hardness. The strength of concrete is affected by environmental factors, particularly heat and moisture. If it is allowed to dry prematurely, it can experience unequal tensile applied stresses that cannot be resisted in an imperfectly hardened state. Curing procedures involve keeping the concrete damp for a period of time after it has been poured in order to slow the shrinkage that occurs as it hardens. Low temperatures also have a negative impact on its strength. To compensate, an additive such as calcium chloride is mixed into the cement. This speeds up the setting process, which generates enough heat to compensate for moderately low temperatures. In freezing temperatures, large bodies of concrete forms that cannot be adequately covered are not poured [7].

1.4 WORKABILITY

Concrete is used in a variety of construction materials. Its versatility makes it simple for construction companies to construct roads, highways, laterally, garages, as well as other constructions out of it its strength can be modified to meet the requirements of the construction. It

is also possible to cut into various sizes and shapes to create one-of-a-kind designs[10]. Concrete workability is a broad and subjective state that describes how a freshly mixed body of cement can be mixed, placed, consolidated, and finished with minimal loss of homogeneity [11]. Workability is a property that has a direct impact on strength, quality, appearance, and even the cost of labor for placement and finishing operations [12].

1.5 ADMIXTURES

Numerous admixtures affect the properties of the concrete, either directly or indirectly. Surfactants such as super plasticizers reduce the attraction between cement and aggregate particles, allowing for more flow able mixes without the negative strength and segregation effects of too much water . Air entraining admixtures for freeze/thaw durability produce air bubbles of a controlled size, allowing for easier finishing, but too much produces a sticky mix with the opposite effect [13].

1.6 PROBLEM OF TENSION IN CONCRETE

The pulling force exerted direction perpendicular and away from the surface is easily defined. The ability to generate an effective graphical effect by pulling on both ends of a rope. When tensile force is applied to rope, it tends to elongate and extend its length along the axis of implementation while decreasing the cross-sectional area of the material [14]. Similar effects may be replicated on non-as materials, though it is important to note that not all types in the future will elongate and easily return to their initial state once the exerted load is removed. This is the case with concrete. The building material would not be able to withstand high amounts of tension and, if used, would result in irrevocable deformation and harm [15]. On a microscopic level, one can imagine heterogeneous units of concrete components being initially bound to each other with the help of a paste or gluing material. It is only logical to believe that the ultimate bond strength is proportional to the strength translated by the glue. In other words, weak links result in low resistance to external forces like tension. Concrete occurs to have this kind of weak connection that renders its limitation forward into tensile stresses [16].

1.7 CONTRIBUTION

The strength of concrete play important role in the resistance of the concrete members toward the effect of the external stresses. Increasing the strength of concrete can eliminate the validity of using

more reinforcement as well as decreasing the chance of crack formation and deflection. The assessment of the contribution of the concrete strength to the overall design output can reflect better figurative view on the decision for using high strength concrete in specific projects. The study had been dealt with that matter by assessment and simulation for improving the design of different projects under various loading.

1.8 PROBLEM STATEMENT

The external loads on the concrete members lead to form various amount of bending and shear stress along the available span. The weakness of concrete strength that face tensile strength lead to cracked sections that occur in that zone. The reinforcement in these cases handle the stresses in which the designer assign more reinforcement amounts to satisfy the desire strength. Understanding the performance of high strength concrete in analytical and simulation way can support the design lines for better choice and results.

1.9 OBJECTIVE

a) Arranging of the effective parameters like the cross section dimensions of beams and the properties of both concrete and reinforcement as well as the behavior of loading as variables for analyzing steps.

b) Building analysis cases by using the ultimate strength method according to the effective parameters and evaluating the safety factor for each case.

c) Applying statistical analysis to evaluate the affectivity of concrete strength on the overall internal strength under various loading cases.

d) Simulating the cases by using ANSYS workbench program that using the finite element analysis method.

Explaining the results in tables and graphs then discussing the validity of the influence of the strength of concrete on the safety factors obtained

2. LITERATURE REVIEW

2.1 INTRODUCTION

Cement is a structural building material that consists of a firm, chemically slow particulate substance called as aggregate (typically shingle and gravel) that is fused together by adhesive and water. Many people believe that concrete is a strong and long-lasting material, and they are correct. Nonetheless, there are various methods for measuring concrete strength. Perhaps more importantly, each of these strength properties adds unique characteristics to concrete, making it an excellent choice in a variety of use bags . It looks at the various types of real strength, why those who matter, and how they affect the quality, longevity, as well as cost of infrastructure projects. It also demonstrates the strength differences between old-style real and a newer, innovative real new tech Ultra-High Performance Real . Concrete is identified by the type of aggregate used before cement, the precise qualities it establishes, or the methods rummage-sale used to produce it. The character of ordinary physical concrete is primarily determined by a water-to-cement relation. The less water gratified, all else being equal, the greater the concrete. The combination must contain just enough water to ensure so each aggregate atom is totally enclosed by adhesive coating, that the spaces between the accumulation are filled, that the real is liquid sufficient to be decanted and expanded efficiently. The quantity of adhesive in connection to the aggregate is yet another tenacity factor[1].

2.2 COMPRESSIVE STRENGTH OF CONCRETE

This measure is the most commonly used putative unit of measure of real strength to assess the performance of a certain real mixture. He assesses the ability of concrete to endure loads that reduce the size of the concrete. Compressive strength is measured by breaking tubular cement specimens in a special mechanism designed for this purpose. He's weighed in pounds per four-sided creep (psi). Compressive is critical because it is the primary criterion that used determine whether a certain concrete mixture will meet the requirements of a specific job. The mechanical properties of real estate is measured in pounds per four-sided creep (psi). A high psi indicates that a given tangible mixture is stronger, and thus more luxurious. However, such stronger concrete mixtures are also more durable, which means they will last longer[2]. The ideal concrete psi for just a given scheme is determined by a variety of factors; however, the bare minimum for any

scheme typically ranges between 2,500 and 3,000 psi. Each concrete structure has a typically acceptable psi range. Concrete handholds and lintels on grade typically require 6000 to 4,000 psi cement. Suspended stone blocks, beams, and finally girders [3]. To control the psi, strength of concrete is typically tested after seven days and previously after 2 weeks. The seven-day test is used to control early strength improvements, and in some cases, it can be completed in as little as three days. However, the tangible psi is based on the findings of the 28-diurnal test, which is well-known in the American Concrete Academy values [4].

2.3 TENSILE STRENGTH OF REAL

Compressive strength is the ability of concrete to withstand breaking before cracking under tension. It is concerned with the size and extent of cracks in real structures. Cracks form when tensile forces exceed the tensile strength of the material. Classical real has a significantly lower tensile strength when compared to compressive. The above means that steel blocks subjected to tensile stress must be reinforced with materials with high tensile, such as enhance. Because it is difficult to directly test the ductile strength of real, rummage-sale methods are used. The most commonly used various techniques are ductility and split ductile strength. A splitting tensile strength examination on concrete tubes is used to ascertain the split tensile strength of concrete. The examination should be performed in accordance with standard [5].

2.4 FLEXURAL STRENGTH OF REAL

Flexural strength is a significant indirect proportion of tensile strength. It is obvious as a quantity of an un - reinforced concrete slab before beam to combat winding failure. In other words, he is the ability of the real to resist winding. Elastic modulus is typically 10 to 15% of compressive strength, depending on the particular real mixture. Here seem to be two standard ASTM tests for determining the modulus of elasticity of real and afterwards . The repercussions are voiced as a psi Modulus of Ruptures (MR). Ductility exams are extremely sensitive to concrete foundation, handling, and curing. Once the sample is wet, the test must be performed. Aiming at these details, results from compressive tests are more commonly used when describing the properties of concrete, as these figures are more reliable[6]. storage towers, water tanks, shells, arc ties, roof then tower trusses, as well as braced corners and towers are examples of real representatives and constructions that convey responsibility for things thru the direct tension rather than bending.

Members including such ground and roof globs, walls, and tunnel coatings can also be applied to straight strain as a result of storage change restraint. In many cases, fast can be attributed to a combination of stresses caused by applied mass and compaction restraint. The repercussions of pragmatic loads as well as the limit of volume modification on the creation of straight cracks are covered in the sections that follow[7].

2.5 TYPES OF CONCRETE

Below is a variety of concrete types, roughly of which are suitable for the same drive. It will be dependent on the company's request to accomplish the objective. To complete the job, the project manager can choose the best concrete process.

2.5.1 Normal Strength Concrete

This tangible syndicates each of the basic ingredients real, dust, and accumulation by using the 1:2:4 ratios. This crop is of average strength. Weather permitting, the tangible place, and the adhesive's properties, it takes 30 to 90 hours to set. He is commonly used in pavements and constructions that do not necessitate great specific strength. It is unsuitable for many other structures even though he can withstand the same stresses imposed by wind trying to load prior to sound[8].

2.5.2 Ordinary Concrete Plain

With those cement, sand, as well as tallies practices, this is another legitimate that employs the prevalent mix project of 1:1.5:3. The contractor can use it to make road surface in front of buildings where tensile strength is not required. It faces the very same challenges as regular strength concrete in that he does not respond well to resonance or breeze loading. In dam construction, basic or ordinary real is also scrounged. The durability score of this concrete care is very satisfactory [9].

2.5.3 Reinforced Concrete

This building is widely used in many industrial manufacturing and modern construction. The arrangement of wires, metal rods, but also cables in reinforced concrete before it sets increases its strength. They make a strong pledge, and as a result, the two or more substances are pitted against various forces. They essentially merge to create a single structural element. It was invented inside

the 19th century and revolutionized the construction industry. Concrete slab is used in the construction of structures, roads, and major roads. When a contractor is near a construction site, he or she is likely to understand reinforced concrete by rebar .These are more commonly referred to as reinforcement bars. Threads were recently used to reinforce this concrete. These reinforcements aid in the resistance to ductile forces, while the concrete itself aids in the resistance to compressive forces [10].

2.5.4 Pre-Stressed

Many large concrete projects make use of pre-harmed concrete units. A unique technique is used to shape pre- hassled concrete. Saloons or tendons are examples of reinforced concrete. However, these saloons or quadriceps are strained before the concrete is applied. Such bars are situated at both ends of the unit in which they are used when the real is mixed and placed. When the real settles, this unit is compressed. This process makes the lower unit of the component more resistant to ductile forces. that may indeed, however, need heavy machinery and skilled labor. Pre-assembled units are typically founded and gathered on-site. Pre-harmed concrete is rummaged-sale to build a bridge, highly restrictive, or long-distance roofs[11].

2.5.5 Precast

This real is then created and cast in a production plant to exact specifications. The precast concrete modules then are elated to their final location and gathered. The Precast real is used for [12]:

a. Concrete chunks

b. Precast ramparts

c. Staircase components

d. Poles

The advantage of using precast real is its quick assembly. Meanwhile the units are manufactured in a factory, they are of actual high quality.

2.5.6 Concrete is Lightweight

Some type of concrete mixture has a concentration of about 1930 kg/m3. Frivolous granules are used to make lightweight concrete. Tallies are components that contribute to the mass of the real style. These frivolous aggregates include common materials such as volcanic rock or vermiculite, man-made materials such as clay particles and long-drawn-out shales, and processed materials such as vermiculite and perlite. Its most important property is its extremely low current conductivity. Fanciful concrete is commonly used to make long-spanning relationship decks as well as structure frames. He is also capable of defending steel structures[13].

2.5.7 High- Thickness Concrete

Tall - thickness cement has a distinct motivation. It is commonly used in the building projects of nuclear power plants. The wear resistant tabulates used in the production of high-thickness concrete aid in energy resistance. Crushed pillars are typically sold at rummage sales. The crushed pillar that is most commonly used is barytes, a colorless or snowy material that contains contrast agent and is the main ingredient in barium [14].

2.5.8 Air-Entrained Concrete

Each cubic foot of some concrete contains billions of infinitesimal midair cells. The pressure on the asphalt is relieved by these tiny midair pockets. They provide small chambers for aquatic to expand once it freezes. During the mixing process, various foaming take including such alcohols, resins, or greasy acids are added to the concrete to entice air. While the concrete is being mixed on the job site, this should be done under careful engineering supervision [15].

2.5.9 Ready- Mix Concrete

Real preparation, followed by a shower in a centralized location Vegetable is known as ready -mix real. The above real appears to be mixed before even being transported to the site in the familiar bonding trucks seen on highways and roads. When the military trucks spread the cement only on the worksite, it can be utilized immediately because no extra treatment is required. True ready-mix cement is a field type of cement that is also mixed to exact specifications[16].

2.5.10 High- Presentation Concrete

Because power and achievement of concrete are distinct properties of real, they are not synonymous. Elevated concrete is determined by its compressive at a given age, whereas high-performance concrete has been defined by performance standards, specifically: high sturdiness, max hardness, and high workability. Elevated concrete is defined as a real that meets a unique combination of demonstration and homogeneity equipment that cannot be consistently achieved using traditional voters and standard fraternization, placement, and curing repeating. Even so, super strength real is defined by having a compressive of language. The language or higher, according to each ACI Code[17]. Many flaws in conservative concrete have been overcome by the use of greater cement, such as lower durability, a weaker buffer layer (aggregate-adhesive interface), low resistance to physiochemical attack, and difficulty in repair and refitting works. In the building projects of many structures, high strength real has been rummaged-sale to reduce the scope of members, reduce dead weight, and weaken cost and building materials[18].

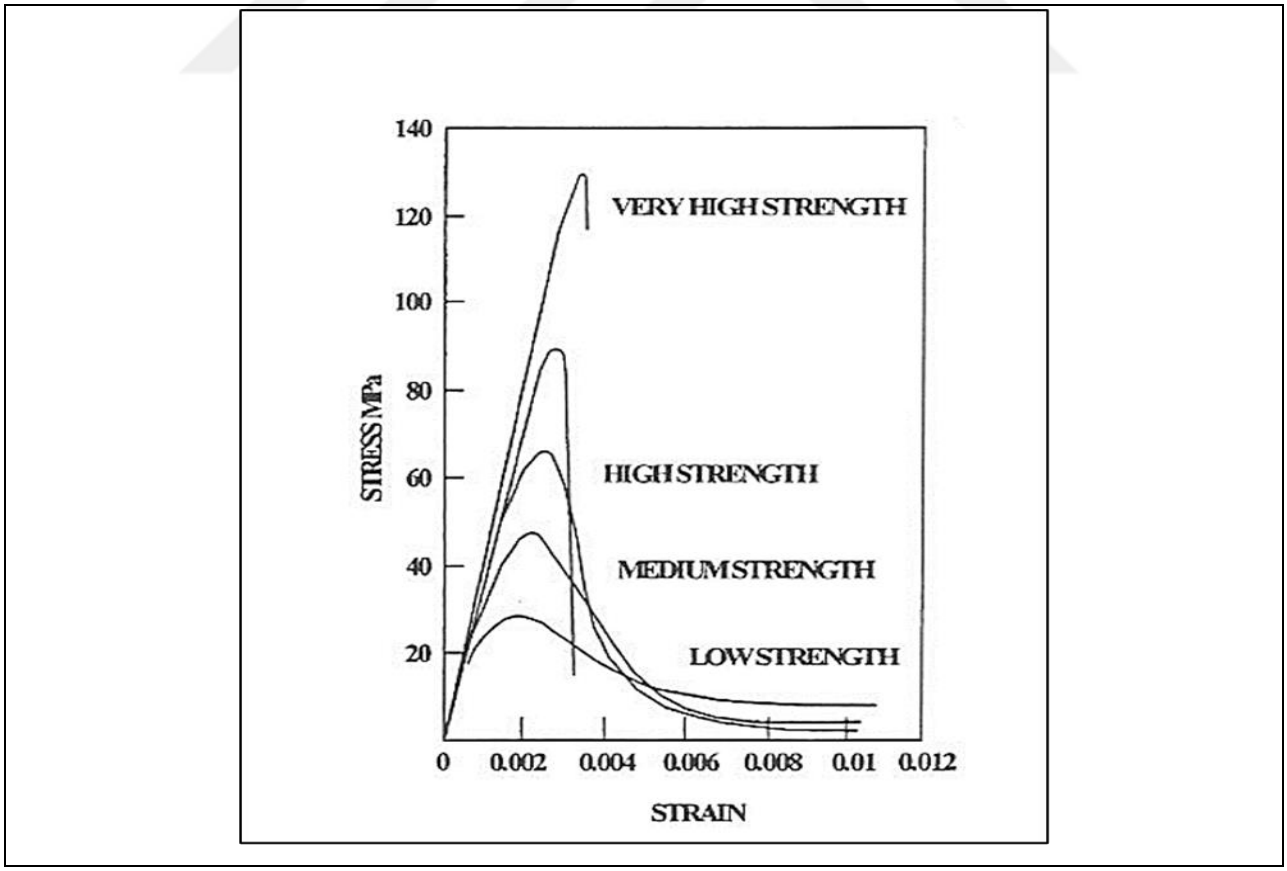

Figure 2.1: Stress-Strain Behaviors For Various Type Of Concrete [19]

2.6 FIBER REINFORCED CONCRETE

It really is defined as a composite composed of cement, spackle, or concrete mixtures and then discontinuous, completely separate, uniformly differentiable suitable fibers. Fiber reinforced real is various types and properties with numerous benefits. Constant interlocks, woven garments, and extended wires or bars are not separated fibers. Fiber is a minor component of a strengthening material with specific properties. They can indeed be circular or square. A suitable parameter known as "aspect ratio" is frequently used to label the fiber. The fiber's aspect connection is the relationship between its length and width . Fiber-reinforced concrete is factual that contains rubbery material that improves structural integrity. It includes short separate threads which are continuously distributed as well as oriented randomly. Steel strands, glass threads, synthetic threads, and natural fibers are examples of threads. The allure of fibre armor-plated substantive improvements with variable concretes, fiber materials, geometries, allocation, alignment, and densities within these various threads. Shot Crete is the most common application for fiber reinforcement. However, it may be used in regular concrete. Fiber-reinforced ordinary concrete is commonly used for occurring -ground basis and sidewalks, but it can also be used for a wide range of construction sections alone or with hand-knotted rebar's. Concrete armor-plated by fibers (which are usually strengthened,) is less costly than hand-knotted rebar while increasing tensile strength multiple times. The shape, measurement, and distance of the fiber are critical. A slender and small fiber, such as a small hair-formed glass fiber, will be efficient in the first few hours after torrential this same concrete (reduces cracking while stiffening the concrete) but will not increase the concrete ductile power.

2.6.1 Important of Fibers in Concrete

Strands are commonly used in real life to control pliable decrease, cracking, and reduction. They, too, decrease the permeability of cement, thereby reducing aquatic blood loss. A few fibers produce greater impact, abrasion, and smash opposition in real life. Fibers, in general, do not improve the strength of true, so he cannot positions resisting before structural steel strengthening. Some threads lessen the strength of concrete. The quantity of fibers added to the a concrete mixture is expressed as a percentage of the total volume of the matrix (concrete as well as threads), which is known as the capacity portion[20]. Threads with such a quasi-cross-unit use an equivalent

diameter for showcase ratio computation. Although the young's modulus of something like the fiber is lower than that of the moderate (concrete prior to mortar binder), they aid in weight bearing by raising the strength of the material. A rise in the aspect ratio of the fiber usually segments the matrix's flexural strength and toughness. Fibers that are too long, on the other hand, tend to "puck" in the mix, causing workability issues. According to new research, using fibers in concrete has a small impact just on impact conflict of tangible resources. This invention is significant because people have traditionally believed that because when real reinforced to threads, ductility tends to increase. The findings also revealed that microfibers have higher impact resistance when compared to longer fibers [21].

The necessity of fiber Reinforced Concrete [22]:

a. It increases the tensile strength of the concrete.

b. It decreases the air vacuums and water vacuums the inherent absorbency of gel.

c. It upsurges the durability of the concrete.

Fibers including such graphite but also glass have excellent tiptoe resistance, whereas the same would be not true for most resins. As a result, the location and loudness of fibers have a massive effect on rebar/tendon creep presentation. Armor-plated concrete is a mixture in which the bolstering acts as the bolstering fiber and the concrete as the matrix. As a result, he is authoritative that the behavior of the binary materials under thermal pressures be similar so that the difference deformations of concrete are minimized. It's been identified that adding small, carefully kind of freaked, and consistently distributed fibers to cement would act as a crack arresting gear and significantly improve its still as well as dynamic properties[23].

2.6.2 Factors Moving Properties of Fiber Reinforced Concrete

Fiber reinforced real is a composite material that contains threads in an orderly matrix of adhesive before being randomly distributed. Its properties are obviously dependent on the improves the speed of stress between medium but also threads. The issues are discussed briefly below[24]:

2.6.2.1 Relative fiber matrix stiffness

For efficient stress transmission, the elastic modulus of the medium must be significantly lower than that of the fiber. Reduced modulus fibers, such as nylons and polypropylene, therefore are unlikely to provide significant improvement; however, they do aid in the uptake of large amounts of energy and thus communicate a higher level of toughness and confrontation to impart. High modulus threads like strengthen, glass, and carbon add strength and rigidity to the matrix. The efficiency of stress transmission from the mixture to a fiber is determined by the interfacial interaction between the matrix and the fiber. A strong bond is required to improve the compressive strength of the material[25].

2.6.2.2 Capacity of fibers

The compression force is primarily determined by the number of threads used in it. Figures 1 and 2 show the effect of quantity on toughness and forte. As shown in Fig. 1, increasing the volume of threads increases the tensile strength and then the tenacity of the composite approximately linearly. The use of a higher fiber fraction is likely to cause segregation and severity of concrete then mortuary [26].

2.7 CURRENT WORK

The study aimed to investigate the physical and the geometrical factors that in the issue of design structure concrete members. The study dealt with the impact of the strength of concrete on the output design validity and the overall strength toward the applying load. The strength of concrete was analyzed according to the conditions of concrete casting and the reinforcement system. The study examined the safety factor for each case then supported the results by simulating the cases under the finite element concepts that found in the applications of ANSYS workbench program.

2.8 LITERATURE SURVEY

This study is a portion of an ongoing experimental workroom investigation for the manufacture and characterization of high strength concrete for the heightening of an existing concrete dam in the middle of Sudan. A summary of the dam's main features and actual works is available. Hundreds of trial mixes were created and tested using local Sudanese aggregates, mineral admixtures (Silica Emission and Fly Residue), and Wonderful plasticizers. Six grades of were

successfully manufactured, and their mechanical properties were measured and recognized. Following a statistical examination of test outcomes, simple correlations relating compressive strength to flexural and splitting forces were developed. The findings provided important insights for optimizing the rheological properties of and allowed for the development of guidelines for optimum mix project methods for from locally available aggregates in Sudan. The effect of w/c ratio on HSC strength was also colored. It has been concluded that native concrete materials, when combined with mineral admixtures, can be used to produce High Forte Concrete in Sudan. Locally shaped concrete materials (aggregates, hover ash, and normal Portland cement) of good excellence and with their optimum proportioning can be successfully rummaged-sale by other chemical and mineral admixtures to produce high forte concrete with outstanding properties when prudently mixed and preserved. When producing mass high strength concrete, it is critical to increase the doses of mineral and biochemical admixtures (silica fume, fly ash, and supper plasticizer) in order to control resource costs[27]. For a long time, false stone has been one of the most common resources in construction. Despite the variety of concrete types, the matrix is in constant development and evolution. Tall power template is commonly used in the construction of high-rise buildings before projects with complex geometry. This article recommends creating high-strength cementations composites via a complex chemical start using admixtures in combination with reactive aggregates, as they stretch good moisture (hardening) of concrete. The results of the investigation confirm that this start practicing of complex chemical start of cement stretches high-strong point concrete with healthier strength, distortion, and durability properties. By analogy with heat action, the preparation of high strength real with distinct properties via complex biochemical activation was found to be more effective when using biochemical amalgam of a younger breed in combination with a reactionary aggregate. A chemical interbreeding containing SiO2 Nano dispersions enhances hydration and restores the modulus of elasticity, crack confrontation, and hardness of concrete[28]. The effect of using recycled rough total revenue and healthy moisture on the physical properties of high-strength concrete was investigated in this study. Following the 2017 conflict, the recycling of devastated constructions as recycled collective became an especially serious issue in Mosul City, Iraq. These proceedings have also made it difficult to obtain drinking water. This education attempted to control this same effect of more readily available well aquatic in Mosul Urban when combined with recycled aggregate on the compressive, excruciating, and fully - developed of tall -strength real. The combinations were created by substituting 4 distinct

percentages of RCA. In total, eight blends were created, four of which were cured using potable water and the other four using well water. The results showed that when using clean and safe water for real made with National commission, the compressive strength decreases by around 16.0%. As well, WW resulted in a decrease of around 13.2%, 10.0%, and 8.5% for real comprising 25%, 50%, and 100% , respectively. Once well aquatic, the given below:- and splitting tensile forces were also reduced. A reversion analysis enabled the formulation of novel material constitutive relations for rising concrete, such as belongings [29]. The study supervised eroded domestically occurring mm (3/8') gravel aggregate by way of entire successor for rough as well as fine totals. Under natural disease, the totals were utilized in the combined national. The education has been carried out with a mix project that included aggregate in its combined as well as natural states, as well as fly ash and nano - silica as extra cementation materials. A total of 25 trial combinations were regarded, including ten high strength and fifteen standard strength concrete combos. The compressive of HSC versus NSC was investigated for the purpose of fly particulate / foundry sand (Fractional anisotropy) and underwater /binder (W/B) ratios. After 3, 7, but rather 28 existences of wet curing, 186 dice specimens of size plates were company and checked for compressive strength. [30]. This news research presents the findings of a public inquiry carried out to assess the compressive of High Strength Real. High Forte Cement is finished with a partial spare of cement via wood ash (FA) and slag cement (SF). In this trying to cut study, the Lecture C fly residue was used in various proportions of 30%, 40%, and 50%, followed by 6% as well as 10% mineral admixtures by concrete heaviness.The concrete mix sizes had a constant underwater binder ratio of 0.4, and concentrated solution was added based on the required degree of flow ability. The total content of the binding material was 450 kg/m3. The cinderblock specimens were baked using standard moist curing under standard air fever. Compressive was high at various long years for up to 90 days. Because the mixture is rather synergistic, this same results show that concrete made with these percentages usually has excellent new and hardened properties. The addition of silica emission demonstrates an initial strength gaining stuff, whereas fly ash demonstrates a long period resilience. The tetragonal system of Portland adhesive-fly residue-silica emission concrete was developed to increase this same concrete's compression strength over time when compared to concrete with only fly residue and silicon dioxide emission[31]. The use of elevated concrete in the biosphere began about four periods ago. Utilizing straps in civil engineering tasks such as reducing the size of framework columns, increasing girder distance, and

increasing building stores by way of healthy as well as financial benefits. The study intends to investigate the effect of varying cement mix compressive on the behavior and load bearing capacity of steel and concrete beams in aspects of rupturing, harvest, failure lots, deformations, and ductility. The experimental program included the casting of six reinforced real beams with a length of 2.3 m and an annoyed section of 200 m. The ray specimens were tested under two different loads. Innumerable concrete mixes were tried in order to achieve the concrete compression strength of 30.9, 40.3, and 40.3. 89 MPa for each specimen beam The following conclusions are complete based on the current work experimental study. The experiments and load slingshot curves demonstrate that increasing the real compressive has a noticeable effect on the rays load capacities and deflections. Early cracks formed on a higher practical load with a cumulative increase in compressive strength, so that the compression strength provides a better restraint to the growth of blows. Although high strength concrete exhibits a sudden disappointment in compression testing, high forte reinforced concrete beams exhibit superior ductility when compared to normal forte concrete beams with the same amount of steel reinforcement. The elastic modulus forte strength of the reinforced specimens increases as the total combined in concrete compressible strength increases due to reduction in intensity of the beam, which means increase in curves ductility, which leads to increase in fast capacity or, in other words, increase in force volume of a real paragraph[32]. Volume changes in reality can have an impact on the structural achievement and tenacity of reinforced concrete structures. It has been discovered that autogenously shrinking high-strength concrete reduces the shear strength of armor-plated real beams when compared to low-shrinkage real. High-drying shrinkage of concrete may also reduce the shave strength of armor-plated real beams made of standard-strength real. The effects of ventilation shrinkage and growth of conventional concrete on the shear forte of reinforced real beams with and without stirrups have been investigated in this study. Six concrete mix sizes were rummaged-sale using dissimilar aggregates and admixtures to control cement volumetric changes. The used cement showed a wide range of volume adjustment, and slightly elevated concrete caused shrinkage-induced cracking in the struts before having to fill. The results of the loading tests revealed that drying shrinkage and expansion decreased, resulting in an increase in shave strength. The prospective equation accurately reproduced the decrease or increase in evaluated shear force caused by volumetric vicissitudes. The formula included a new idea of strain transformation in tension zone caused by

concrete reduction or growth, which had previously been predicted for spalling shrinking of high-strength real estate [33].

Conservative reinforced concrete constructions are frequently associated with the deterioration of steel reinforcement. Carbon fiber reinforced polymer saloons have emerged as a new promising option for flexural strengthening. This news study presents a state-of-the-art flexural strength on real -reinforced beams. Concrete compressive strength, followed by bar ductile strain, bolstering ratio, surface action on saloon, and concrete compressive were identified as aspects of behavior. The literature had formed all aspects of behavior that affected the flexural strength, ricochets, and crack physiognomies of beams. Having to cut adding, the new result on beam specimens following the literature protest that standards underplay the maximum tensile instant capacity of beams. Kara and Ashour's forecasts, on the other hand, are more precise with the new values. Furthermore, hotspot investigation topics were overemphasized for further consideration in future studies. Forecasts on the final flexural moment volume were included in the global design standards at the time, as proposed by Kara and Ashour. They are summed up to ensure a better understanding of their competence[34].This cutting-edge research work presents an experimental investigation on the flexural strength of reinforced concrete rays exposed to passion for 6-hours at 1000°C. The beams are finished with recyclable concrete totals replacing 50% of the usual coarse aggregates. A total of 12 armor-plated real beams were used, with a 1:1.5:3 mix (ironic mix) and a 0.54 water-adhesive ratio. The rays were divided into two groups. Group 1 rays were made with 50% biodegradable aggregates, while group 2 rays were made with all-natural aggregates (switch specimens). Overall, beams were exposed to fire on the aforementioned fever, followed by a challenge in a universal weight testing machine below the central point weight. A comparison of the findings shows that the proposed rays have comparable altercation even after a 6-hour fire at 1000°C. This news study presents a new assessment of the effects of 6-hour enthusiasm on rich combination reinforced concrete beams made with 50percent coarse aggregates totals replacement with recyclable totals from old destruction concrete. 12 RC beams were cast with an ironic combination and cured for 28 days. To compare the results of these rays, half of the samples were cast with all-natural totals. The beams were heated for 6 hours at 1000°A and before being subjected to central point weight test results in a widespread load challenging device. Weight, diversion, as well as cracking were all measured at regular intervals. A comparison of the findings shows that the proposed samples were tested' deflection and flexural were reduced by less than

10%. This demonstrates the effective use of proposed totals in rich pairing concrete without compromising the ductility of the concrete[35].

The tensile resistance of sixteen filled over-reinforced tangible rays with and without nano silica built from high-strength concrete , was experimentally investigated and logically in this study. As a partial substitute for Cement concrete, nano silica was used. The tests performed rays were divided into four collections based on the NS ratio: 0%, 1%. Shear distance to efficient complexity (a/d) relationships of 1,5 and 2.5 were used in each group, followed by two different nylon webbing ratios (against) of 0percent of the overall and 0.38%. The shear strength supplies used by various international rules, such as the American Concrete Organization the Successfully delivered and the Egyptian, have been investigated when applied to beams with and without NS. The most important factors to consider were the effect of NS on the shave span to real depth (a/d) ratio and the shear of the struts with and without straps. The new results were validated by performing a finite element nonlinear analysis with the processer program . The exploratory results revealed that the cumulative NS relationship reduced the number of cracks while increasing crack spacing and decreasing crack width. These impacts were more pronounced in specimens without stirrups[36].

This education compares the flexural responses of tall-strength fiber-reinforced real struts and tall-strength real beams. Under pure flexural loading, a series of HSFRC and HSC beams were tested. The effects of concrete type, compressive, and compressive rebar proportion on the flexural behavior of concrete rays were investigated. The flexural behavior of the as well as HSC floor joists was compared, such as the induced crack and failure patterns, load as well as ricochet capacity, blow stiffness, ductility index, as well as flexural. The crack problem of the HSC and rays increased as the rebar ratio increased. The crack difficulty of a struts was significantly greater compared to the HSC struts for similar rebar ratios. -e ductility directory of HSC beams decreased abruptly with an increase in rebar ratio, whereas the ductility folder of the HSFRC struts did not show a significant decrease with accumulated rebar ratio. -eflexural tenacity of the rays was greater than that of beams on higher rebar relations of 1.47% then 1.97%, indicating that the beams had better energy preoccupation than the HSC rays. The results of the tests also revealed that HSFRC developed healthier and much more reliable conductivity with advanced rebar ratio. Furthermore, the results of the tested winding power and sectional assessment were especially in comparison [37].

Over the years, computational modeling of break in reinforced adhesive concrete beams observing multiple variables has been a stimulating task. This research presents a crack modeling practice in three sizes for carbon fiber reinforced polymer wired beams using a three dimensional nonlinear limited finite element model of the beam subjected to four opinion loading. The physical warping of concrete is demonstrated. Several real failure parameters are considered, including shear transmission coefficients, uni - axial compression and tensile strengths, biaxial compressive and disastrous strengths, and difficulty reduction in fractured concrete in the ductile region. In numerical models, a strengthened light containing and without hanger bars is analyzed, and the results are compared to experimental data. In the following case, a -enhanced beam is looked into for analysis. A parametric study is carried out, taking into account the different lengths of Frp composites used for ductility reinforcing of beams, order to model CFRP as orthotropic and isotropic, and ranging the region of reinforcement in the tension region. According to the findings, the proposed method can accurately help predict, crack patterns, and load capacity. The findings are comparable to experimental findings in the literature[38].

3. METHODOLOGY

3.1 ANALYSIS THEORY

The tensile strength of the concrete influences the structural behavior of RC beams during the loading stages. This simple truth can be obtained from the appearance of the concrete's strength fc' in the done in a particular for uncracked and cracked sections.

3.1.1 Stage One: Uncracked Section Analysis

The working stress process includes designing a structural element so that the stresses caused by the action of service loads (also known as working loads) and computed by the mechanical systems of elastic members do not exceed some predetermined allowable values. The service load is the load that is assumed to occur when the structure is in service, such as dying, live, snow, air, and earthquake. The strain - life method is expressed as follows:

Ƒ applied ≤ f allowable

Where:

Ƒ applied: an elastic stress, such as by using the flexure formula $f = Mc/I$ for a beam, computed under service load.

f allowable : a limiting or allowable stress prescribed by a building code as a percentage of the compressive strength f' for concrete, or Fy of the yield stress for the steel reinforcing bars.

The service loads are risen by factors in the strength design method (formerly known as the ultimate strength method) to obtain the load at which failure has been considered "imminent." This is known as the factored load or factored service load. The structure or structural component is then proportioned in such a way that the strength is achieved when the factored load acts. This strength is calculated using the non - linear stress-strain behavior of concrete. The strength design procedure is expressed as follows: provided strength Where the "strength supplied" (such as moment strength) is calculated in accordance with building code requirements, and the "strength requisite" is obtained by conducting a structural analysis with factored loads.

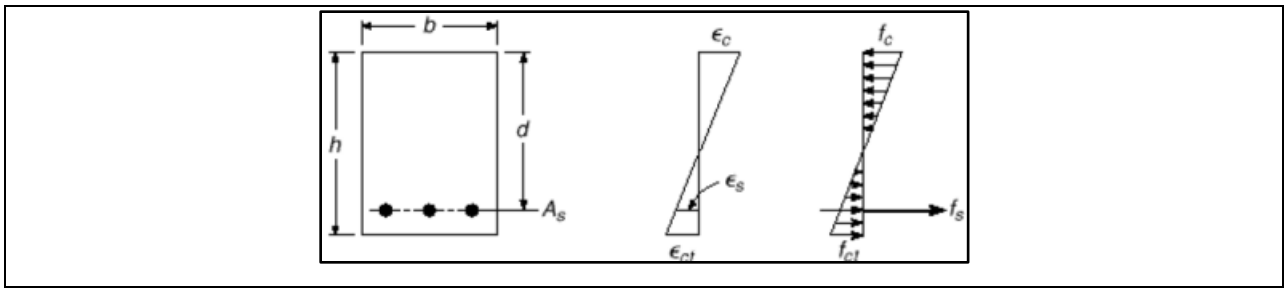

Figure 3.1: The Stress Formation in Elastic Stress –Strain Behavior of Concrete

The magnitude of the tensile strength is derived inside the working stress theory according to the deformation curvature of the beam. The derived stage was explained in the following parts:

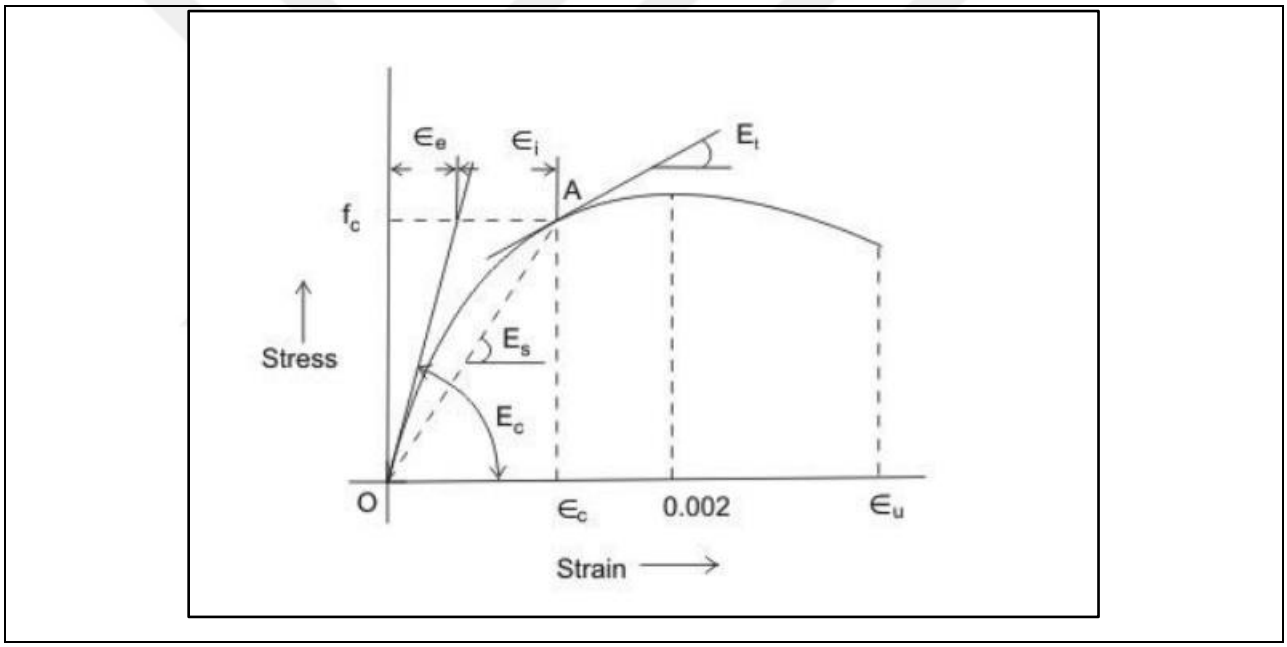

Figure 3.2: The Stress –Strain Behavior of Concrete Linear and Non-Linear

The relationship of stress strain in the theory matches the linear form so that the modulus of elasticity reflects the dividing of the stress by the strain.

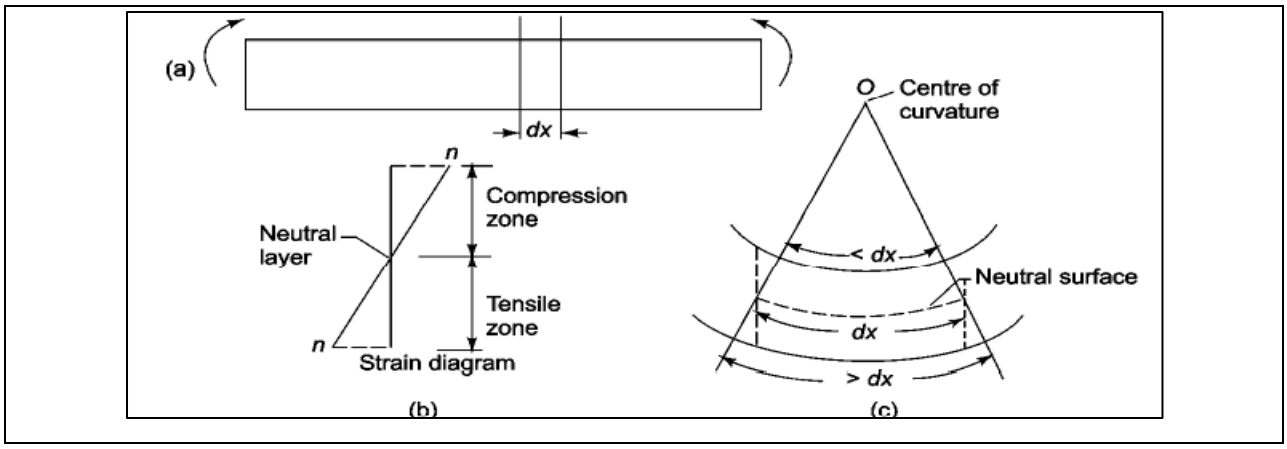

Figure 3.3: The Deformation of Beam for Working Stress Analysis Theory

From the figures, the sequences of the analytical equation toward the merging between the main elements of the theory were explained as following:

$$dx = R\, d\theta \tag{3.1}$$

$$the\ chage\ in\ length = R\, d\theta - (R - y)\ d\theta = y\, d\theta \tag{3.2}$$

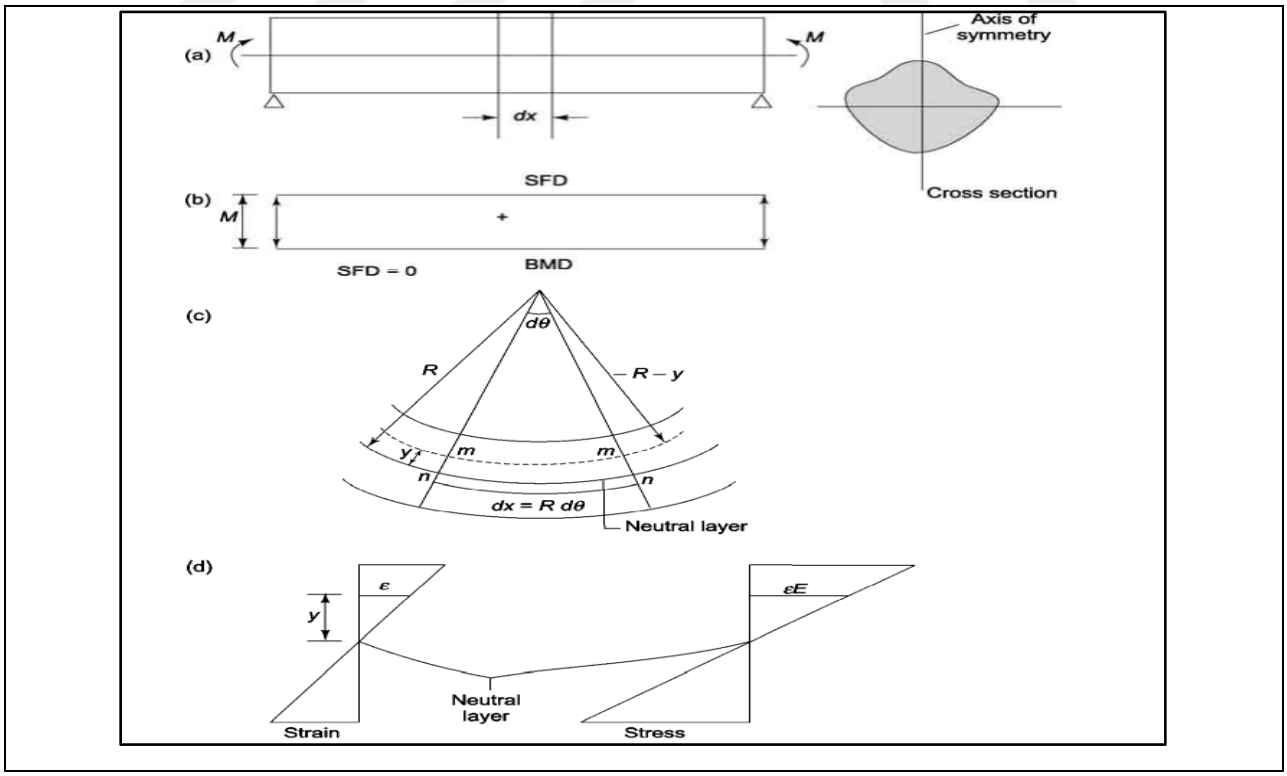

Figure 3.4: The Deformation Curvature and the Displacement Variables for Working Stress Analysis Theory

$$\varepsilon = \frac{\Delta L}{L} = \frac{y\, d\theta}{R\, d\theta} = \frac{y}{R} \quad (3.3)$$

By the linear relationship as confirmed for the stress-strain, the equation converted to:

$$\sigma = E\frac{y}{R} \quad (3.4)$$

By taking the force element based on dividing the stress by the strip area:

$$dF = E\frac{y}{R}\ b\ dy \quad (3.5)$$

The elementary moment dM then can be identified as:

$$dM = E\frac{y}{R}\ b\ dy\, y \quad (3.6)$$

$$dM = E\frac{y^2}{R}\ b\ dy \quad (3.8)$$

As the elementary moment of inertia is the represented by the term $by^2\, dy$, by integrated the equation for the whole section:

$$M = \frac{E\, I}{R} \quad (3.9)$$

$$M = \frac{\sigma}{y}\, I \quad (3.10)$$

So that:

$$\sigma = \frac{M\, y}{I} \quad (3.11)$$

For uncracked section, the value of σ can be replaced by the tensile strength of concrete to figure out the maximum loading on the member before the cracked section reached.

3.1.2 Stage Two: Ultimate Moment Analysis

In the case of non-linear behavior for the stress-strain in concrete elasticity, the ultimate strength design method can be used. The theory of the method based on converting the curved shape of the compression stress on the member cross section to rectangular one with 0.85 fc' in width:

The internal stresses of this case was illustrated in figure:

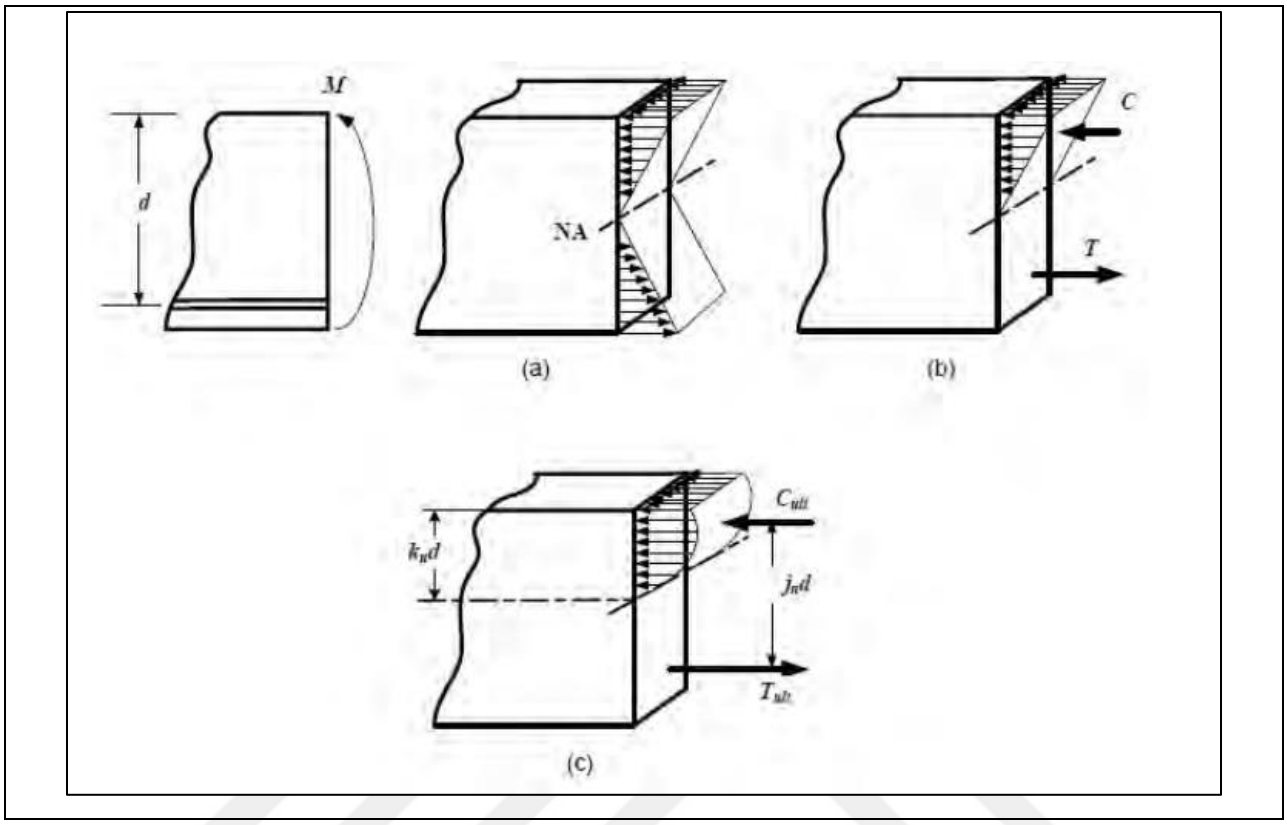

Figure 3.5: The Formation of Stress on Beam Cross Section Tension and Compression

3.2 DERIVING FORMULAS

3.2.1 Uncracked Section Stage

For uncracked section, the magnitude of the tension stress for a specific strength of concrete is:

$$Fct = 0.62\sqrt{Fc} \qquad (3.12)$$

The equation of working stress method be in the form of:

$$0.62\sqrt{Fct} = \frac{M\,C}{I} \qquad (3.13)$$

The moment of inertia for uncracked section is:

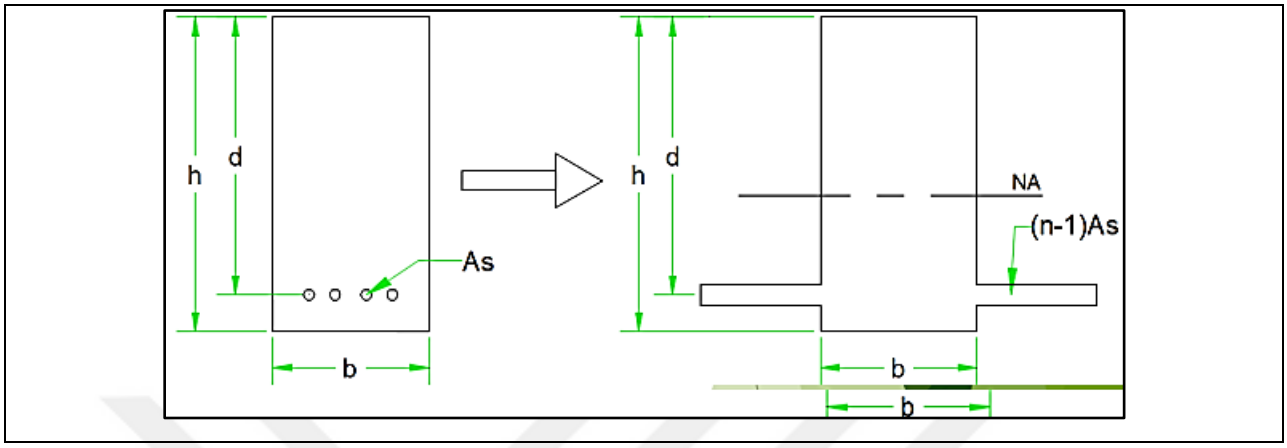

Figure 3.6: The Analysis of the beam cross section for working stress theory

$$I = \frac{b\,h^3}{12} + b\,h\,(C - \frac{h}{2})^2 + (n-1)\,As\,(d-C)^2 \qquad (3.14)$$

$$C = \frac{b\,h\frac{h}{2} + (n-1)\,As\,d}{b\,h + (n-1)As} \qquad (3.15)$$

$$M = \frac{0.62\sqrt{Fc}\;I}{C} \qquad (3.16)$$

For member with span length of L and concentrated load p:

$$\frac{P\,L}{4} = \frac{0.62\sqrt{Fc}\;I}{C} \qquad (3.17)$$

$$Fct = \frac{P^2\,L^2\,C^2}{6.15\,I^2} \qquad (3.18)$$

For member with spa length of L and uniform load of W:

$$\frac{w\,L^2}{8} = \frac{0.62\sqrt{Fc}\;I}{C} \qquad (3.19)$$

$$Fct = \frac{W^2\,L^4\,C^2}{24.6\,I^2} \qquad (3.20)$$

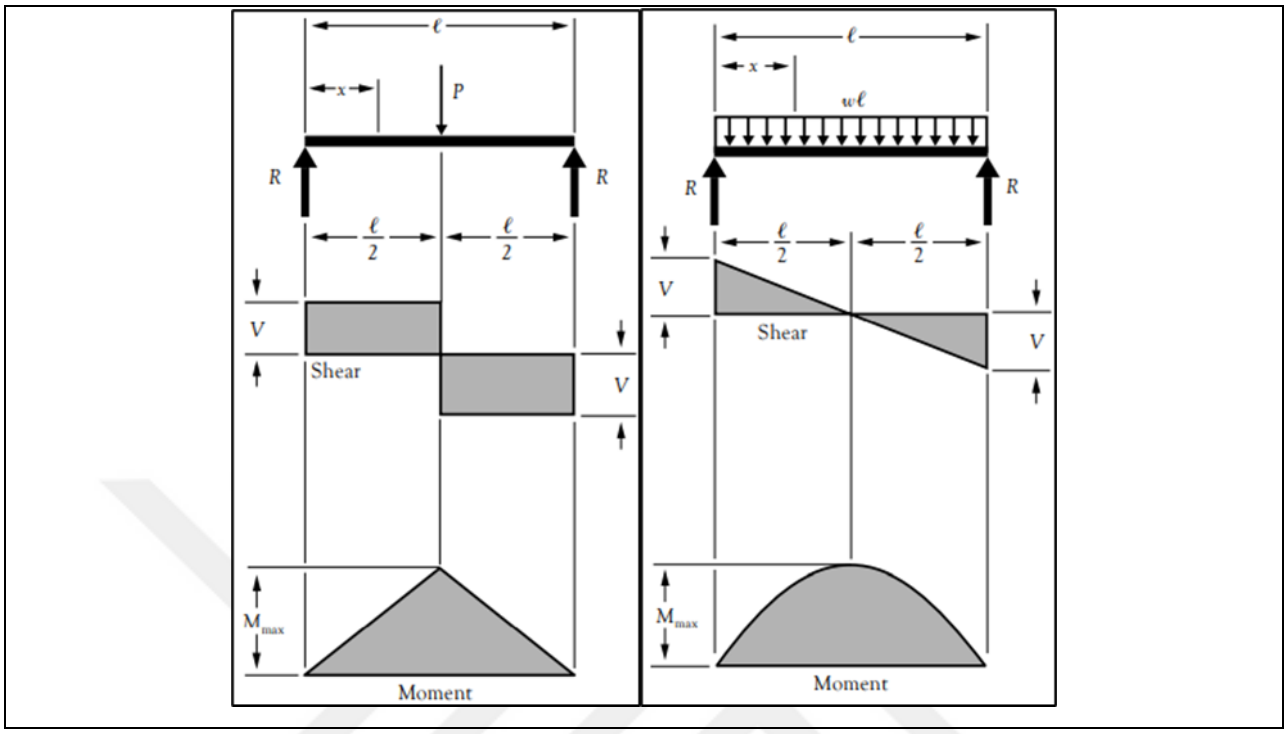

Figure 3.7: The Shear and Moment Distribution for Beams Under Concentrated And Uniform Loadings

For the three cases:

Table 3.1: The Equation of Strength Index According To the Loading Conditions

Case	Maximum M	Equation
Concentrated load	$P\frac{L}{4}$	$Fc = \frac{P^2\ L^2\ C^2}{6.15\ I^2}$
Uniform load	$W\frac{L^2}{8}$	$Fc = \frac{W^2\ L^4\ C^2}{24.6\ I^2}$

The term strength index can be used to identify the contribution objective of the tensile strength of the concrete for raise the level of cracking loading.

3.3 ANSYS SIMULATION PREPARATION

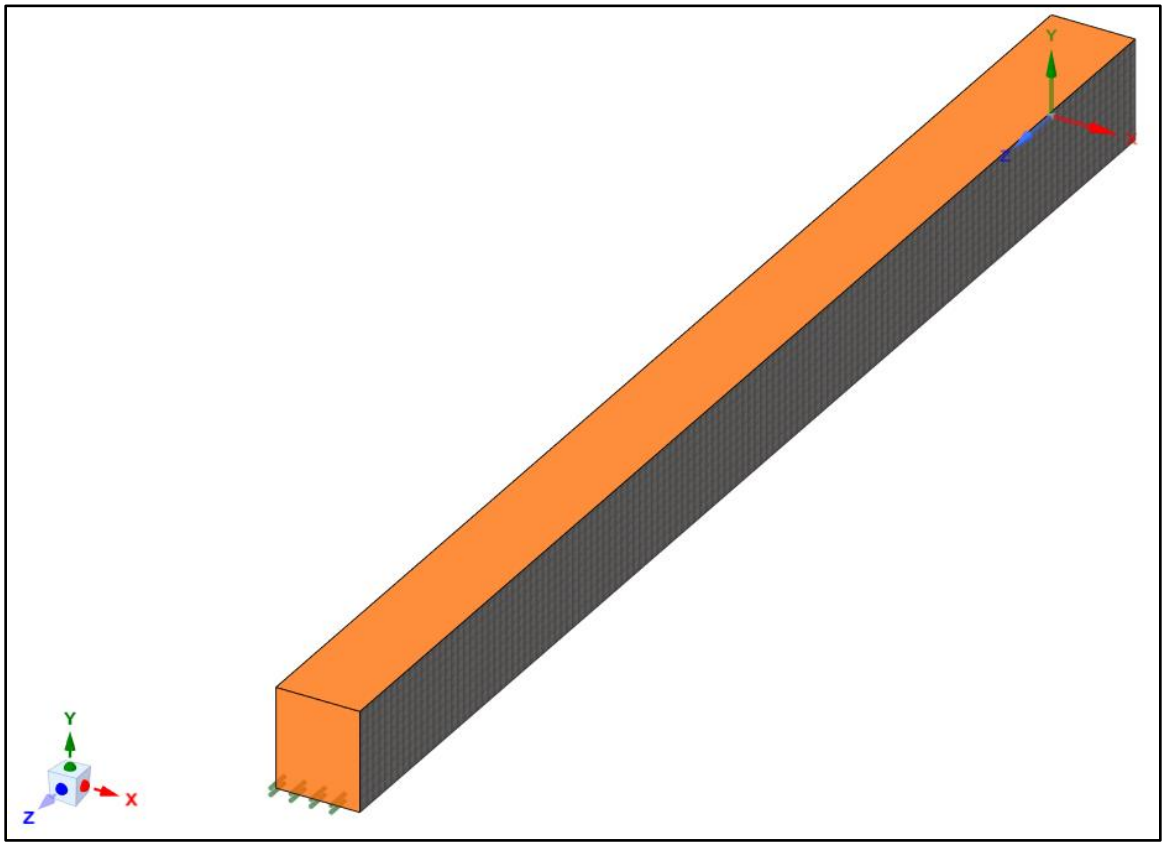

Figure 3.8: The Beam Geometry In ANSYS Simulation

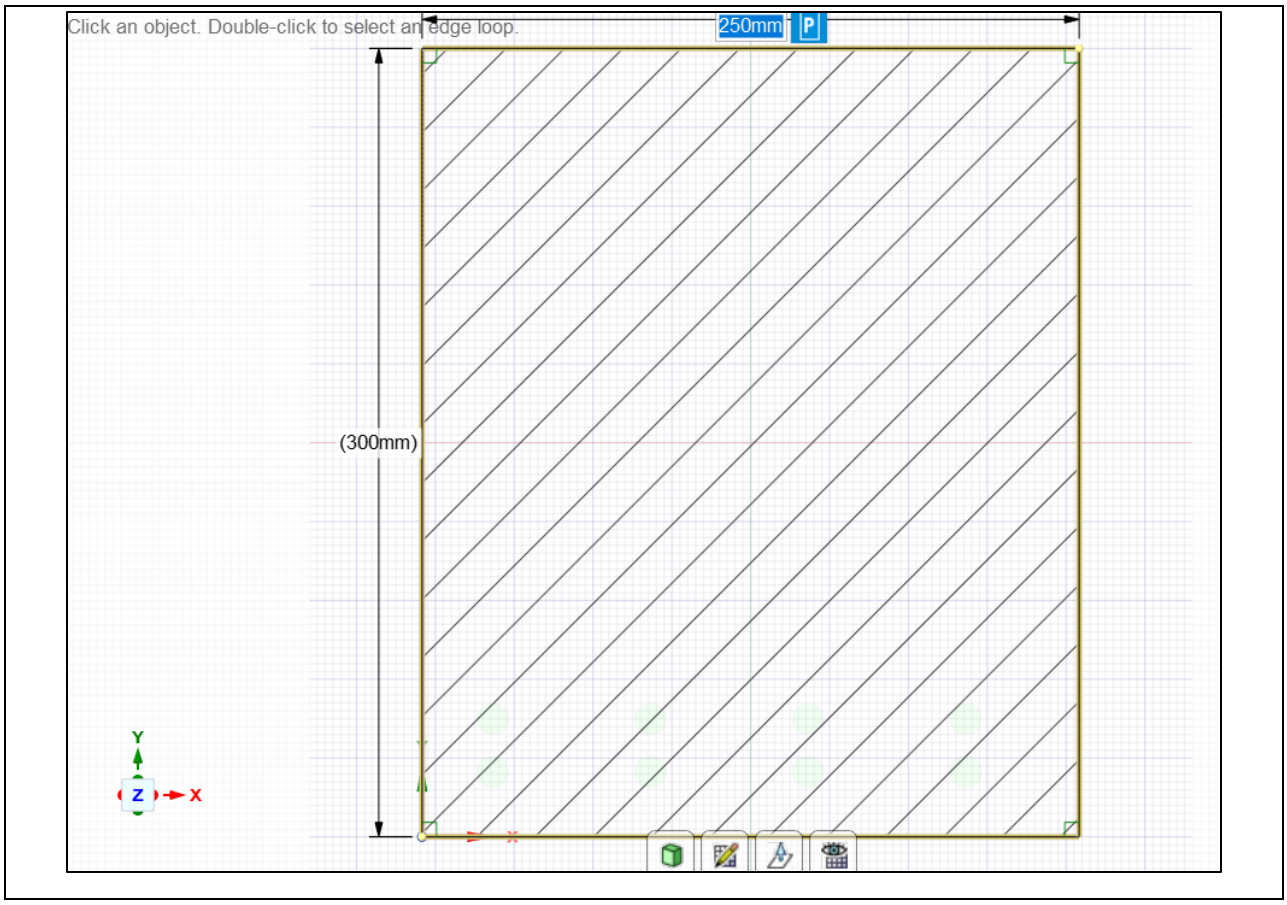

Figure 3.9: The Beam Cross Section And Dimensions Set In ANSYS Simulation

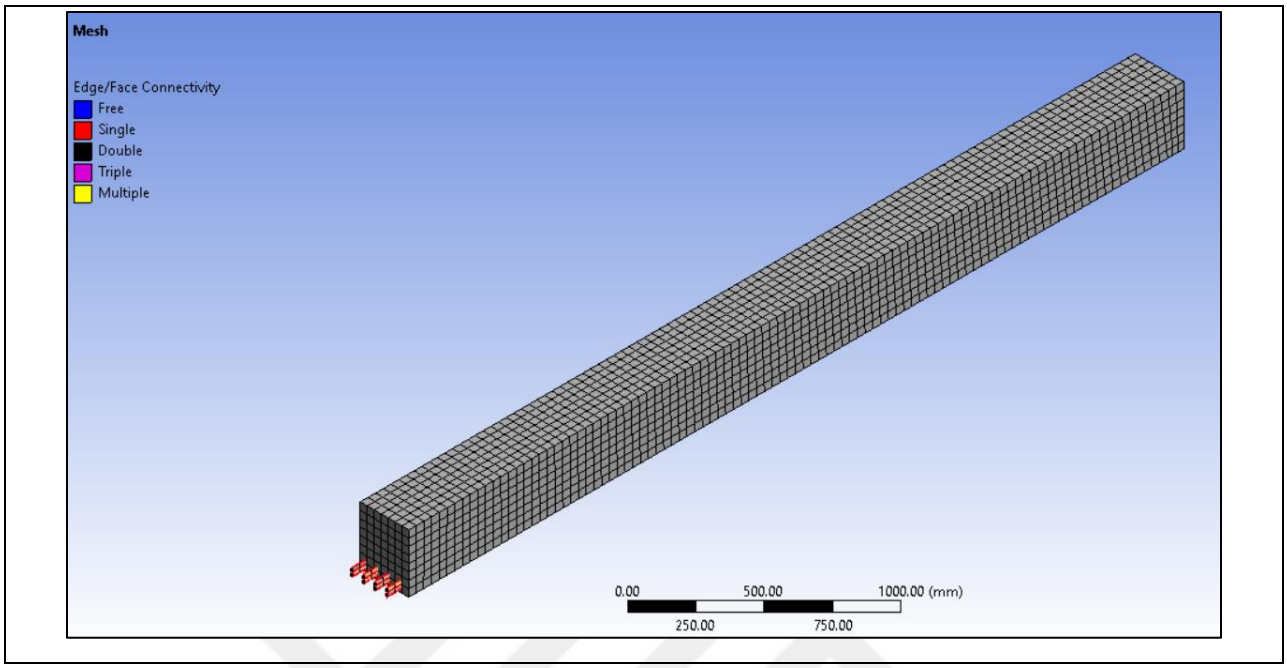

Figure 3.10: The Beam Meshing In ANSYS Simulation

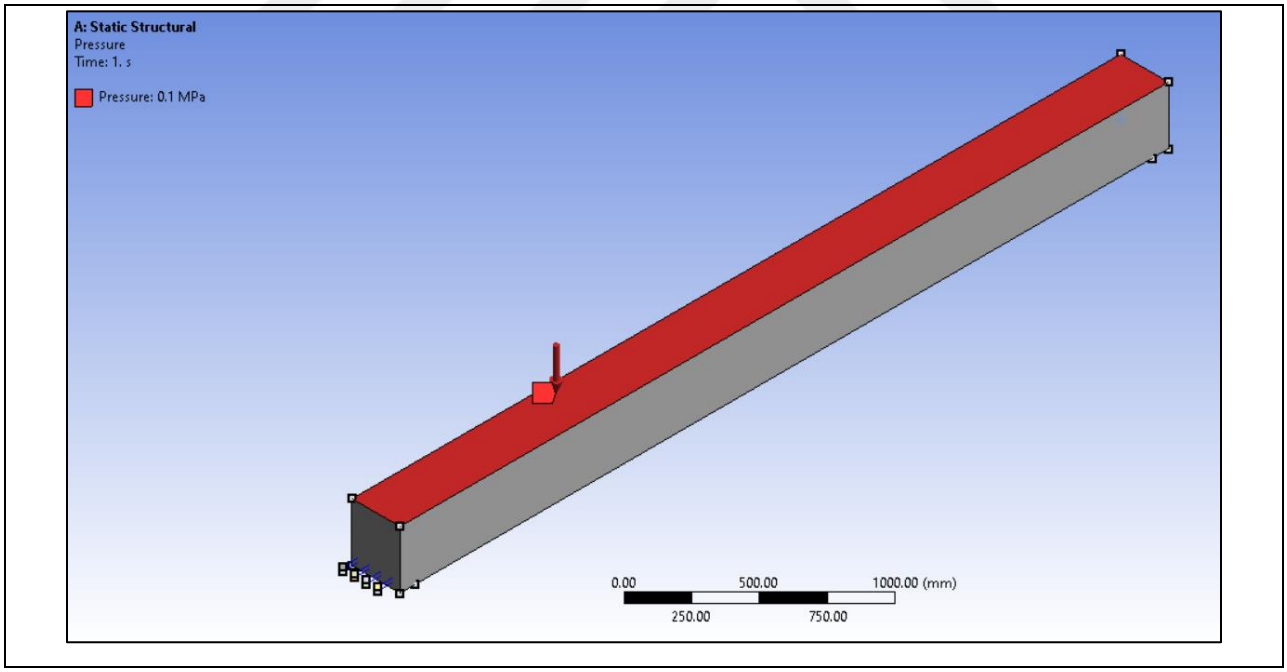

Figure 3.11: Assigning Loading By Model Panel In ANSYS simulation

4. RESULTS

4.1 CALCULATION AND RESULTS

4.1.1 Case One: Concentrated Loading

The calculation of the strength index for the RC beam under concentrated and uniform loading was identified for the dimensions of the beam cross section and the steel area, the effect of beam width was showed in table 4.1.

Table 4.1: The Effect Of B On Strength Index

b (mm)	Strength index
300	0.038374
350	0.028412
400	0.021882
450	0.017370
500	0.014123
550	0.011708
600	0.009864

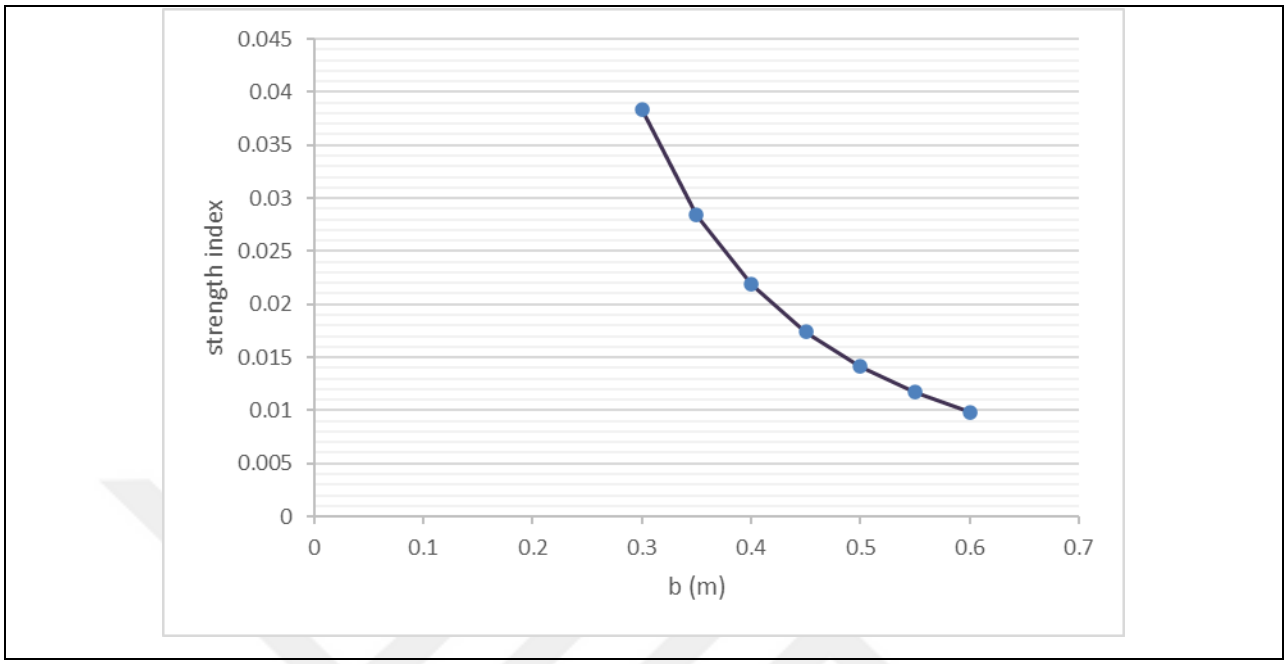

Figure 4.1: The Effect Of B On The Strength Index

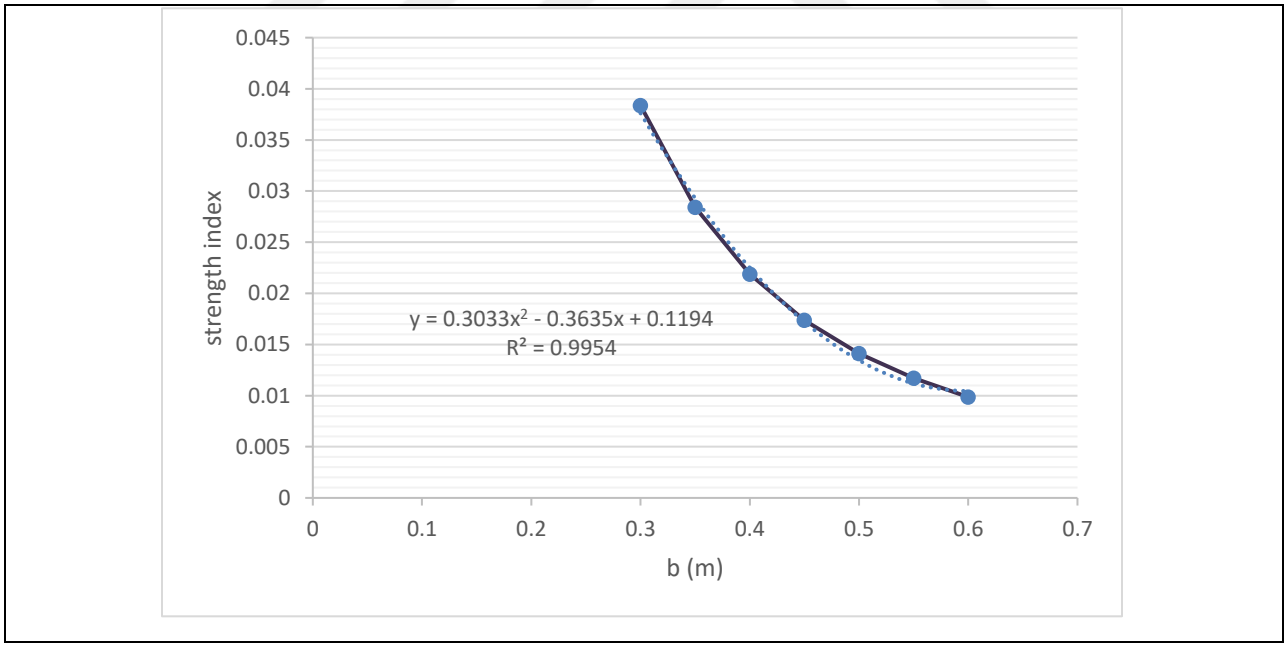

Figure 4.2: The Effect of B on the Strength Index (curve fitting)

Table 4.2: The Effect of h on Strength Index

h (mm)	Strength index
300	0.121733
350	0.065506
400	0.038374
450	0.023972
500	0.015749
550	0.010775
600	0.007622

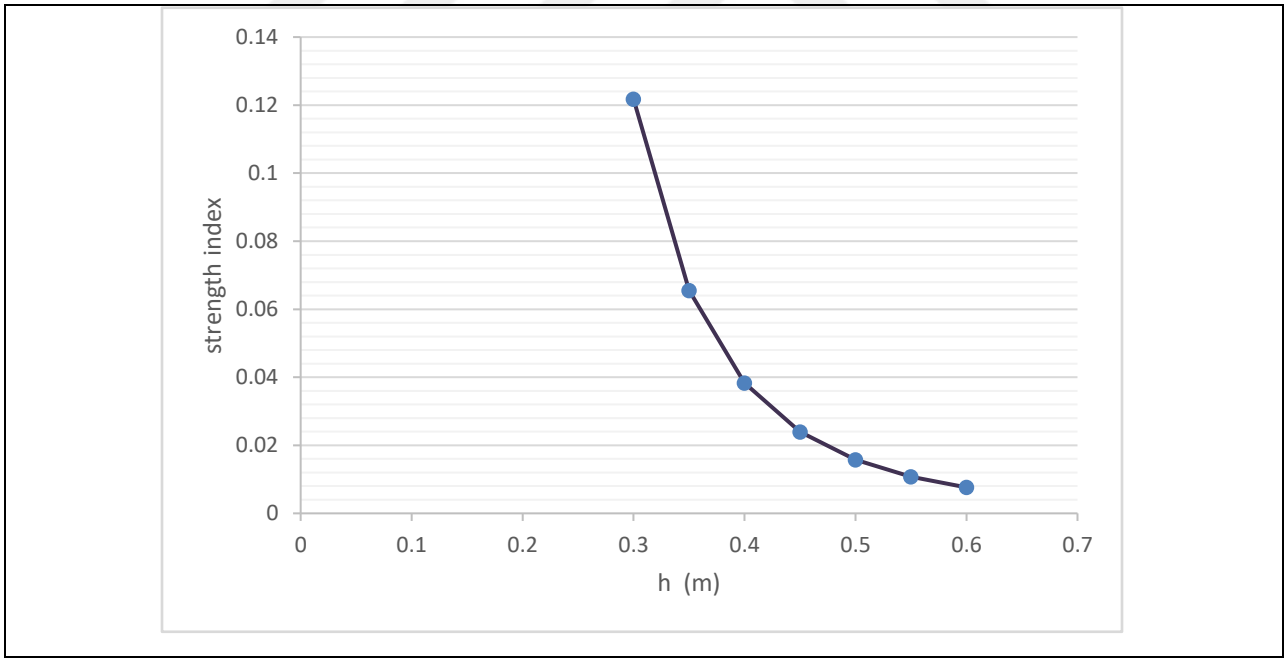

Figure 4.3: The Effect of H On The Strength Index

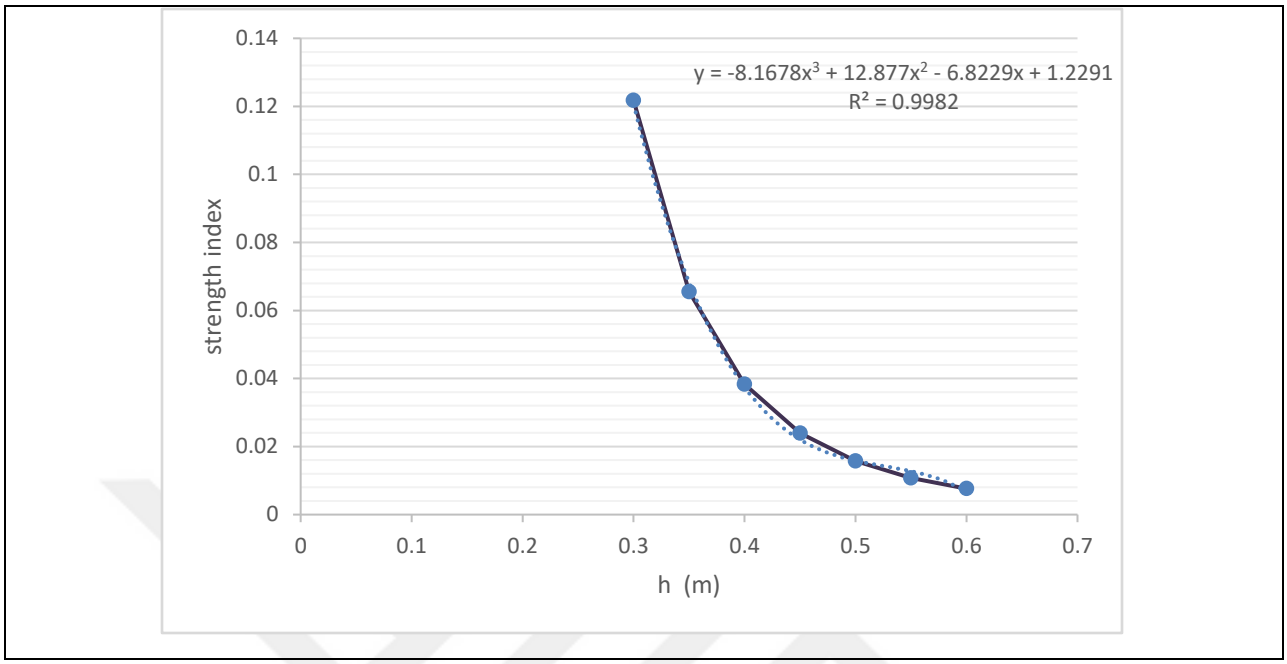

Figure 4.4: The Effect of h on The Strength Index (curve fitting)

Table 4.3: The Effect of As on Strength Index

As (mm2)	Strength index
339.292	0.039231
452.389	0.038794
565.486	0.038374
678.583	0.037969
791.681	0.037579
904.778	0.037204
1017.88	0.036841

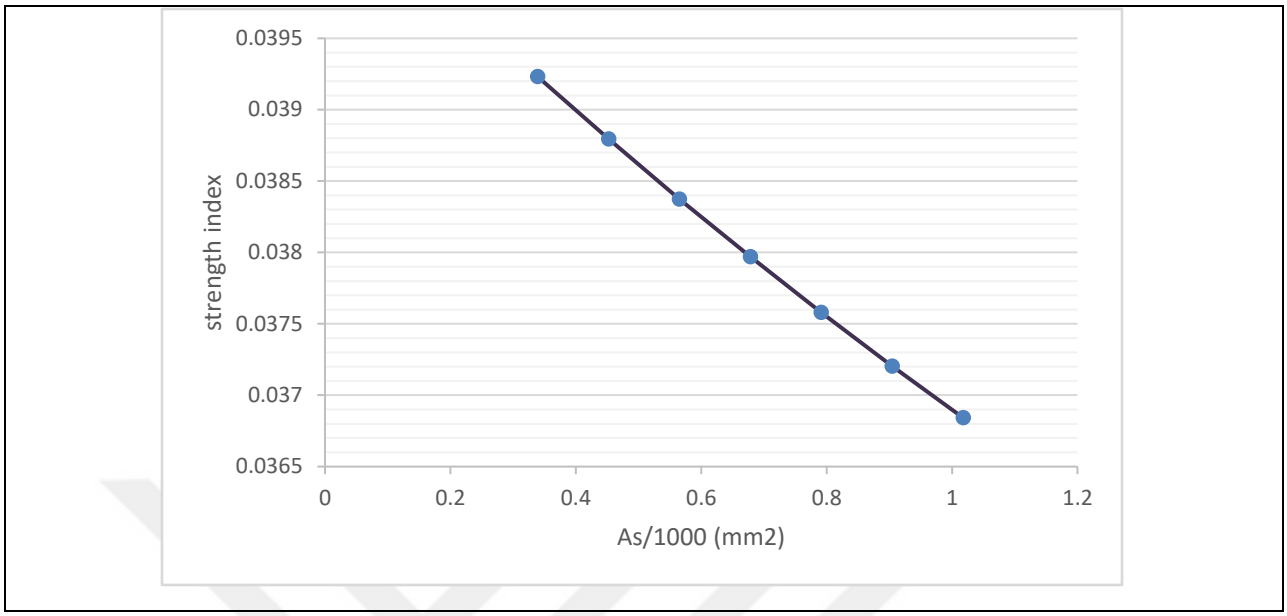

Figure 4.5: The Effect Of As On the Strength Index

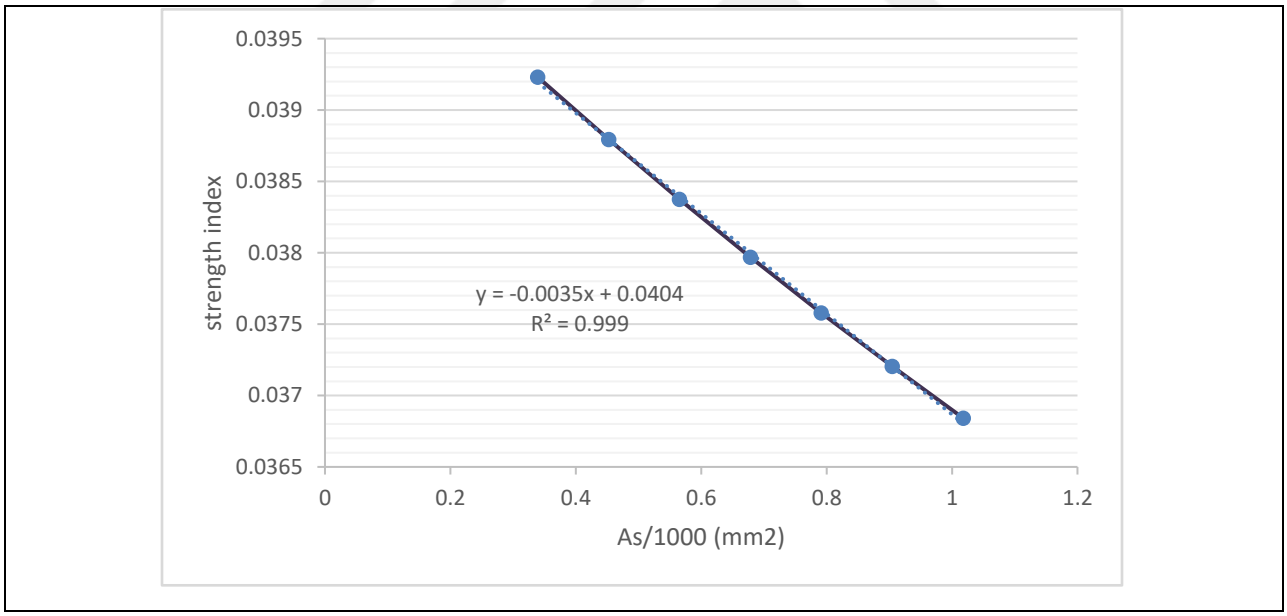

Figure 4.6: The Effect of As on The Strength Index (curve fitting)

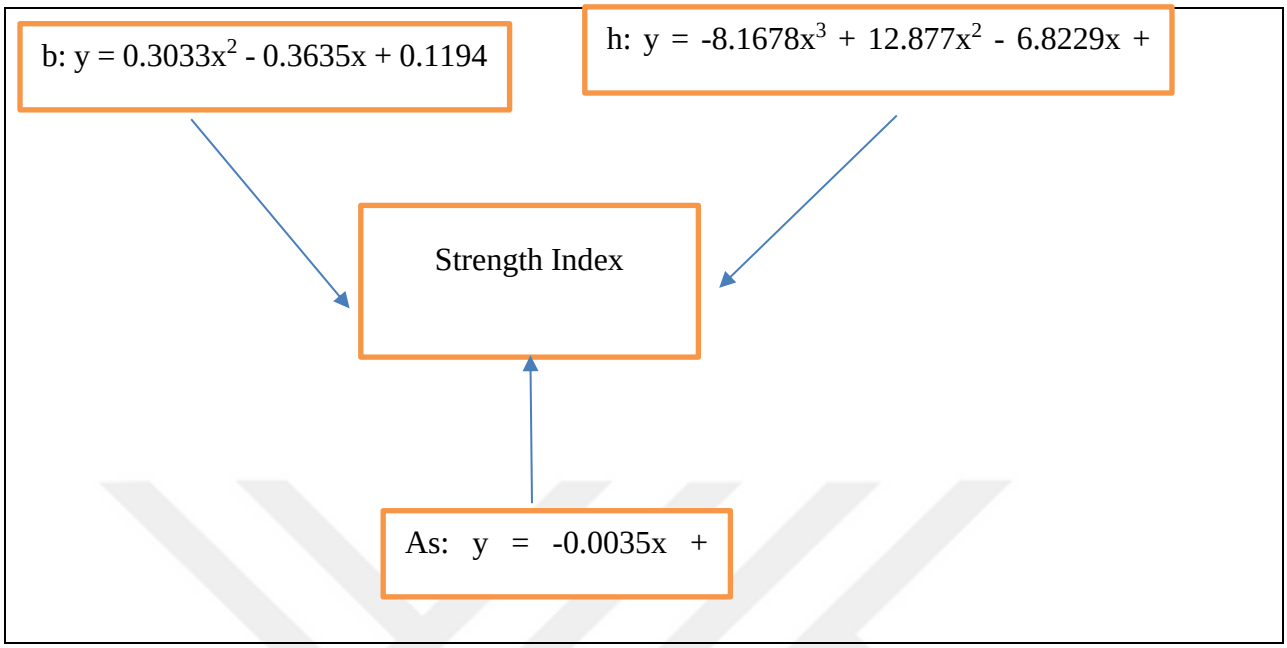

Figure 4.7: The Effect of fitting equation for the strength index (case one)

Table 4.4: The Strength Index Change Based On The Variation of b, h, and As

Item	Strength index change
b	0.028510
h	0.114112
As	0.002389
L	-0.079146

Table 4.5: The Percent of Effect For b, h, and As on strength index

Item	% Strength index effect
b	19.66
h	78.69
As	1.65

From the resultants in table, the portion of h gave the highest impact on the assigned strength index so that:

Table 4.6: The Examination Of Strength Index Portion For F(h) with the derived F(h)

Strength index by typical analysis	Strength index portion for F(h)	F(h)
0.124	0.095	0.0978
0.049	0.054	0.0385
0.022	0.030	0.0172
0.011	0.017	0.0085
0.006	0.013	0.0045

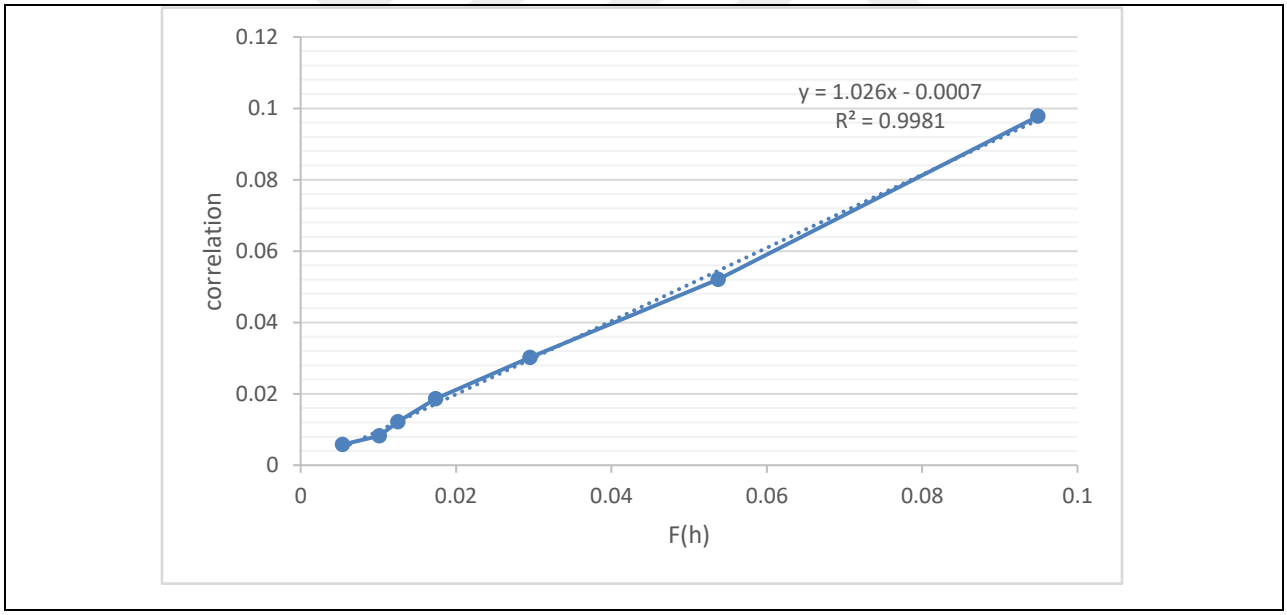

Figure 4.8: The Fitting Equation For The F(h) when b=0.3 m (case one**)**

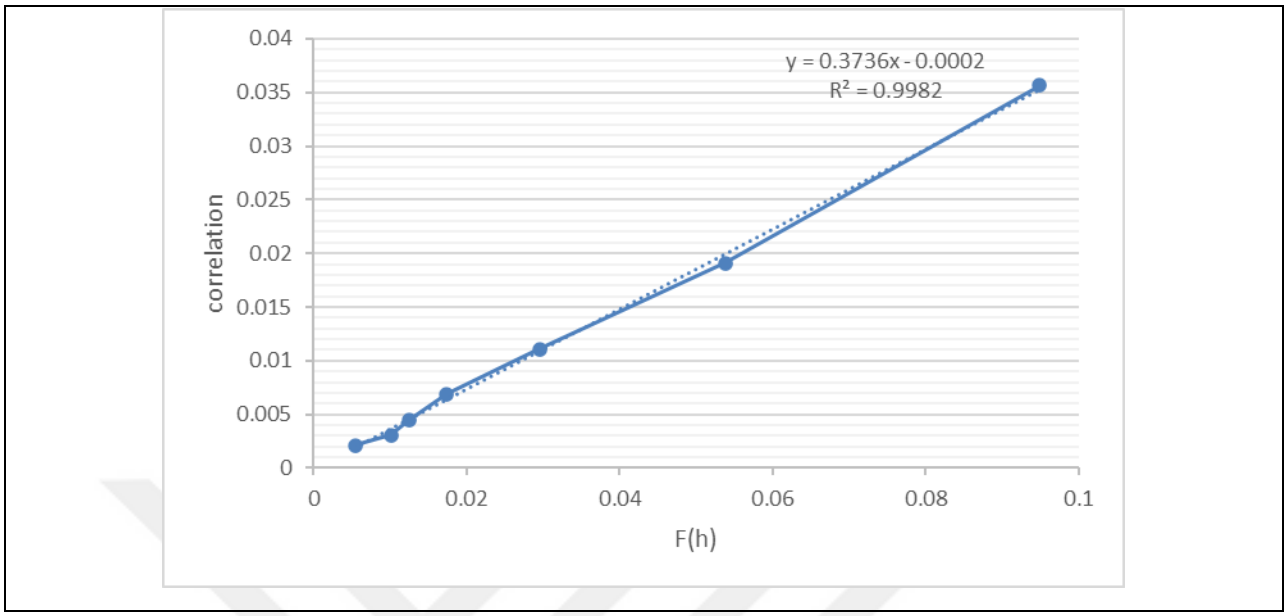

Figure 4.9: The Fitting Equation For The F(h) when b=0.4 m (case one)

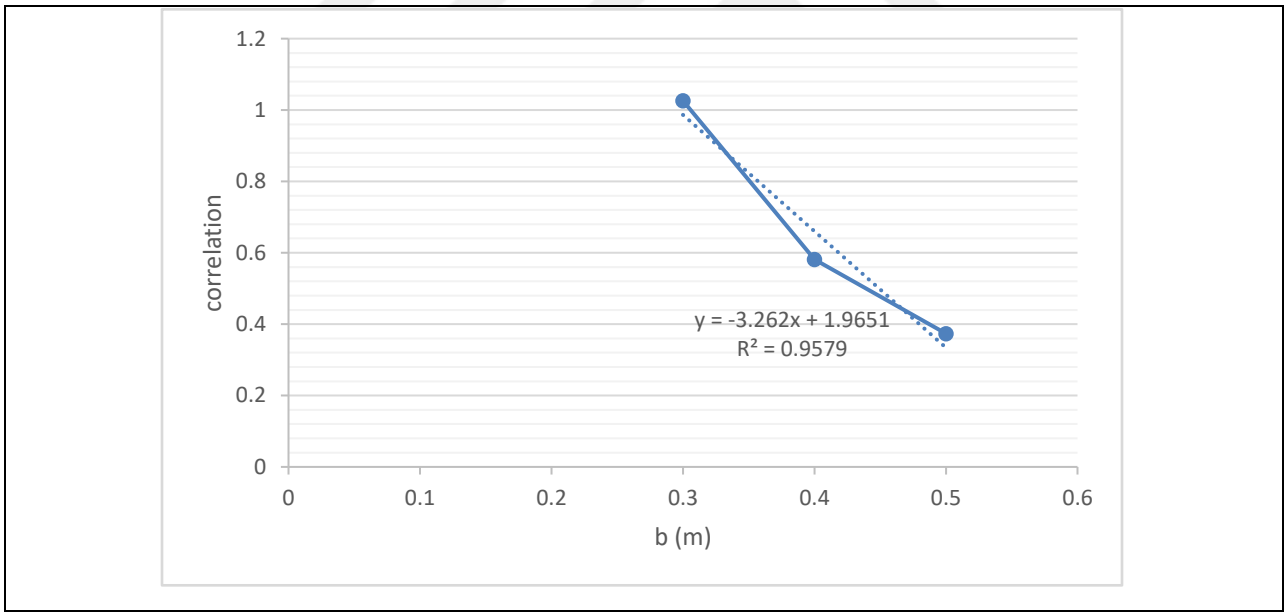

Figure 4.10: The Fitting Equation For The F(h) when b=0.5 m (case one)

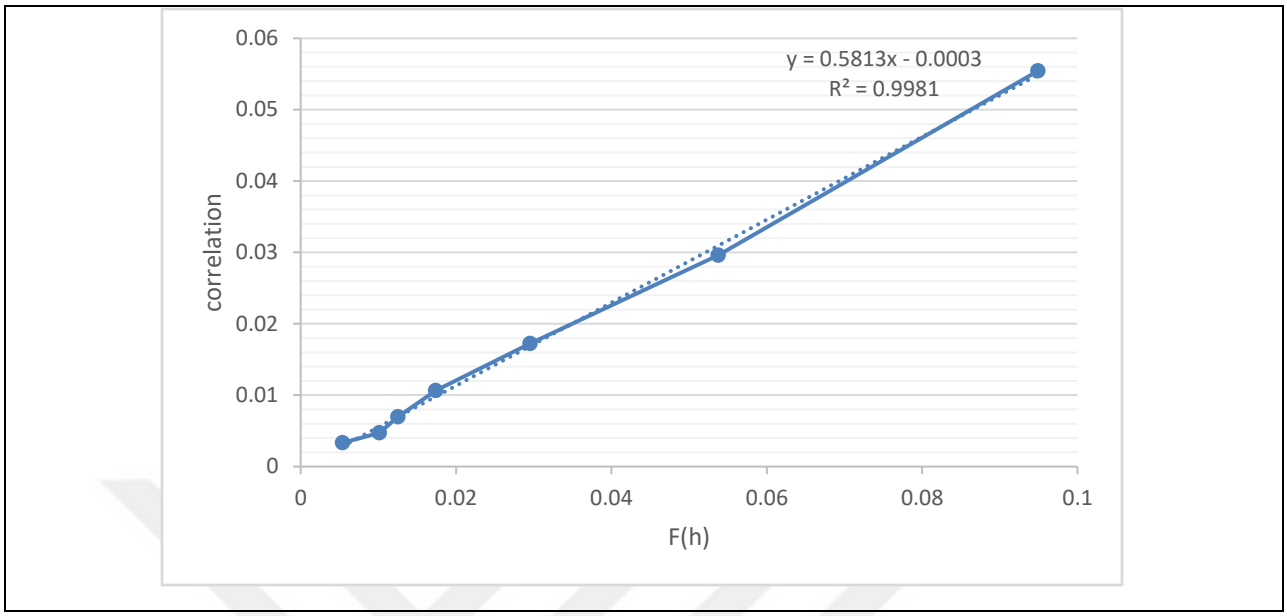

Figure 4.11: The Fitting Of b in F(h) equation (case one)

The magnitude of strength index with respect to F(h):

$$strength\ index\ =\ -3.262\ F(h)\ b + 1.965\ F(h)$$

For more value of width with the equation, the linear fitting of the equation lead to:

Table 4.7: The Checking Of Strength Index Portion For F(h),b

Strength index for F(h) by typical analysis	Strength index for F(h),b
0.124	0.094
0.049	0.044
0.022	0.019
0.011	0.009
0.006	0.004
0.003	0.002

From this equation the increment of the benefit of increasing the strength of concrete according to raising the cracking moment can be identified. For concentrated loading on beam, the effect of the span length can be taken as portion for the effect of b and h, the following table showed the change in te strength index when the length L increased to 5.5 m and 7m:

Table 4.8: The Checking Of Strength Index Portion For F(h),b,L

Fc/P2 when L=4 m	Fc/P2 when L=5.5 m	Fc/P2 when L= 7m	Column2/Column1	Column3/Column1
0.1243	0.2349	0.3805	0.3940	0.1761
0.0490	0.0925	0.1499	0.4470	0.2200
0.0219	0.0414	0.0670	0.4922	0.2613
0.0108	0.0204	0.0330	0.5309	0.2996
0.0057	0.0108	0.0175	0.5643	0.3349

By taking the averages for each case of span length, the following equation was generated:

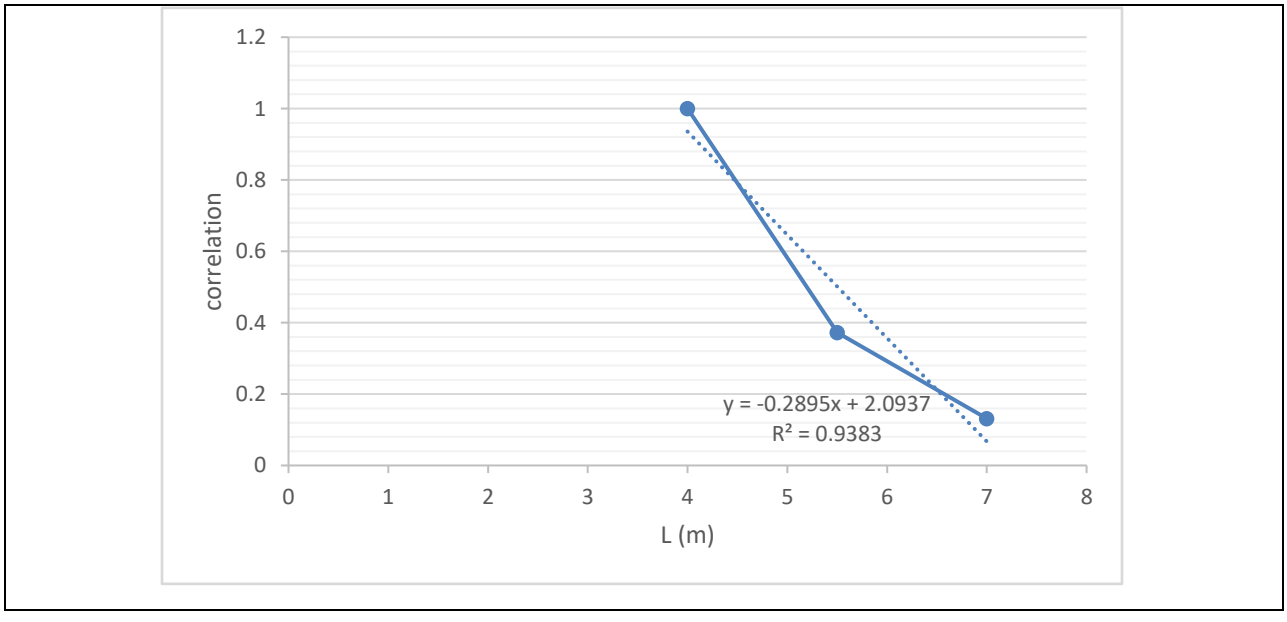

Figure 4.1: The Fitting Equation For L with F(h),b (case one)

From the figure, the correlation forms of the equations can written as:

$$strength\ index\ =\ -3.262\ F(h)\ b + 1.965\ F(h) * F(L)$$

$$F(L)\ =\ -0.2895\ L\ +\ 2.0937$$

The equation can be used to get how the compressive strength of concrete can contribute to the controlling of the change in width or height with addition to the available reinforcement of beam specially for high strength concrete. In other line, the equations can assign the needed strength of concrete for changing the geometrical cross section denomination and also the length of span to be still in the uncracked section behavior. The concentrated loading for these cases can be obtained by multiplying the strength index by the strength of concrete used and then using the square root as indicated in the following equation:

The concentrated load for untracked section:

$$Pcr = \sqrt{0.787 * \frac{Fc}{strength\ index}} \qquad (4.1)$$

Table 4.9: Identifying Pcr For Various Compressive Strength Of Concrete Based On F(h),b

b (mm)	h (mm)	Derived strength index	Fc (MPa)	Pcr (kN)	Pcr calculated by working stress method
300	300	0.48821	30	15.88	15.54
350	350	0.19928	35	24.95	26.74
400	400	0.08114	40	40.19	42.76
450	450	0.03908	45	64.01	64.64
500	500	0.02803	50	96.96	93.52

4.2 CASE TWO: UNIFORM LOADING

Table 4.10: The Effect of B on the Strength Index (case two)

b (mm)	Strength index
300	0.153495
350	0.113649
400	0.087528
450	0.069481
500	0.056492
550	0.046833
600	0.039456

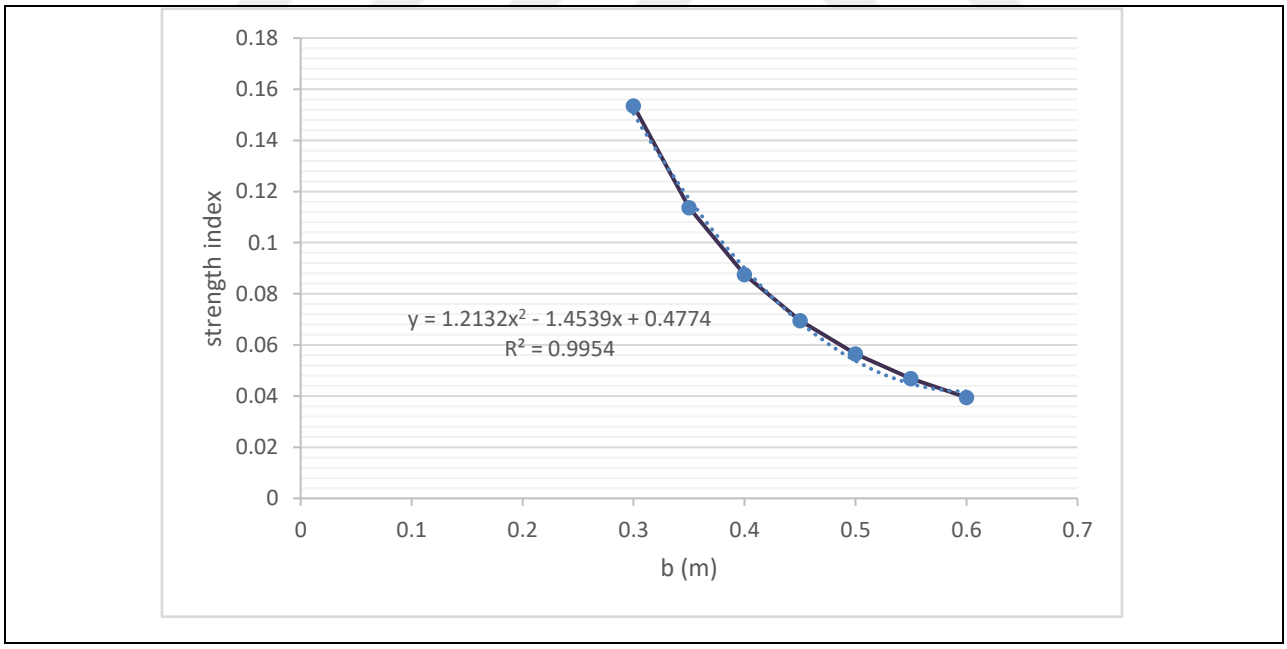

Figure 4.2: The Effect of B on Strength Index (case two)

Table 4.11: The Effect Of H On The Strength Index (case two)

h (mm)	Strength index
300	0.486933
350	0.262024
400	0.153495
450	0.095889
500	0.062996
550	0.043099
600	0.030486

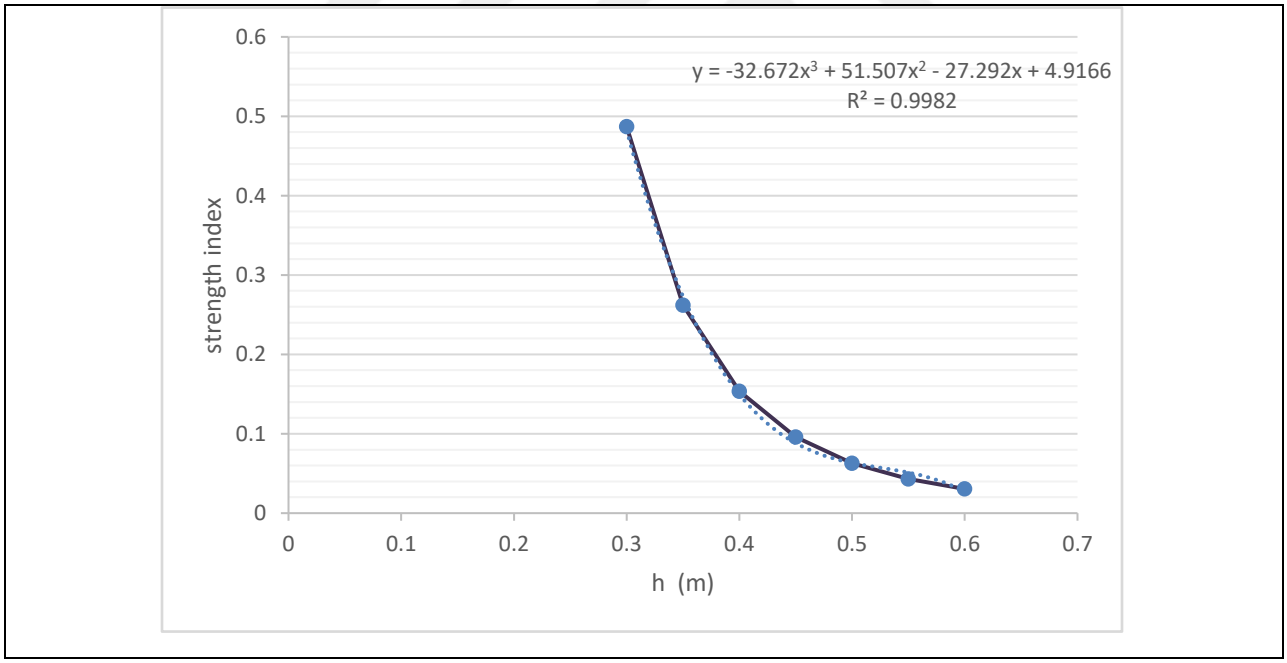

Figure 4.3: The Effect of H on Strength Index (case two)

Table 4.12: The Effect Of As On The Strength Index (case two)

As (mm2)	Strength index
339.292	0.156923
452.389	0.155176
565.486	0.153495
678.583	0.151877
791.681	0.150318
904.778	0.148815
1017.88	0.147365

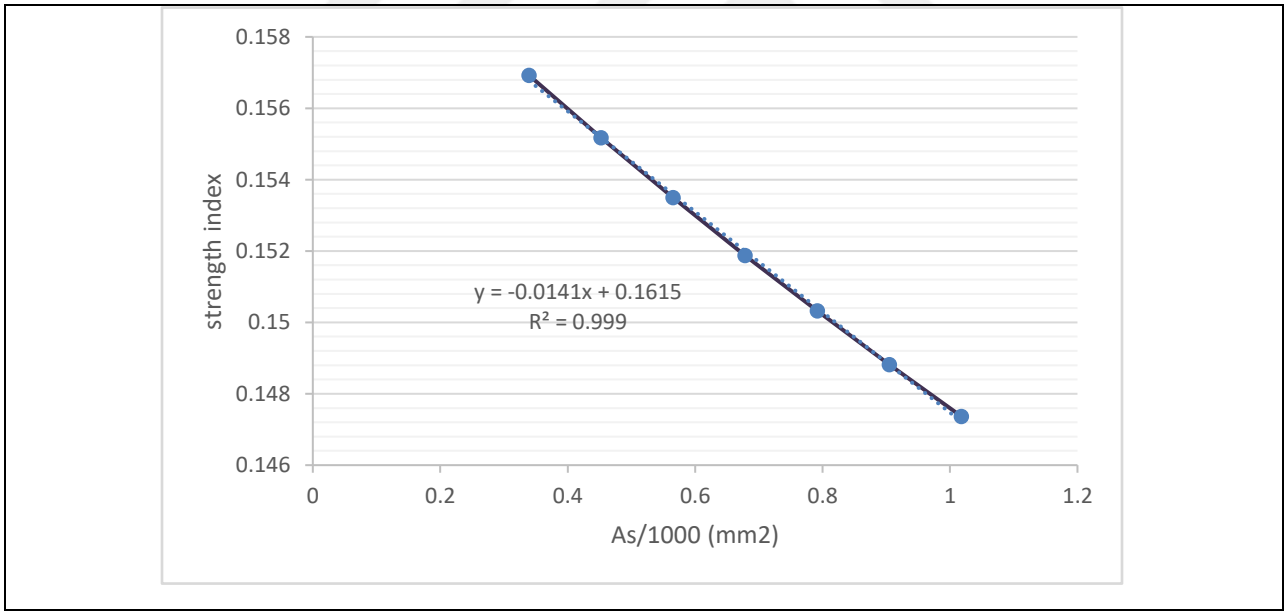

Figure 4.4: The Effect of as on Strength Index (case two)

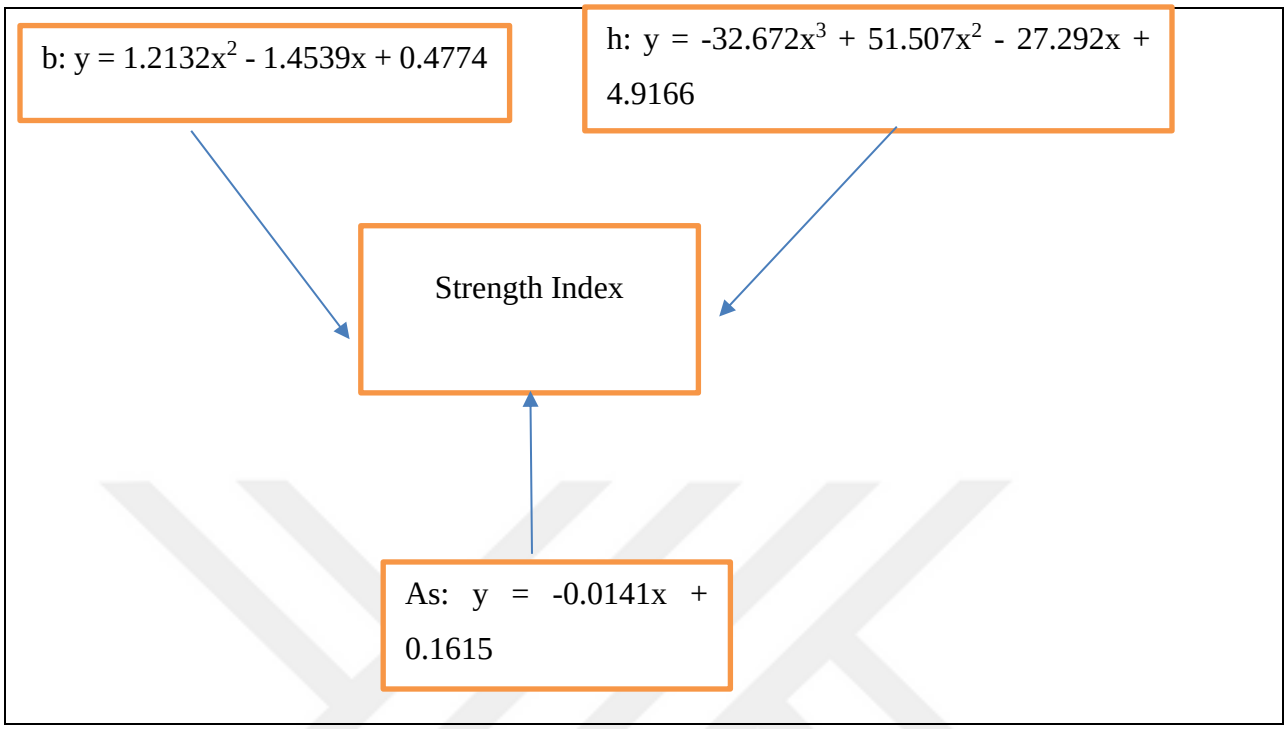

Figure 4.16: The Fitting Equation For Strength Index (case two)

Table 4.13: The Strength Index Change (case two)

Item	Strength index change
b	0.114039
h	0.456447
As	0.009558

Table 4.14: The Percent of Strength Index Change (case two)

Item	% Strength index effect
b	19.66
h	78.69
As	1.65

$$F(h) = 0.7869\,(-32.672\,b^3 + 51.507\,b^2 - 27.292\,\mathrm{b} + 4.9166)$$

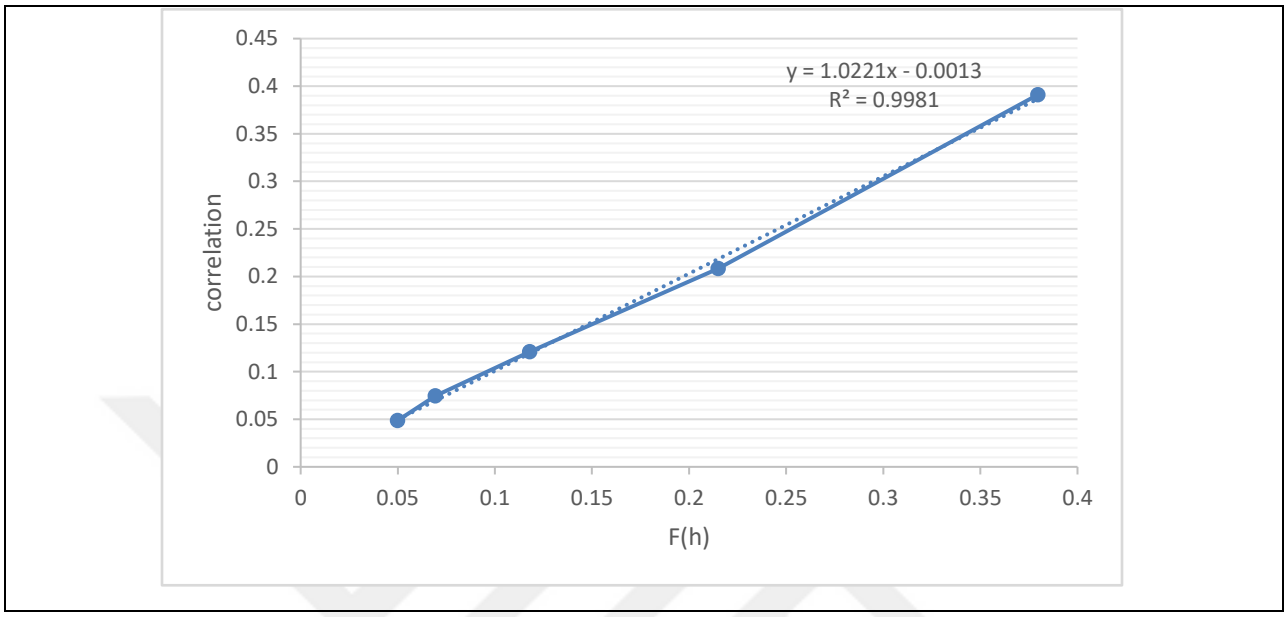

Figure 4.5: The Fitting Equation For F(h) when b=0.3 m (case two)

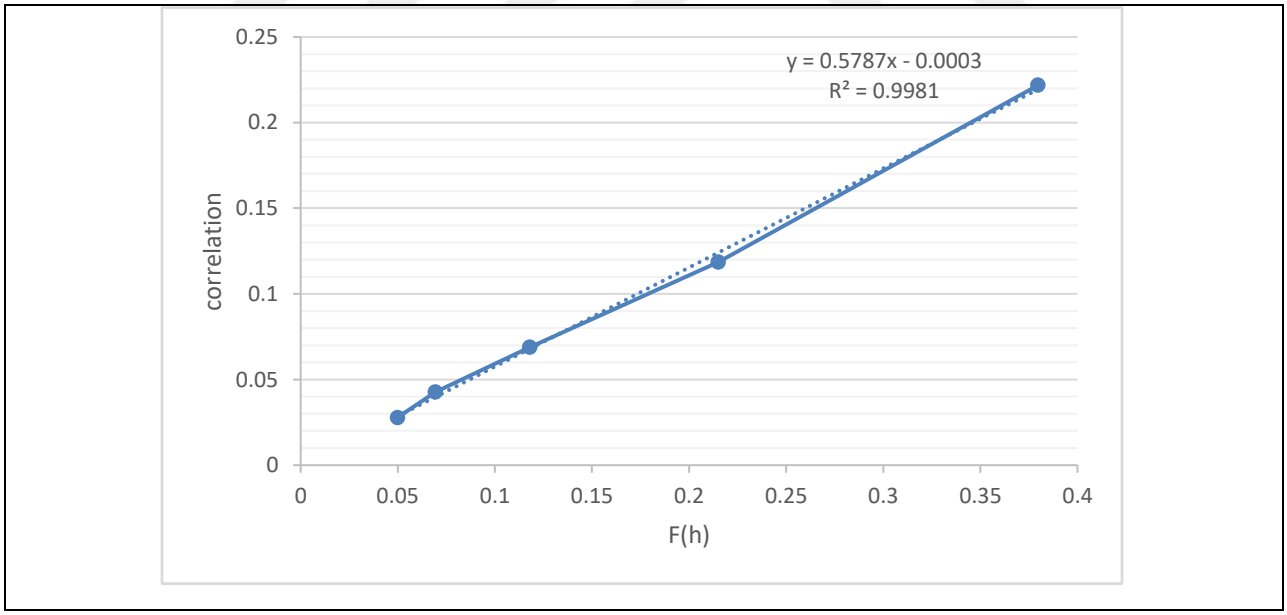

Figure 4.6: The Fitting Equation For F(h) when b=0.4 m (case two)

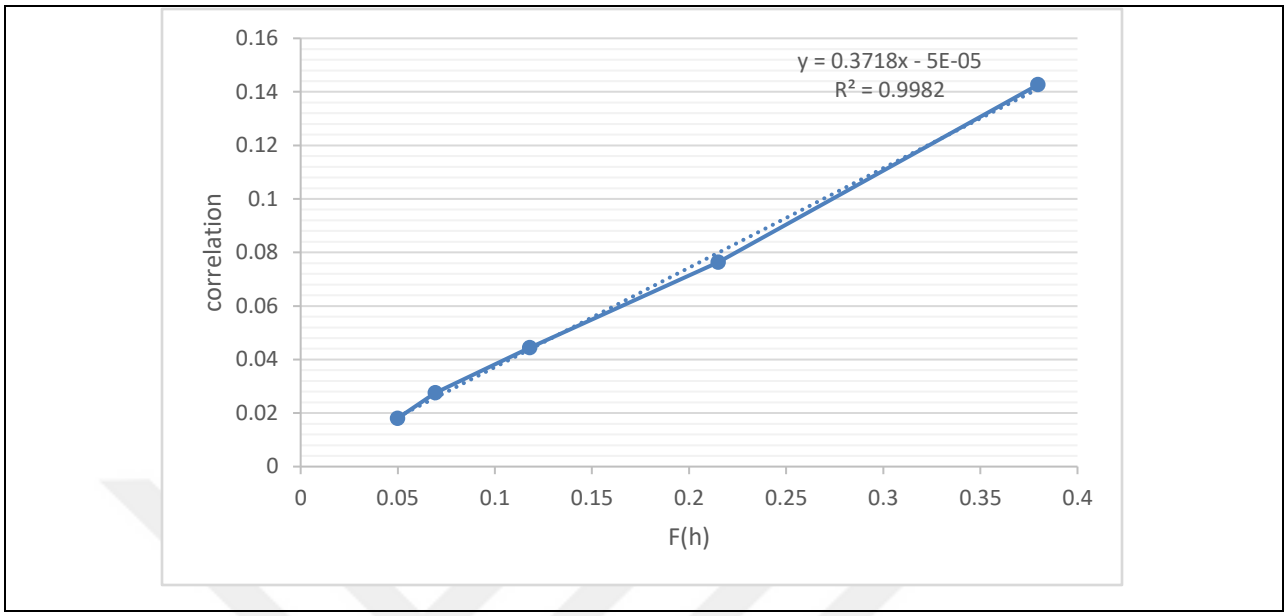

Figure 4.7: The Fitting Equation For F(h) when b=0.5 m (case two)

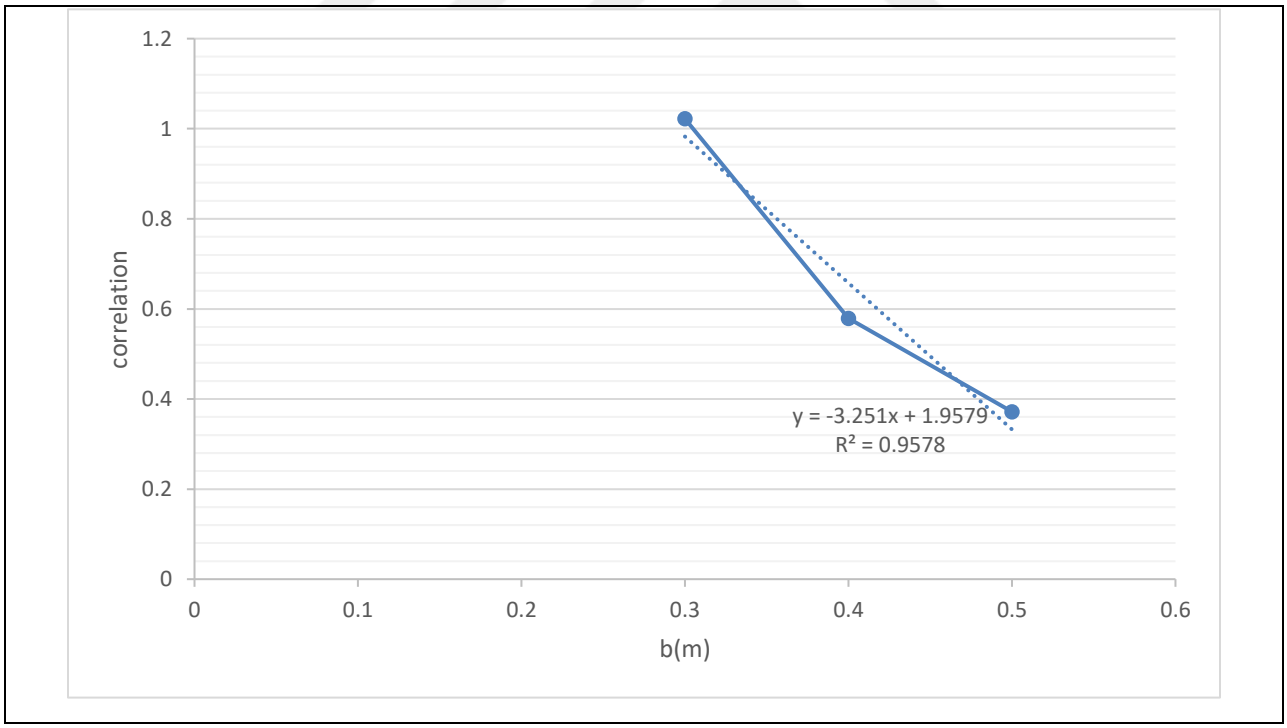

Figure 4.20: The Fitting Of b for F(h) (case two)

Table 4.15: The Strength Index Portion for F(h) and derived F(h) (case two)

Strength index by typical analysis	Strength index portion for F(b)	F(b)
0.497009	0.098	0.0296
0.195804	0.038	0.023
0.087528	0.017	0.0177
0.043081	0.008	0.0135
0.022871	0.004	0.0106

The magnitude of strength index with respect to F(b):

$$strength\ index\ = -3.25\ F(h)\ b + 1.958\ F(h) \qquad (4.2)$$

Table 4.16: Checking Strength Index Portion for F(h) By Typical And Derived Calculation (case two)

Strength index for F(h),b by typical analysis	Strength index portion for F(h),b
0.3911	0.37321
0.1541	0.17639
0.0689	0.07762
0.0339	0.03436
0.0180	0.01660

For uniform loading on beam, the effect of the span length can be taken as portion for the effect of b and h, the following table showed the change in Strength index when the length L increased to 5.5 m and 7m:

Table 4.17: Checking F(h) and F(L) (case two)

Fc/w2 when L=4 m	Fc/W2 when L=5.5 m	Fc/w2 when L= 7m	Column2/Column1	Column3/Column1
0.391097	1.4	3.66806	3.57	9.38
0.154078	0.55	1.44509	3.57	9.38
0.068876	0.25	0.64598	3.57	9.38
0.03	0.12	0.32	3.57	9.38
0.02	0.06	0.17	3.57	9.38
0.01	0.04	0.1	3.57	9.38
0.391097	1.4	3.66806	3.57	9.38

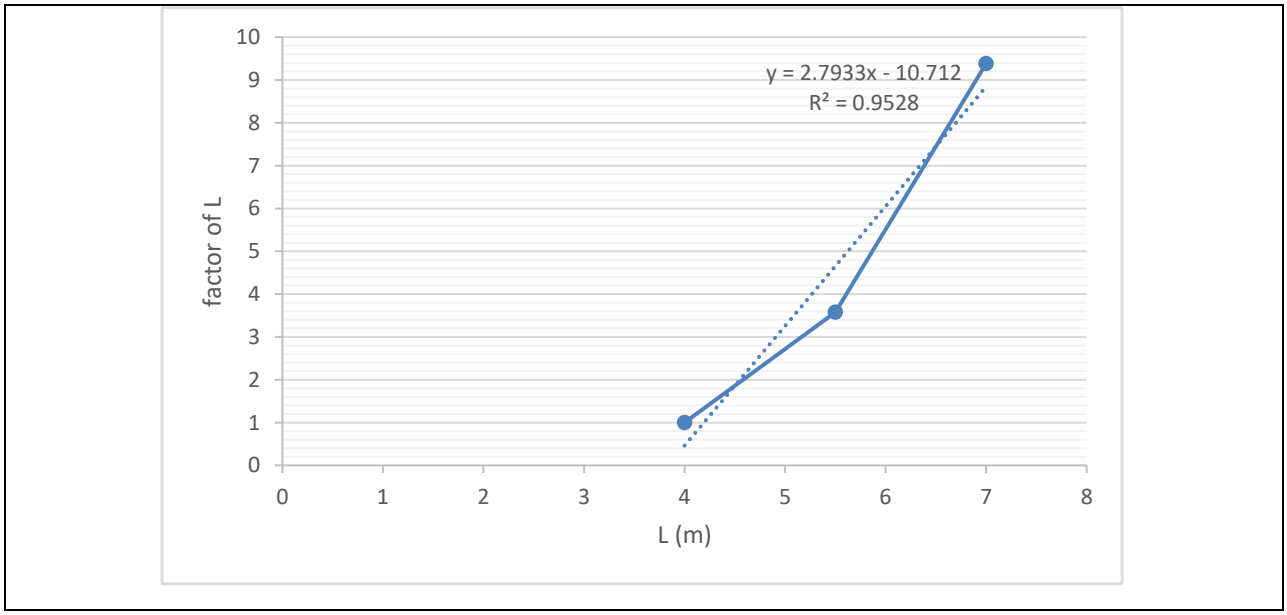

Figure 4.21: The Fitting of L for F(h),b (case two)

From the figure, the correlation forms of the equations can write as:

$$sstrength\ index\ = \left(-3.25\ F(h)\ b + 1.958\ F(h)\right) * F(L) \quad (4.3)$$

$$F(L) = \ 2.7933x\ -\ 10.712 \quad (4.4)$$

The maximum uniform loading for uncracked section:

$$Wcr = \sqrt{0.787 * \frac{Fc}{strength\ index}} \quad (4.5)$$

4.3 CALCULATION THE LIMITS OF CRACKING

As results of the derived equation, the minimum value of Fc can be assigned for the design purpose, the following table showed the variation of the width of beam and the compressive strength of concrete in the way of increasing the limit of the cracking uniform loading:

Table 4.18: Calculation Of Wcr by F(h),b,L

b (mm)	h (mm)	Derived strength index	Fc (MPa)	Wcr (kN/m)	Wcr calculated by working stress method
300	300	0.48821	30	7.953	7.769
350	350	0.19928	35	12.5	13.370
400	400	0.08114	40	20.14	21.378
450	450	0.03908	45	32.1	32.321
500	500	0.02803	50	48.68	46.758

4.4 ANSYS SIMULATION RESULTS

The simulation images shown explained the directional deformation in figure 4.21, and the normal stress in figure 4.22. the input data was changed for the concrete to raise the compressive strength from 30 to 40 then to 50 MPa. The safety factor data shown by the program indicated the

decreasing of critical color from the tension zone as the compressive strength raised. These visual appearance can be detected by comparison among figure 4.23, 4.24, and 4.25.

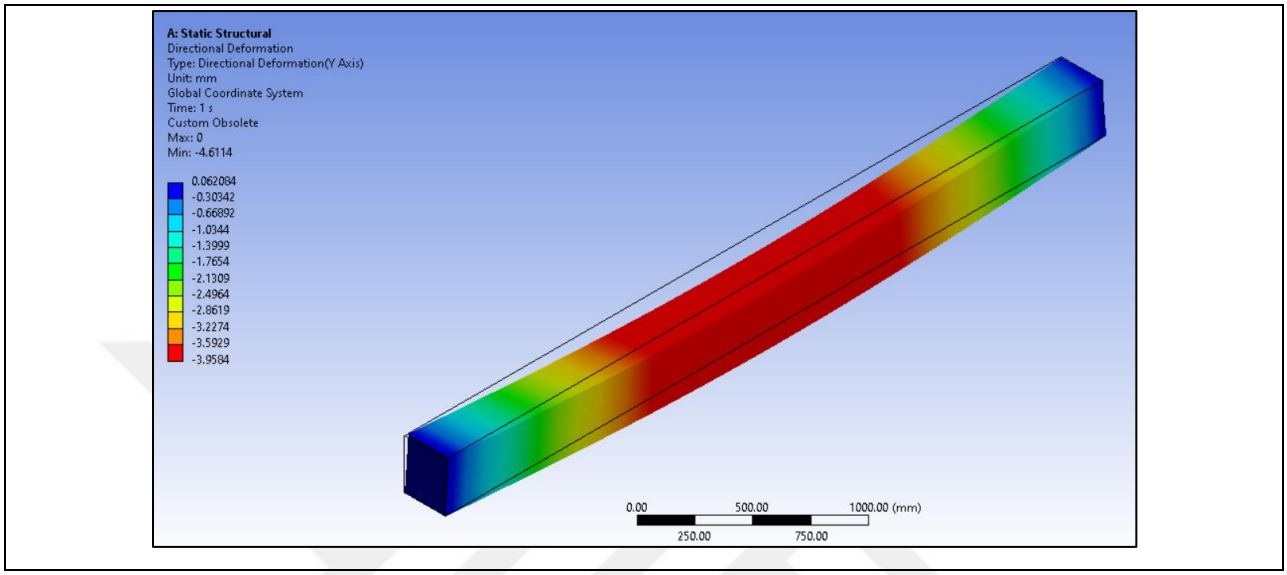

Figure 4.22: Directional Deformation for RC beam (ANSYS)

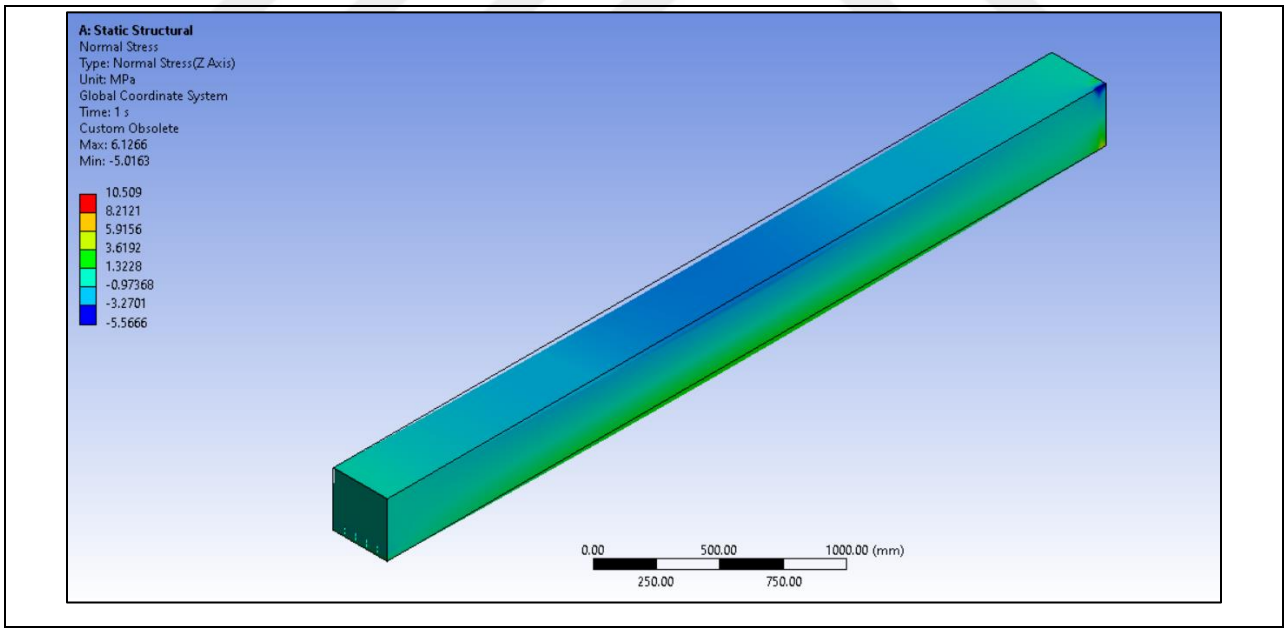

Figure 4.8: Normal Stresses For RC beam (ANSYS)

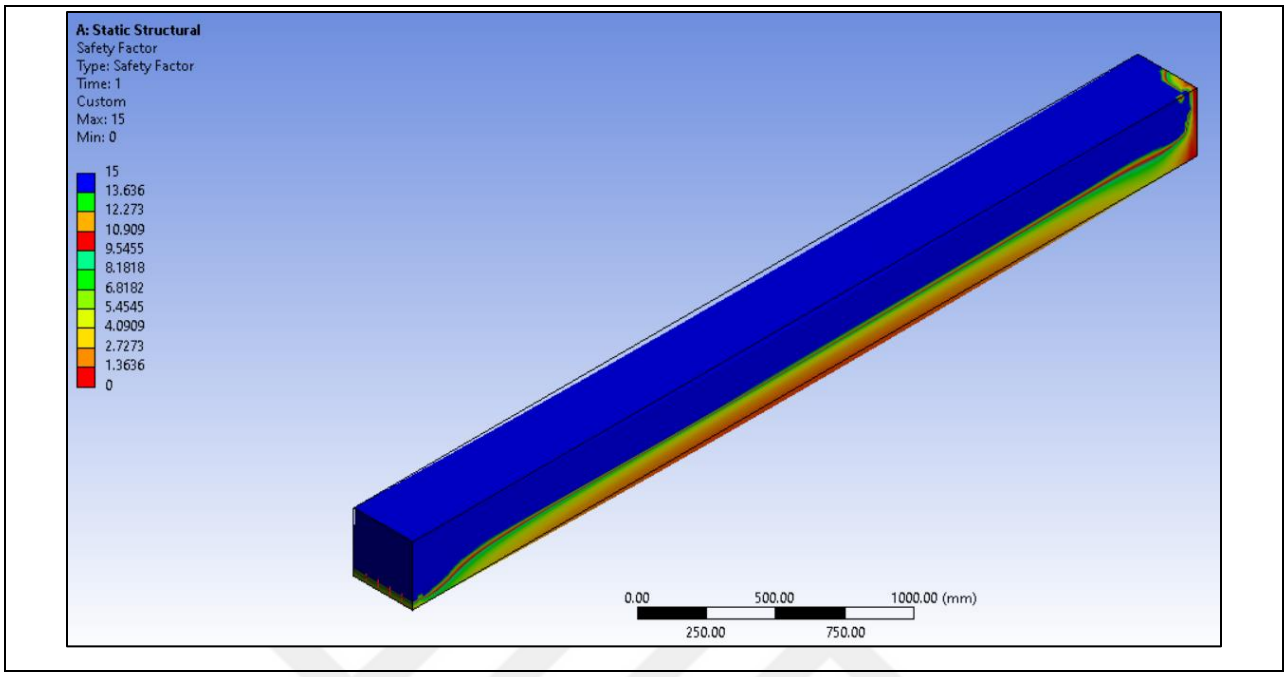

Figure 4.9: Safety Factor for RC beam Fc=30 MPa (ANSYS)

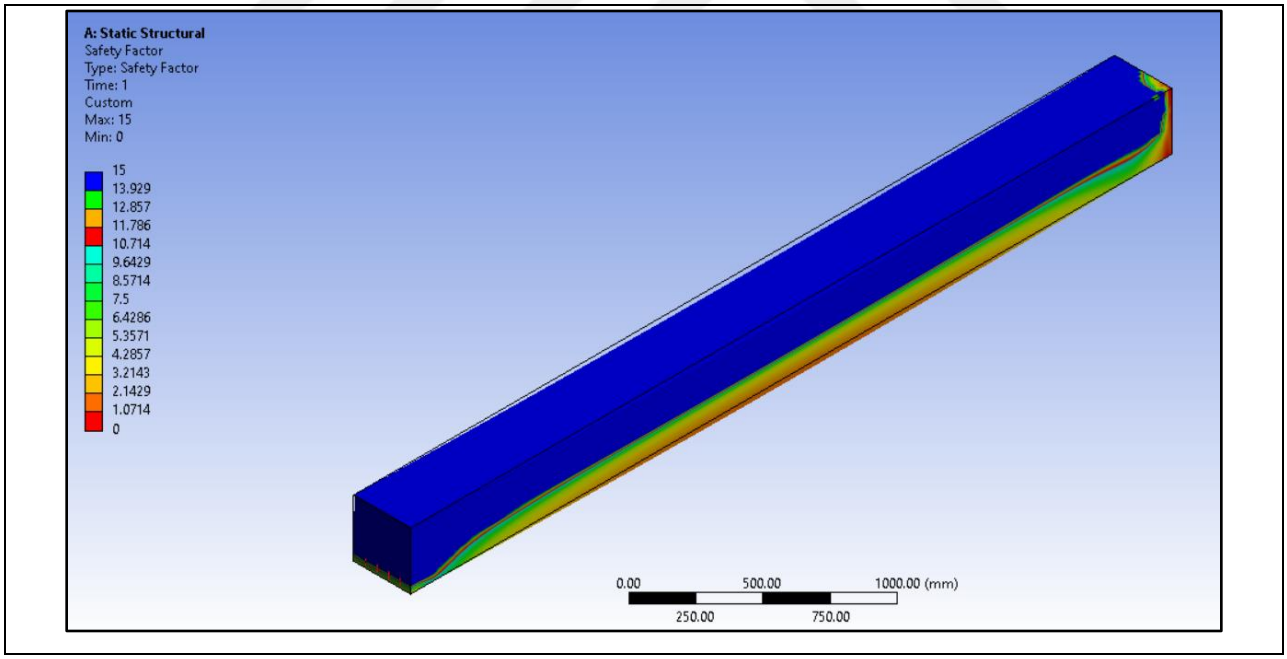

Figure 4.10: Safety Factor for RC beam Fc=40 MPa (ANSYS)

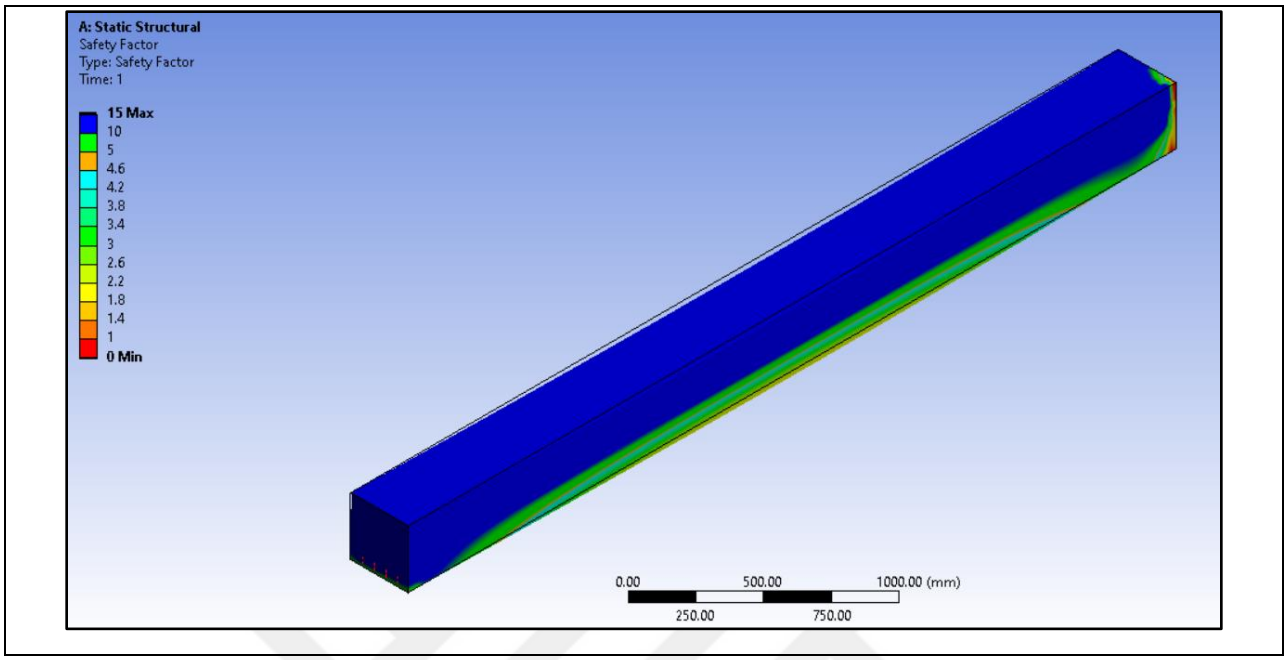

Figure 4.11: Safety Factor for RC beam Fc=50 MPa (ANSYS)

5. DISCUSSION AND CONCLUSIONS

5.1 CONCLUSIONS

The study built the analysis for the structural benefit of increasing the compressive strength of the concrete for two cases of RC beams: the first was beam under concentrated load at middle span and the second for beam under uniform loading. The study used the theory of working stress method and the tensile strength equation according to ACI code then mixed them to identify the strength index with referred to Fc/P^2 for case one and Fc/W^2. The study used the curve fitting processing on the charts that based on the relationship between the strength index and the main parameters I the theoretical equation which ere the height of beam h, the width b, and the steel area As. The study evaluated the most effect parameter by determining the percent of effect of each of them. The height of the beam showed more than 78% of the impact contribution as comparison with b and As. The study derived the equation for F(h) to get the strength then modifying the equation to cover the variation of b and L. the examination of the strength index was made for each case.. The study showed the equation of identifying the cracking force for case one and the cracking uniform load for case two. 9The study showed that according to the equations, the cracking force can raised from 15 to 20 kN for the compressive strength of the concrete from 30 to 50 MPa and fixed b and h at 0.3 m. By changing the parameters b, and h from 0.3 to 0.5 m and the compressive strength of the concrete from 30 to 50 MPa the cracking force raised from 15 kN to about 90 kN. The same analysis was made for the case two in which the cracking uniform loading raised from 7 to 10 kN/m when the compressive strength of the concrete from 30 to 50 MPa. and raised to about 46 kN/m when the h, b increased to 0.5 m. the simulation of the cases was part of the study by explaining in colored 3d images as output of ANSYS program the variation of the safety factor when the compressive strength of concrete changed from 30 to 50 MPa.

5.2 FUTURE WORK

The coming ideas can used more cases constructions for investigating as quantities and cost effective analysis the feasibility of increasing the tensile strength of concrete and modeling the cases to give more flexible ways for the designers to give their opinions. The future studies can build their modeling concepts on advanced stages like the ultimate strength method or the RC beams with pre-stressed technique to identify the contribution of the high strength concrete on the overall strength of the construction elements specially when it subjected to high external value of loadings and it limit to specific geometrical design.

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