"Study on recron Fibres"

A PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

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CERTIFICATE

This is to certify that the work which is being presented in the project title **“Study on recron Fibres”** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology and submitted in the Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Preeti Chauhan (141608), Anchit Thakur(141630), Divyansh Tewari(141636)** during the period from August 2017 to May 2018s under the supervision of **Mr. Abhilash Shukla**, Assistant Professor(Grade-II), Civil Engineering Department, Jaypee University of information technology.

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ABSTRACT

The present day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibres and other admixtures in concrete up to certain proportions. In the view of the global sustainable developments, it is imperative that fibres like glass, carbon, polypropylene and steel fibres provide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitation, erosion resistance and serviceability of concrete. Fibres impart energy absorption, toughness and impact resistance properties to fibre reinforced concrete material and these characteristics in turn improve the fracture and fatigue properties of fibre reinforced concrete research in glass fibre reinforced concrete resulted in the development of an alkali resistance fibres high dispersion that improved long term durability. This also deals with the variation of fracture energy of concrete with addition of recron fibre . The study involves experimental determination of fracture energy by testing three point bend concrete beams of same size but varying percentage of recron fibres.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER-1

INTRODUCTION

1.1. GENERAL INTRODUCTION:

Concrete is one of the most important materials used for building wide range of structures . Concrete is the second most consumed substance in the world after water . The concrete industry is about $37 billion . Around 10 billion tons of concrete is produced every year around the world. Concrete's durability is of more than thousand years. While the usage of concrete as a construction material is ever expanding, the researches and studies have been undertaken to enhance the properties like durability, strength, superiority and other factors. The concrete exhibit great compressive strength but fails in tension. The rigid pavement laid of concrete exhibit cracks that are arise due to the changing temperature. The pavement shrinks. Efforts have been undertaken in order to mitigate the splits and introduce changes in ductility of concrete. By using strengthened steel bars and by use of limiting procedures the service life can be extended. However,the above mentioned both these techniques impart rigidity, but they don't build the elasticity of concrete itself.

It has been perceived that the infusion of little firmly divided and consistently scattered fibres to concrete would go about as split protection and generously enhance its various properties.This kind of concrete is known as Fibre reinforced concrete. In these papers, an effort is being made to understand the behaviour of concrete blended with RECRON 3s Fiber in correlation with plain concrete.

Concrete has excellent resistance against fire rating, extensive service life and shielding capability, under normal and accidental conditions. Concrete is very easy to use, cast and is cheaper than most of construction materials. However, concrete having such excellent properties, ,structures made from concrete usually exihibit micro-cracking that may result in fracture of a concrete structures when subjected to accidental load or service loads and/or exposure to normal environmental conditions. Therefore, a micro-crack in concrete causes crack propagation that leads to the probable catastrophic failure. So, in order to mitigate this type of catastrophic failures, it is necessary to forecast the mechanism of failure of concrete. This can ensure safety and extend service life of the structures. The failure mechanism of concrete can be checked by the calculation of the energy that gets consumed in a crack propagation that leads to the formation of new crack surfaces. In the concrete structure, for the extention of crack, a certain amount of energy is required that can only be understood by an energy based propagation phenomenon. It provides a basic for understanding the phenomenon of a concrete fracture mechanism. Concrete exhibits an elastic material response under loaded conditions. The reason of the non-linearity phenomenon is due to the formation of a FPZ in front of the crack tip. In the quasi-brittle materials like concrete, fracture energy is introduced that is the energy dissipated for the formation of FPZ ahead of crack tip. Concrete fracture energy showing the failure process is still under a hot research topic. Fracture energy is a size-independent fracture energy and is the one the most useful technique for the cracked concrete structure.

Fracture mechanics is in increasing stage therefore there are numerous things to research. In this present study, Fracture Energy which is one of the significant parameter will be calculated using work energy method. Work energy method is the best technique and permitted by RILEM, thus the name is RILEM method. The present work is restricted considering the experimental testing to be done. This Study involves investigational testing of pre-notched beams under three point bending. Beams of the same size but with changing notch to depth ratio are used. Mathematical modelling of the present work is out of scope.

1.2. STATEMENT OF THE PROBLEM

Since the concrete is powerless in tension, overwhelming reinforcements must be made the solid to expand its tensile and flexural quality. This builds the cost of the structure to a bigger degree. Likewise the erosion of the reinforcements is a severe problem. Additionally concrete is fragile so its impact strength is likewise low.

1.3. OBJECTIVES OF THE STUDY:

The following are the principle goals of study:

1. To relate the crushing quality of plain bond concrete with the fiber fortified concrete.
2. To assess flexural quality of plain cement concrete and fibre reinforced concrete.
3. To Estimate split tensile strength of plain cement concrete with fiber reinforced concrete
4. To examine Fracture mechanics, concrete behaviour, failure mechanism and load bearing capacity of structures of concrete.
5. To examine concrete as a quasi-brittle material through a load displacement curve.
6. To examine crack propagation of pre-notched beams.
7. To calculate Fracture Energy and study variation of same w.r .t changing notch to depth ratio.

1.4. SCOPE OF THE WORK:

The various properties of the Recron fibre reinforced concrete and numerous factors such as water to cement ratio, type of fibre used, volume, aspect ratios and its influence on strength is well recognized & investigations have been carried up to date. The development in strength of Recron reinforced concrete is supplemented by a relatively larger increase in flexural toughness & impact resistance, which are chief factors. Recron fibre reinforced concrete's structural behaviour needs to be examined.

CHAPTER 2

LITERATURE REVIEW

SREETAM KANUNGO’S TRAINING AT RSP, ROURKELA

Ordinary strengthening steel is proposed to assess all the malleable and bending stresses and additionally temperature related worries in solid structures. The design contemplations are entrenched in the Indian Standard Code I.S. 456 and are the base basic commitment for plan and development. These essential steel are named for this paper as essential steel. Use of auxiliary reinforcements does not adjust the necessities of "Essential Steel". In any case, a basic reinforcement does not give its welfares until the point that solid fortifies. Henceforth a secondary reinforcement as fibre support ought to be additionally added to the concrete is still in plastic stage. They enhance a portion of the properties of hardened concrete too. Subsequently it is checked that by collection of little amounts of evenly disseminated optional fibre fortification expands the static and dynamic properties of the concrete. Fibre support concrete disperses the three dimensional arbitrary reinforcement in the total mass of the solid. The properties which fibres encourage is absolutely innate to the sort and the quantity of strands being directed with concrete i.e. each sort of the fiber will prompt various types of qualities into the solid mass. As a whole fiber fortified cement has bigger restriction to the Drying Shrinkage Cracking, Compressive strength, Tensile & Flexural quality, Abrasion and effect protection and water permeability/penetration. Recron 3s FRC has been allowed by different governments, semi-government ,private and mechanical ventures. It has been concurred by many authorities .

It has been likewise utilized as a part of mechanical and private undertaking specified by the structural advisors. The endorse has been conceded after broad field judgements by every one of these experts. It has been maintained by inside and out points of interest testing of the Recron 3s on all contemplations at a significant number of the organizations including "IITChennai &Guahati", "CRRI Delhi" and so on.

S.Y. ALAM, A. LOUKILI, F. GRONDIN, E. ROZIÈRE,

There are a few inquires about carried on Fracture Mechanics now-a-days. Some of the papers which I discovered critical for my examination are contemplated and talked about here. In paper by S.Y. Alam, A. Loukili, F. Grondin, E. Rozière, June 2015;Use of the computerized picture relationship and acoustic discharge procedure to ponder the effect of auxiliary size on splitting of strengthened cement; an experimental exploration is performed by utilizing two test systems at the same time i.e. advanced picture relationship and acoustic discharge to ponder the debasement of reinforced solid bars. The primary strategy gives exact estimation of surface displacements, in this way break openings and split dispersing are resolved. To investigate the harm mechanisms, the acoustic discharges coming about because of internal damage are likewise broke down completely. To examine the impact of basic size Beams of three distinct sizes yet relatively comparable, were tried. Experimental measurements were contrasted and Euro-code articulations. In light of results, following things were finished up. Twisting tests were performed on reinforced concrete pillars. In the initial segment of the examination, under administration stacking, correlation of Euro-code articulations for break openings and splits dividing and experimental measurements were finished. At low strains and for the littlest bar measure the outcomes

demonstrate that the deliberate qualities pretty much concur with the computed values. However, as the strain expands, the Euro-code articulations think little of the crack openings and separating. As the extent of the pillar expands the discrepancy between Euro-code estimation and trial estimations of split openings and break separating increments. It appears that distinction in articulations is expected to the

move in disappointment modes watched when the extent of the example builds, which isnot considered in articulations. Smaller scale breaking is contemplated through AE parametric investigation in the second piece of the examination,. AE hits and AE vitality are analysed in the best and base sensors. Bigger the bar measure, the quantity of hit sand AE vitality discharged are low amid the underlying stacking stages. The AE energy release is more unexpected in bigger bar (D3) at top load, while in the littler shafts it is semi ceaseless. A gathering strategy (like K-implies technique) is utilized to identify diverse classes of AE vitality discharged. At the point when the size expands from small to huge shafts, the AE vitality discharged parameters are investigated thoroughly to recognize miniaturized scale breaking and large scale splitting stages. The conclusions are based on the outcomes acquired on 1:3 scale. As the crack procedure is more unpredictable in reinforced concrete when contrasted with plain solid, more definitive outcomes may be obtained on a more extensive scale.

In A. Nazari, J.G. Sanjayan, June 2015, The Stress force factor against fracture durability in practically reviewed as geo-polymers; the advantages of producing practically evaluated geo-polymer as far as their adjusted stress intensity factor and crack strength are talked about. Pre-indented functionally graded geo-polymer pillars were created by two diverse fly powder based geo-polymer blends. The heap that was connected in parallel to the practically graded region; two unique structures were assessed by changing the situation of the notch. The acquired outcomes showed that the split nucleation and development depend on the connection between stretch power factor and break sturdiness. After this the split encounters a break sturdiness area upward in nature and is arrested, when the connected pressure is equivalent to the weakest quality of the constituent

materials. Then again, the break strength of a split confronting a downward fracture sturdiness angle is more than that confronting an upward one, without any subsequent capturing. It was demonstrated that the situation of the score, and experiencing of descending or upward slope in mechanical properties for the most part decide the final flexural quality of the examples. Following conclusions were made in this paper. A change technique was proposed to the varieties of stress intensity factor, K, in FGG example. At to start with, break durability, Kc, of practically reviewed

locale was proposed to change exponentially. By the met bends of K and Kc, crack strength of practically reviewed examples was determined. However, to convey a thorough definition of K, an adjustment procedure was continued. Not withstanding the varieties of K in practically reviewed area, the post solid district in FGG is influenced by the variety of K in functionally graded locale. The change factor of flexible modulus proportion was acquainted with

decide the impact of the score position on break durability of specimens. While the two examples comprise of G1 and G2 solid examples, the fracture energy firmly relies upon the indent tip position. Notwithstanding the substance of constituent materials, upward and descending changes of mechanical properties determine the break starting and proliferating over the FGG examples. This modification factor isn't seen in most hypothetical models and just variety

of properties in reviewed district is considered. In any case, trial observations in this paper demonstrate this critical distinction highlight.

Paper by Xiufang Zhang, Shilang Xu, March 2011, "A relative investigation on five ways to deal with assess twofold K crack sturdiness parameters of concrete and estimate impact analysis "[11] talked about here. When utilizing the various experimental strategies and 4 pre-known existing explanatory techniques are known, the current paper exhibited a definite examination of twofold K break toughness parameters of the solid are assessed. Crack tests were completed on

reduced strain wedge part examples with different profundities fluctuating from 200mm up to 1000 mm. In the explanatory count, contingent upon the relationship between basic break tip opening uprooting and the abscissa estimation of turning point on bilinear softening bend, two unique conveyances of strong pressure are considered along split expansion. Four accessible investigative estimations yield almost similar estimations of twofold K break durability parameters and concur well with those got from the examination, which affirms the consistency of five approaches. He reasoned that, split advancement process from beginning splitting to stable propagation to flimsy proliferation in cement might be very much depicted through double-K crack model in which two break control parameters, called twofold K fracture strength, i.e., start crack sturdiness and shaky fracture toughness are presented. In this examination, a correlation of twofold K fracture toughness parameters decided from the test estimations and four existing expository arrangements, i.e., Gauss– Chebyshev fundamental technique, streamlined the equivalent strong power strategy, improved the Green's capacity strategy and 4terms weight work strategy, was tried on the minimal strain wedge splitting specimens with different profundities. It must be worried in the count of cohesive fracture durability that when huge examples are viewed as, the estimation of the basic break tip opening dislodging CTODc is generally higher than that of was on the bilinear softening bend. The presumption of the direct durable stress distribution along split expansion is inapplicable for huge examples especially ones with profundity of in excess of 600 mm , which was received in the past studies for littler examples. From estimate impact investigation, the accompanying primary conclusion can be made:

a) precarious crack sturdiness and start break durability are not much affected by the examples profundity, with the normal estimation of around 1.656 MPa-m1/2and 0.806 MPa-m1/2, individually.

b) when the profundity of example increments up to around 600– 800 mm profundity range, both the broadening basic break process zone (AC-AO) and basic split tip opening removal CTODc are appeared to increment. Past this range, they appear to adjust close to nothing and might be considered as material properties.

Ultimately, paper by N. Trivedi, R.K. Singh, J. Chattopadhyay, March 2015, Acomparative examination on three ways to deal with research the size independent fracture vitality of concrete"[10] talked about here manages examination of size-free crack vitality (Gf) of cement. The examination includes numerical modelling of three point twist solid pillars that are geometrically comparative having constant length to profundity proportion with differing indent to profundity proportions.

Qualities assessed numerically and tentatively for RILEM break vitality (Gf) are observed to be in reasonable assention. Gf is assessed from created relationship of fracture energy discharge rate and through bilinear model by Gf esteems. Gf esteems have been utilized to develop a basic strategy for estimation of Gf. Comparative analysis has been done for Gf from three distinct philosophies. Based on results he finished up, the size-autonomous break vitality of cement is the most useful parameter in the examination of broke solid structure which is investigated in the present work. The limited component reproductions of the TPB examples of different sizes with a/W= 0.05, 0.25 and 0.33 are performed by consolidating the concrete properties in light of break vitality strain softening model. Following conclusions are drawn from the above examination:

• The evaluated RILEM break vitality (Gf) estimations of cement from the numerically anticipated and tentatively watched load– stack line displacement curves are observed to be in sensibly great understanding.

• The present work builds up a simple and hearty strategy for the assurance of the measure free break vitality of cement. The investigation likewise conjures a primary approach in light of solid crack mechanics that depicts the nonlinear aspects of solid conduct through load– stack line reactions for a scope of a/W ratios and help to comprehend the disappointment systems and load bearing limit of concrete structures.

• A relative examination of 3 strategies used to gauge the size-independent fracture vitality of cement has been done. The watched estimations of GF from the three techniques are observed to be in sensible understanding. It is, therefore, concluded that either strategy can be utilized to acquire a one of a kind estimation of the size-free crack vitality of cement because of reliable pattern of break energy values assessed by all techniques.

CHAPTER-3

OBJECTIVE OF THE PROJECT

3.1.GENERAL

The utilization of fibre reinforced concrete can be tracted in history to the development of the Roman Coliseum; still, it took quite a long while of fibres tributes for the far reaching use to wind up standard, the utilization of fibres in concrete has increased popularity in the most recent decade.

In the present concrete industry, these fibres can be comprehensively gathered into two classifications:

1. Steel and

2. Manufactured which is synthetic

Steel fibres are utilized as a part of particular applications are not ordinarily utilized as a part of basic concrete sections, pavements for latwork. Steel fibres mixed in concrete where high impact resistance is fundamental. Floors of concrete subjected to a mechanical condition, (for example, automotive assembly plant) is the place where the utilization of steel strands can without much of a stretch be justified. Steel fibres will decrease shrinkage, splitting, and also engineered fibre, notwithstanding, it isn't frequently one uses steel fibres for insurance against shrinkage breaking . Steel strands are found in a Varity of sizes and shapes. The most well-known 1.5" to 2" variety with a serrated shape & measurement of diameter around 2mm. The dose rates per cubic yard shift from 50 to 200 pounds. Synthetic fibres are produced using polypropylene, Recron, nylon or glass strands. Recron fibres are very light in weight and have a tendency to be genuinely light significance they can gather more at the surface of the section. Nylon fibres are additionally light weight yet heavier than Recron . With the utilization of nylon and Recron filaments ending up more far reaching, fibre glass items have taken the secondary lounge and its utilization decreased.

Fresh mixed concrete experiences a variability of chemical actions. while the alteration from a plastic material to a hard material , heat is generated from this chemical transformation . Although for the gain of early strength this heat is very essential, it can also act as an opponent to the concrete in that lead to expansion. As this expansion in concrete taking place continuously , peak temperature is grasped. The concrete gradually cools and then contact or shrink after reaching this temperature. This expansion can create pressures in it, which may lead to thermal cracking. These Fibres link across the stressed areas & provide an interconnecting matrix of connectivity

3.2. HOW FIBRES WORK IN CONCRETE?

Before we learn about the problem we should know or study about the source of problem. There are two types of stresses that occur in concrete that is internal stresses or external stresses.

The furthermost normal sort of characteristic breaking occurs in the plastic state and is created by plastic drying shrinkage. These cracks are formed within first 24 hours after a concrete have been placed Settlement and. Shrinkage cracks won't not be identified until some later date. They are often surface sealed by a finishing operation or are merely not wide sufficient to be seen until the concrete shrinks further or a load causes these weak planes to deteriorate into visible cracks.

3.3. BENEFITS OF FIBRES IN CONCRETE:

FIBRES VS WELDED WIRE FABRICS: Both the synthetic fibres and a wire mesh used as secondary reinforcement can help in control of cracking. The prime differences are when and how finely they function.. Fibres are the most valuable soon after the placing the concrete by monitoring the formwork. Rather, the work just holds the breaks together after they have shaped, provided that the wire is properly placed in a concrete. From an economic perspective, fibres are the most cost effective than wire (characteristically about half the cost of wire in a 4 inch slab) and unlike wire, fibre won’t corrode and can’t be misdirect in the concrete.

OTHER BENEFITS:

The impact of fibres on the performance of the plastic and hardened concrete differ depending on the concrete materials, mix proportions, type of fibres , length and additional rate. Study from several sources normally agrees that synthetic fibres to concrete can increase the following properties (depending on additional rates).

i. Improvement in impact and shatter resistance.

ii. Improvement in abrasion resistance.

iii. Lower permeability.

iv. Delivers toughness & post crack integrity.

3.4. FACTORS AFFECTING PROPERTIES OF FRC

FRC is the complex material contains fibres in the cement matrix in the arranged manner or arbitrarily dispersed manner. Its properties would depend upon the effective transfer of stress between framework or mesh wire and fibres, and dispersal of the fibres, mixing and compaction method of concrete, and size and shape of the aggregate. These factors are briefly discussed below:

Relative fibre matrix stiffness:

The modulus of elasticity of matrix (framework) is much lower than that of fibre productive stress transfer. Low modulus fibres such as nylons and polypropylene may not give strength improvement, but these low modulus fibres absorb large energy and in turn, gives the greater degree of toughness and resistance to impact. High modulus fibres such as steel, glass and carbon may affect the quality as well as stiffness.

Interfacial bond between the matrix and the fibre likewise decide the adequacy of stress transfer from the framework to the fibre. for improving tensile strength of the complex the bond between the framework and fibre is crucial. The interfacial bond is could be upgraded by covering the larger area of contact, improving the frictional properties and degree of griping and by treating the steel fibre with sodium hydroxide or acetone.

Orientation of fibre:

Primary contrast between traditional reinforcement and fibre reinforcement is that in traditional reinforcement, bars are aligned in the desired direction while the fibres are subjectively oriented. To see the result or the consequences of arbitrary random, mortar specimens reinforced with 0.5% volume of fibres were tested. In one set specimens, fibres were aligned in the direction of the load, in another in the direction perpendicular, to that of the load and in the third randomly distributed. It was observed that the fibres which are parallel to the applied load had great tensile strength and toughness than arbitrarily dispersed and perpendicular fibres.

Workability and compaction of concrete:

Integration of steel fibre reduces workability considerably, the condition has largely impactful affects on the consolidation of fresh mix. Even with large sessions of external vibration face to compact the concrete, the volume calculated of the fibre at which this condition arises is completelty dependent on diameter and length of sample. Another significance of poor workability is uneven spreading of the fibre. Generally, the workability and compactions standard of the mix is enhanced through improved water/cement ratio or some quality of water reduced may be used.

Numerous studies suggested that the maximum size of a coarse aggregate is maximum allowed upto 10mm to avoid significant decrease in strength of the composite. Fibres too act as aggregate. In spite of the fact that they have a straightforward geometry, their effect on properties of crisp cement is really complex. The bury molecule rubbing amongst fibres and aggregates reins the introduction and conveyance of the strands and in like manner the properties of the composite. Friction diminishing admixtures and admixtures that enhance the cohesiveness of the blend can fundamentally enhance the blend.

3.5. TYPES OF FIBRES

Although each sort of fibre has been gone for in bond and cement, not every one of them can adequately and monetarily utilized. Each type of fibre has its characteristics properties and limitations. Some examples of fibres that can be used are Recron, polypropylene, steel, nylon, asbestos, coir, glass and carbon fibres.

Fibre is minor piece of reinforcing material which have definite characteristics properties. Fibres can be circular and/or flat. The fibre is frequently defined by a suitable parameter called "aspect ratio". Aspect ratio of the fibre is determined from the ratio of the fibre length to the equivalent fibre diameter.

i. Polypropylene Fibre:

This type of fibre is an cheap material which offers a mixture of outstanding physical, mechanical, thermal and electrical properties that are not found in some other manufactured fibres. There are two common types of fibres currently accessible in a market. These are referred to as fibrillated and a monofilament.

ii. Recron Fibre :

Recron 3s fibres is launched by the reliance industry with the motive of enlightening the quality of a plaster and the concrete. The overall properties and uses of RECRON 3s fibre reinforced concrete used in a construction.

3.6. DETAILS OF RECRON 3s FIBRE

Recron 3s strands is propelled by the dependence business with the thought process of illuminating the nature of a mortar and the solid. The general properties and employments of RECRON 3s fiber strengthened cement utilized as a part of a development. The more slender and the more grounded components spread crosswise over whole segment, when utilized as a part of low measurements captures splitting. It is a triangular polyester fiber in cross segment with cut length of 6mm and 12mm which is in effect widely utilized as a part of the Indian development industry showcase. It is far shoddy than some other imported development filaments. At the predetermined measurement of 0.25% by wt of bond there are heaps of strands which frame a work in the solid. The dispersing is around under 1millimeter between any two fibres in any organize of the grid.

This characterizes the general properties and utilization of RECRON 3s fibre fortified cement utilized as a part of development. The more slender and the more grounded components spread crosswise over whole area, when utilized as a part of low dose captures breaking.

Fabrication:

Before blending the concrete, the fibre length, amount and design blend factors are changed in accordance with keep the fibres from balling. Fibre – strengthen cement boards contain no coarse aggregate. These items are normally made, by showering mortar and fine cut fibre at the same time. Mortar with a high water: cement proportion is utilized to encourage spraying. Other application techniques incorporate basic casting, which is less adaptable than spraying, and press shaping which brings about a lower compelling water: cement proportion, in this manner delivering a more grounded item. Super plasticizer, when added to the fibre – strengthened cement, can bring down water: concrete proportions, and enhance the quality, volumetric stability and taking care of characteristics of the wet blend.

Aspect Ratio : Aspect ratio is determined from the ratio of the fibre length to the equivalent fibre diameter. The diameter of a Recron 3s fibre is very small i.e 33-35 micron. That is why we neglect aspect ratio of the Recron fibre”.

Table3.1: Specifications of recron fibres

CUT LENGTH	6mm, 12mm, 24mm
TENSILE STRENGTH	6000kg/cm2
MELTING POINT	>2500C
DISPERSION	Excellent
ACID RESISTANCE	Excellent
ALKALINE RESISTANCE	Good
ELONGATION	45-55%
MOISTURE	<1%

Figure 3.1:recron fibres

3.7. PROPERTIES OF RFRC:

SHRINKAGE CRACKS:

Concrete will get cracks. The use of Rercon 3s fibres avoids the formation of micro cracks and further propagation of those micro cracks into macro cracks. Large number of uniformly dispersed recron panels the bleeding/segregation and enhanced homogeneity.

fibres with the good tensile strength links the cracks even after opening . Cracking leads to spaces & fractures due to which water infuses cause distress to reinforcement by corrosion in rust formation. Recron fibres lessens the water penetration and permeability by 50 percent or more . It can also be used as waterproofing admixture. Basic characteristics of RFRC are fall in shrinkage cracks & enhancement in elastic properties of concrete.

Fig.3.2:Cracking in FRC

FLEXURAL STRENGTH:

adding of these fibres deliver nonlinear bend after first split, achieves its crest at a definitive quality of most extreme static load. Elements that are influencing the flexural quality are fiber type and a fiber volume. Polymeric fibres, having moderately less modulus of elasticity, marginally lessens the intial stiffness and strength

DETERIORATION RESISTANCE:

The consequence of adding of Recron fibre to concrete mix and suitable concrete curing in improving the deterioration opposition of concrete surface skin subject to cyclic wet/dry sea water exposure were evaluated. The results are indicating that the addition of Recron 3s fibre effectively hinders the weakening process of surface skin of concrete specimens that are cured in warm weather environment.

ABRASION/ IMPACT RESISTANCE APPROVALS:

Recron 3s Fibres reinforced concrete that has been permitted by the various government, semi government, private and Industrial Projects. It has been permitted by the following authorities and services of India –

1. Airport Authority of India
2. Military Engineer Services
3. State PWD Schedule of Rates

3.8 ROLE OF RECRON 3S FIBRE

1. **Fibres Control cracking:**

   Recron 3s inhibits the shrinkage cracks established while curing which makes the structure/plaster/componentchar acteristically stronger.

2. **Fibres Reduces water permeability:**

   The cement structure free from such micro cracks inhibits moisture from incoming and migrating throughout the concrete. Due to it the deterioration of steel is prevented that is used for the primary reinforcement in concrete structure. Which further increases the longevity of concrete structure

.**3.Fibres Increases flexibility:**

The modulus of elasticity of Recron 3s fibres is very high with regarding the modulus of elasticity of the concrete or mortar binder. The Recron 3s fibre help to increase the flexural strength. The post cracking performance has shown its capability to continue to absorb energy as fibres starts to pull out.

3. **Safe and easy to use :**
   Recron 3s fibres are eco-friendly and harmless. They simply scatter and separate in the mix.

Economical : just 0.2-0.4 percent by cement Recron 3s is adequate for attainment of above benefits.

Direction of use of recron:

First Sprinkle the fibre in site mixer with little water. Keep rotating and add chips, sand, cement and balance water. Mix it for a rare time. In a case of manual mixing, in order to get the best results mix half the fibre in a bucket of water then stir well and mix in the mortar. Also add balance fibre. Recron 3S fibre is meant for improving the quality of construction, improves savings on wastage and is also used to speed up the work pace. Recron 3S is used for the secondary reinforcement only.

Dosage rate of Recron fibre:

The standard dosage per cement bag (50kg) is 120-200 grams. After some tests and research, it is found that this amount of dosage improve the following

1. Compressive strength increase by 15% with 0.5% fibre.
2. Thermal cracks are substantially reduced.
3. Thermal crack resistance is outstanding with fibres.
4. Rebound loss is reduced by 50% that results in saving labour, raw material.

3.9. ADVANTAGES OF RFRC:

1. Development of tensile strength.
2. Bigger impact opposition of FRC.

3. Reduces permeability.

4. Arrest drying shrinkage.

5. Easy to use as well as to mix.

6. Control of cracking.

7. Diminishes the rebound loss-Brings direct savings and gains.

8. Increase in flexibility and abrasion resistance.

3.10 DISADVANTAGES OF RFRC:

1. Formation of identical small lumps while mixing of the fibres.

2. The fibres which are visible on concrete's surface are not suggested .

3.11 APPLICATIONS OF RFRC:

1. Plain concrete and wall plastering.

2. Used in footings, foundations and tanks.

3. Pipes, burial vaults, pre-stressed beams etc.

4. Roads and pavements.

5. Bridges and dams.

CHAPTER 4

EXPERIMENTAL METHODOLOGY

4.1 MATERIAL USED AND THEIR PROPERTIES

The following are the material used in experimental work:

1. Cement
2. Water
3. Coarse aggregate
4. Fine aggregate
5. Recron 3s fibre

CEMENT:

In this experiment we have used OPC grade 30 cement and the tests are conducted by following Bureau of Indian Standards (BIS) confining to IS-12269: 19870. The physical characteristics of the tested cement have been shown in table Physical characteristics of cement.

COARSE AGGREGATE:

The coarse aggregate in concrete are used in greater volume, which contributes stability and durability of the concrete. These should be in proper shape, hard, strong and well graded. Coarse aggregate are those which are retained on IS sieve no. 4.75 for structural concrete. The common coarse aggregate are used in our project was crushed stone.

Table:4.1 Sieve analysis of coarse aggregate.

Sl No.	Is sieve destination	% of passing	Standard requirement
1	20mm	95	95-100
2	10mm	29	25-55
3	4.75mm	2	0-10

FINE AGGREGATE:

Sand is used as fine aggregate which is locally available River to be used in mortartar mix. Fine aggregate testing is done by following Bureau Of Indian Standards (BIS) in accordance with IS: 650-1966 7 IS: 2386-1968 to which helps to find specific gravity and fineness modulus of sand.

Table 4.2: Grading of fine aggregates

SL NO	IS sieve Destination	% of passing	Standard requirement
1	4.75mm	99	90-100
2	2.36mm	97	75-100
3	1.18mm	88	55-100
4	600 micron	66	35-59
5	300 micron	53	80-30
6	Pan	NIL	0.00

Table 4.3 : Physical Chrematistic of fine Aggregate

SL NO	Particular of test	Results
1	Fineness modulus	2.68
2	Specific gravity	2.83
3	Zone	3
4	Water absorption	1.0%

4.2. CONCRETE MIX DESIGN

Concrete mix is obtained by adding water to the dry ingredient i.e. Fine aggregate, Coarse aggregate and cement.The main objective is to design a concrete mix inorder to obtain required characteristic strength and workability at lowest cost.

Concrete designation : M30

Characteristic compressive strength = fck = 30N/mm^2

Table 4.4: Mix design Ratio

	Cement	Fine Aggregate	Course Aggregate	Water
Ratio	1	1.4	208	0.45
Kg/m³	413	600	1190	186

4.3. RESULTS AND DISCUSSION

4.3.1 Compressive Strength of Recron Fibre Concrete Cubes The compressive strength of the Recron Fibre concrete is tested with four different percentage of recron fibre mixing, they are

0.5,1,1.5and 2 percentage of Fibre is mixed with the concrete cubes. The value of compressive strength is shown in the table 5 with 7 and 28 days of curing the concrete. As per international journal of civil engineering and technology (IJCIET) volume 4 issue 1 the results are verified.

Fig. 4.1 Compression Test

Table 4.5: Compressive Strength of concrete having recron fibres

Sr. No.	**Percentage of recron (%)**	**7 days (strength in MPa)**	**28days (strength in MPa)**
1	0	17.7	30.96
2	0.5	18.62	31.77
3	1	19.69	32.98

4	1.5	19.17	32.18
5	2	18.88	31.48

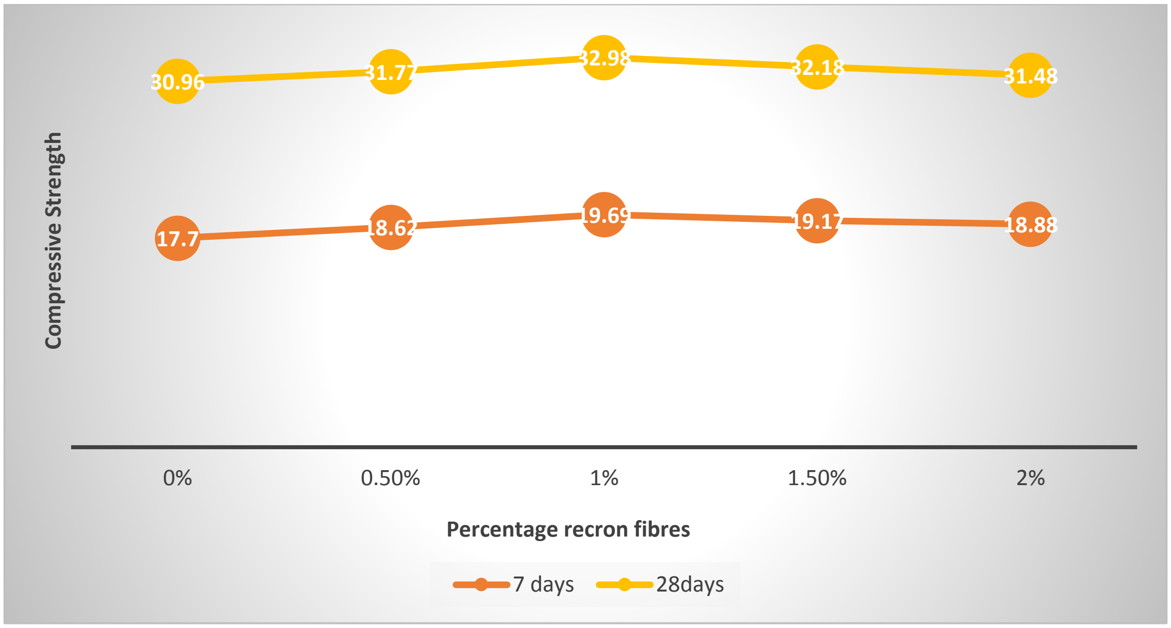

Fig. 4.2 Change in compressive strength w.r.t change in recron fibres percent

4.3.2 Split Tensile Strength of concrete having Recron fibres: The cylindrical specimen is placed horizontally between the loading surfaces of a compression testing machine. Narrow packing strips of plywood (2-3mm wide) is used to reduce the high compression stresses. The load is provided gradually. The value of split tensile strength is shown in the table 6 with 7 and 28 days of curing the concrete. As per international journal of civil engineering and technology (IJCIET) volume 4 issue 1 the results are verified.

Fig. 4.3 Split Tensile Test

Table 4.6: Split Tensile Strength of concrete having recron fibres

SNO.	**Percentage of recron(%)**	**7 days (strength in MPa)**	**28days (strength in MPa)**
1	0	2.21	2.94
2	0.5	2.38	3.09
3	1	2.64	3.38
4	1.5	2.57	3.17
5	2	2.45	3.1

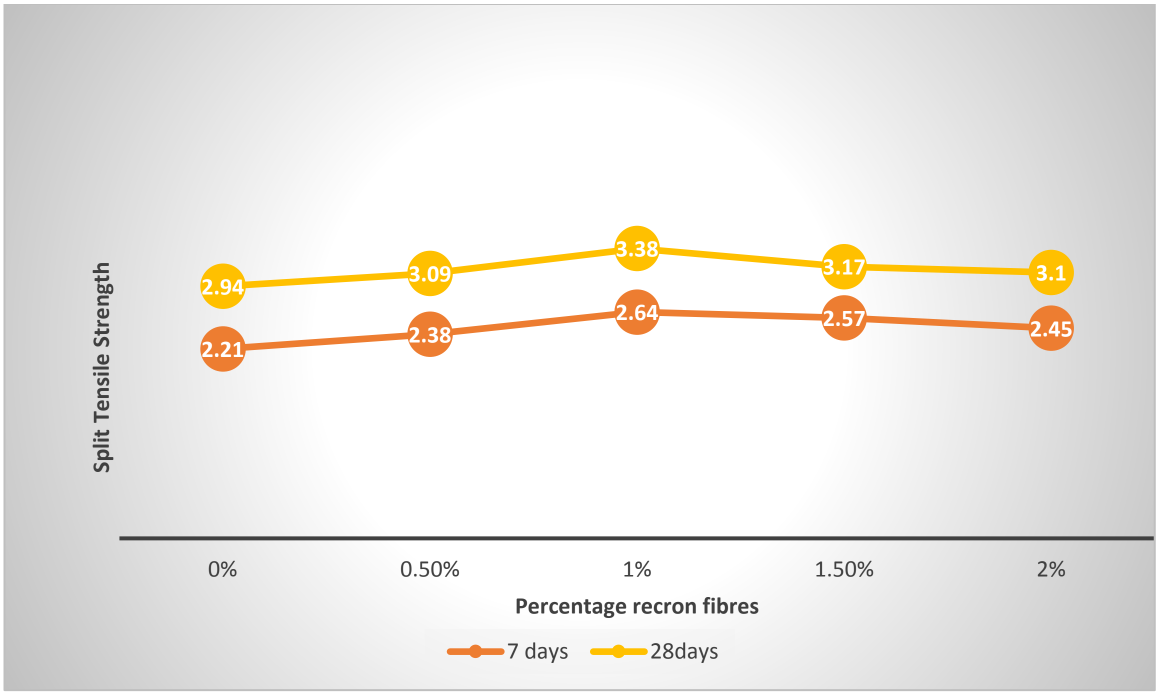

Fig. 4.4 Change in split tensile strength w.r.t change in recron fibres percent

4.3.4 Flexural strength of recron fibres:

Flexure strength is also known as modulus of rupture or fracture strength, it is a material property which is defined as the at which material starts to yield in flexure. We have used the transverse 3 point bending test, in which a specimen having a circular cross-section is bent until it is fractured or yielded. Flexural strength MPa after 7 days and 28 days are noted and shown in table 4.7. As per international journal of civil engineering and technology (IJCIET) volume 4 issue 1 the results are verified.

Table 4.7: Flexural Strength of concrete having recron fibres

SNO	**Percentage of recron(%)**	**7 days (strength in MPa)**	**28days (strength in MPa)**
1	0	3.52	5.96
2	0.5	4.11	7.67

3	1	4.48	8.74
4	1.5	4.36	8.61
5	2	4.30	8.55

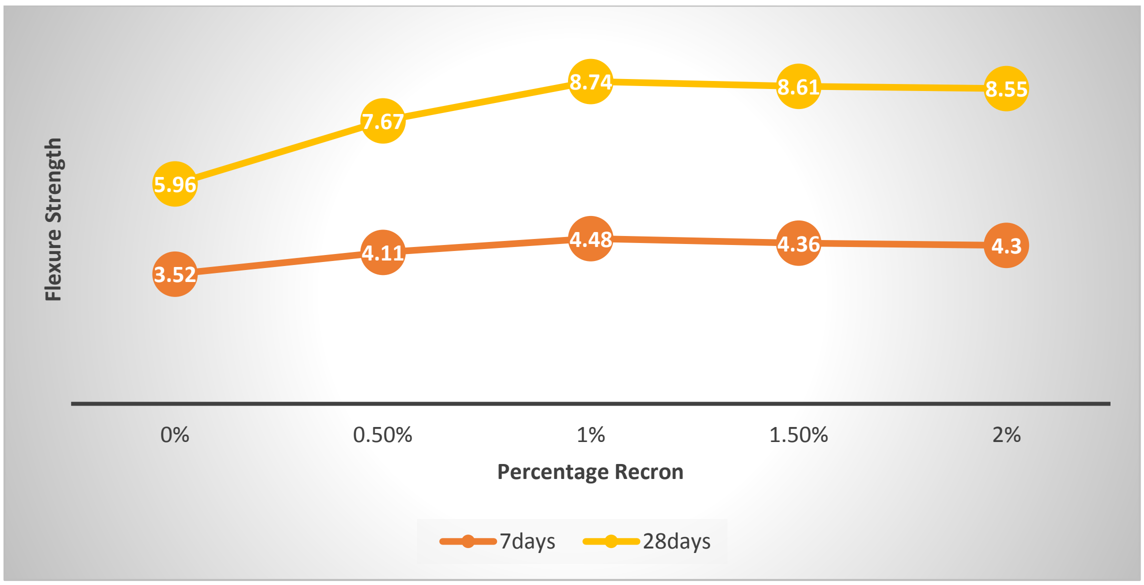

Fig. 4.5 Change in flexure strength w.r.t change in recron fibres percent

CHAPTER 5

EXPERIMENTAL WORK FOR CALCULATION OF FRACTURE ENERGY

5.1 MATERIAL USED AND THEIR PROPERTIES

Materials used:

- Cement: OPC 43 Grade conforming to IS:269-1976 was used.
- Aggregate: Sand got from nearby stream beds was utilized as fine aggregate having maximum size of 20 mm
- Water: Ordinary water was used
- Recron 3s fibres were used

Mix Adopted:

A concrete mix used was of ratio 1:1:2 with 0.45 water to cement ratio which gives M25 grade concrete

Casting and curing of specimens:

Plywood of 2-3mm thick is used to make a notch, which is marked at the depth at which notch is made**,** Concrete was poured in three layers and vibrated. After that plywood is removed 3-4 hours after initial setting time. After 24 hours the mould is removed and concrete is cured for 28 days.

Test Specimens: A total of 4 beams were cast for testing. All 4 beams were of same size having different notch to depth ratio as 0 and .15. In each beam notch was at the centre. Following are the details:

Table 5.1: Test Specimens

Beam Type	Beam Size	Notch to depth ratio	Percentage of recron fibres
P1	500x150x150	.15	1
P2	500x150x150	0	1
P3	500x150x150	.15	0
P4	500x150x150	.15	0

5.2 DETAILS OF EXPERIMENTAL SET-UP:

The general perspective of trial set-up for three-point stacking is appeared in fig.2. Testing of the beam was completed on Universal Testing Machine(UTM).Load is gradually increased and deflection along with load is notted and plotted which helps to determine ductility of concrete.

Experimental methods to obtain softening portion:

At the point when the was nearing the most extreme, the pointer in the deflectometer on Ultimate Testing machine demonstrated a sudden twitch to the retrogressive bearing. In any case, the diversion all of a sudden expanded. Starting there the load diminishes slowly as redirection increments. Sooner or later, the framework ends and become stable. Along these lines, with diminishing burden, higher avoidance is recorded before entire break of the shaft. The negative slant of the bend load Vs. deflection is called softening bit of the bend.

Figure 5.1: Experimental set-up for 3-point-bend test.

Figure 5.2: Casting and development of artificial notch using ply-wood.

5.3 RESULTS AND DISCUSSION

The Load Vs Deflection curve for all 4 beams are plotted using results given below in table.

Table 5.2. Experimental results for Beam P1

Beam P1	
Load (KN)	**Displacement(mm)**
0	0
0.4	0.02
0.8	0.03
1.2	0.04
1.6	0.05
2.0	0.06
2.4	0.07
2.8	0.08
3.2	0.09
4.0	0.12
4.4	0.14
4.8	0.16
5.2	0.18
5.6	0.19
6.0	0.20
7.0	0.22
6.6	0.30
6.2	0.40
5.0	0.45
4.6	0.55
3.4	0.57

3.0	0.63
2.6	0.65
2.2	0.68
1.8	0.72
1.4	0.86
1.0	1.01

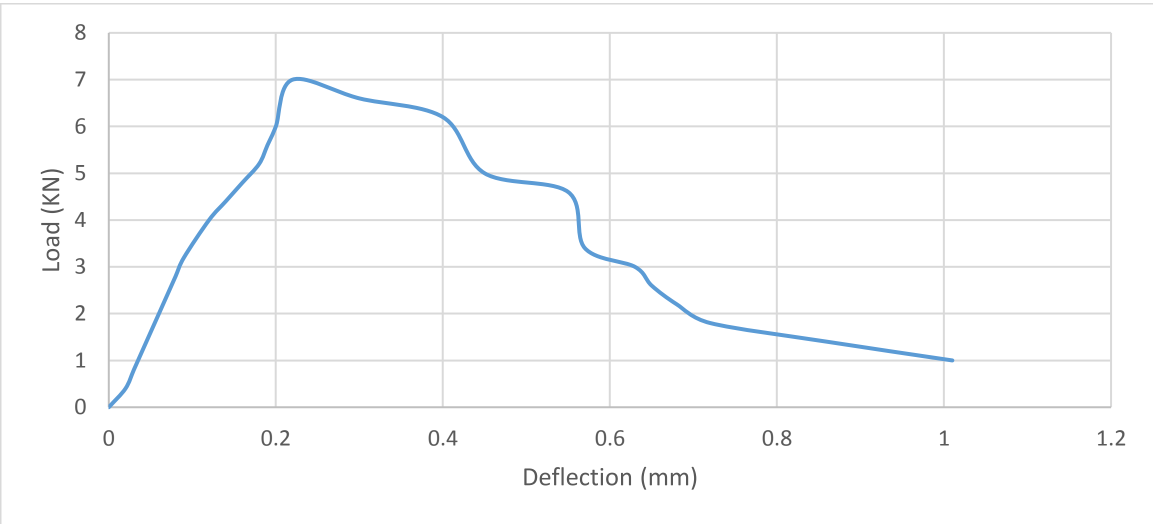

Figure 5.3: Load displacement curve for beam P1

Table 5.3. Experimental results for Beam P2

Beam P2	
Load (KN)	**Displacement(mm)**
0	0
0.4	0.03
0.8	0.07
1.2	0.11
1.6	0.15
2.0	0.19
2.4	0.24

2.8	0.29
3.2	0.34
3.4	0.42
3.0	0.50
2.6	0.53
2.2	0.56
1.8	0.59
1.4	0.63

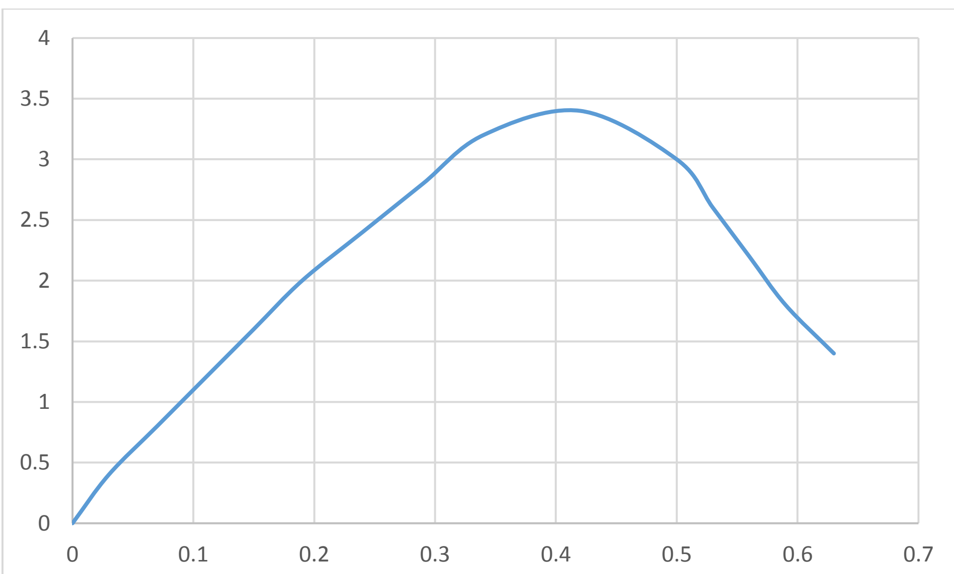

Figure 5.4: Load displacement curve for beam P2

Table 5.4. Experimental results for Beam P3

Beam P3	
Load (KN)	**Displacement(mm)**
0	0
0.4	0.01
0.8	0.03
1.2	0.05
1.6	0.07
2.0	0.09
2.4	0.11
2.8	0.14
3.2	0.17
3.6	0.23
3.0	0.31
2.6	0.36
2.2	0.39
1.8	0.43
1.4	0.49

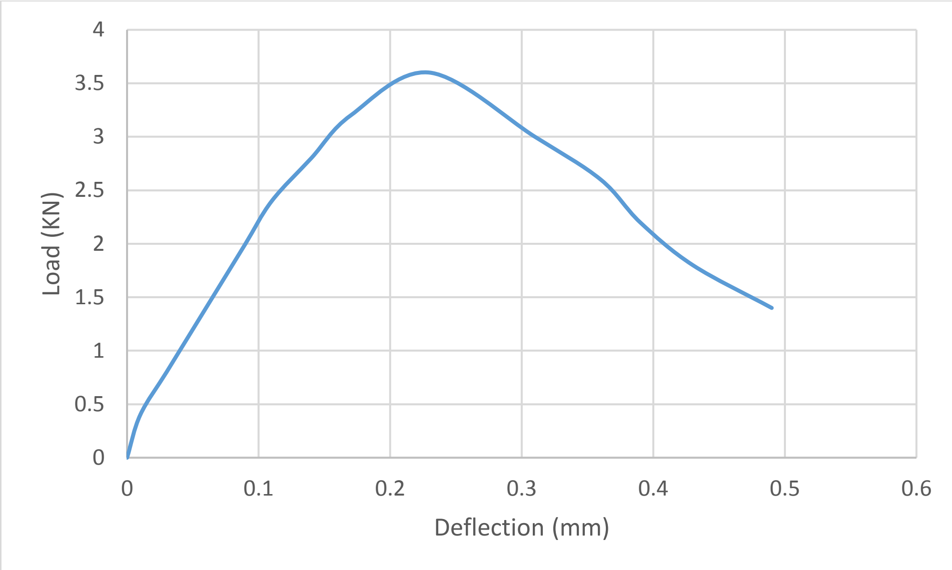

Fig 5.5. Load displacement curve for beam P3

Table 5.5. Experimental results for Beam P4

Beam P4	
Load (KN)	**Displacement(mm)**
0	0
0.4	0.01
0.8	0.02
1.2	0.03
1.6	0.04
2.0	0.05
2.4	0.06
2.8	0.07
3.2	0.08
4.0	0.09
4.4	0.12
4.8	0.14

5.2	0.16
5.6	0.18
6.0	2.0
6.8	2.2
6.4	0.31
6.0	3.7
5.6	0.4
4.2	0.43
3.4	0.50
3.0	0.56
2.6	0.59
2.2	0.61
1.8	0.64
1.4	0.67
1.0	0.75

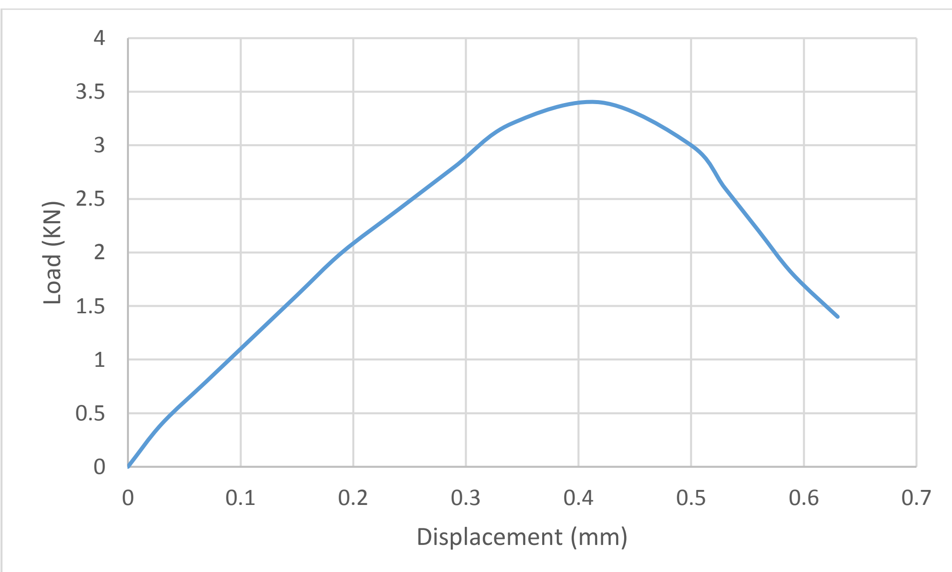

Fig 5.6. Load displacement curve for beam P4

From all the Load Vs Displacement curve for each beam casted. It is observed that the curve is straight until it is reached maximum displacement. When it apporaches to max. displacement the curve becomes non linear and a sudden increase in displacement when we reach to max load. Beyond that, the load gradually decreases but displacement gradually increases until the beam is failed. Softening portion of a curve is a portion after max load is attained. Such strain hardening and strain softening shows concrete is a Quasi-brittle material. Some of the equations derived by Brown and Swarley is used:

- Brown and Swarley's equation for (S / D) = 4 for Geometry Function 'Y',

$$Y\left(\frac{a}{W}\right) = 1.93 - \left[3.07 * \left(\frac{a}{W}\right)\right] + \left[14.53 * \left(\frac{a}{W}\right)^2\right] - \left[23.98 * \left(\frac{a}{W}\right)^3\right] + [25.22 * \left(\frac{a}{W}\right)^4 2)$$

- Fracture Energy, $Gf = A/[(W - a) * B]$
- Bending Moment,

$$BM = \frac{P * S}{4} + BM\ due\ to\ self\ wt.of\ beam$$

- 4) Stress Intensity Factor (Fracture Toughness),

$$K_{IC} = \frac{6 * Y * BM * \sqrt{a}}{B^2 * W}$$

Table 5.6. Values of Fracture Energy and Stress Intensity Factor

Beam	Notch to depth ratio (a/W)	Notch Depth ‘a’ (m)	Max. load 'P' (KN)	Area under Curve 'A'	Bending Moment 'BM'	Gf (N/m)	Y	KIC (MPa m1/2)	Gc (N/m)
P1	0	0	7.0	4.01	1.067	209.67	1.728	491.7	9.637
P2	0	0	3.4	1.388	1.037	94.91	1.986	426.2	9.632
P3	0.15	0.0225	3.6	1.365	0.557	92.24	1.986	450.5	9.624
P4	0.15	0.0225	6.8	3.443	1.037	180.03	1.728	477.9	9.136

CHAPTER 6

CONCLUSION

As we can see theat at 1% v/v ratio of recron used we are getting the maximum value of compressive split tensile and flexure, and from research paper published by RILEM on “Experimental Determination of Fracture Energy” we know that at varying notch to depth ration we get different values of fracture energy and it is deterimened in the paper that at notch to depth ratio of 0.15 we get maximum value of Fracture Energy (Gf). So further in this project we have determined the maximum fracture energy of the beam by comparing the notch to depth ratio (0&0.15) and percent recron used (0% and 1%). The maximum displacement of all three types of beams vary. From load V/s displacement curve, type P1 and P4 is more ductile than other two types. The fracture energy or the fracture toughness " Gf " is calculated for the other types P2 and P3 and they do not have much difference. Stress intensity factor "KIC" is calculated using Brown and Swarley's equation. "K_{IC}" is also called as Toughness. Both fracture toughness "Gf" and toughness "K_{IC}" are one and the same. They define the propagation of cracks one in energy and other in stress respectively. The range of K_{IC} varies from range 426.2 to 491.7 MPa. Energy release rate Gc characterized by Griffiths considering concrete as a brittle material is likewise figured here. Qualities decided tentatively for Gc & Gf ought to be equivalent however it is discovered they are most certainly not. Consequently, we can affirm concrete is not a brittle material. Additionally, Gc and Gf determines only the energy dissipated in front of notch to propagate till failure whereas Gf gives the total energy dissipated in the beam i.e. to propagate notch. The range of Gc is found out near 8-10 N/m.

REFRENCES

[1]. ACI Committee 446.1R (chaired by ZDENEK P. BAZANT), "Fracture Mechanics of Concrete: Concepts, Models' and Determination of Material Properties", Fracture Mechanics.

[2]. ACI Committee446 (chaired by Vellore Gopalaratnam), "Finite Element Analysis of Fracture in Concrete Structures: State of The Art", 446.3R-97.

[3]. BARENBLATT G. I. 1959," The formation of equilibrium cracks during brittle fracture. General ideas and hypothesis. Axially-symmetric cracks", PrikladnayaMatematikaiMekhanika, Vol. 23, No.3, pp. 434-444.

[4]. Bazant, Z.P., 1985,"Fracture Mechanics and Strain-Softening in Concrete," Preprints in ,The U.S.-Japan Seminar on Finite Element Analysis of Reinforced Concrete Stuctures, Tokyo, Volume.1, p.p. 47-69.

[5]. Hillerborg, A.; Modeer, M.; and Petersson, P. E., 1976, “Analysis of Crack Formation and Crack Growth in Concrete by Means of Fracture Mechanics and Finite Elements,” Cem. and Conc. Res., V. 6, 773-782.

[6]. Griffith, A. A., 1920, “The Phenomenon of Rupture and Flow in Solids,” Philosophical Transactions, Royal Society of London, Series A, V. 221, pp.163-198.

[7]. David Roylance, June 14, 2001, "Introduction to Fracture Mechanics", Department of Materials Science and Engineering, Massachusetts Institute of Technology,Cambridge, MA 02139.

[8]. Witt mann, F.H.,(ed.): 1983, "Fracture Mechanics of Concrete",The Elsevier Science Publishers Company Inc. Proceedings of a Conference held in Lausanne.

[9]. Materials and Structures/Materials et Constructions, Vol. 33, January-February 2000, pp 3-5 "RILEM TC 162-TDF : Test and design methods for steel fibre reinforced concrete".

[10]. N. Trivedi, R.K. Singh, J. Chattopadhyay, March 2015," A comparative study on three approaches to investigate the size independent fracture energy of concrete", Elsevier, Engineering Fracture Mechanics 138 (2015) 49-62.

[11]. Xiufang Zhang, ShilangXu, March 2011, "A comparative study on five approaches to evaluate double-K fracture toughness parameters of concrete and size effect analysis", Elsevier, Engineering Fracture Mechanics 78 (2011) 2115-2138.

[12]. S.Y. Alam, A. Loukili, F. Grondin, E. Rozière, June 2015, "Use of the digital image correlation and acoustic emissiontechnique to study the effect of structural size on cracking of reinforced concrete", Elsevier, Engineering Fracture Mechanics 143 (2015) 17-31.

[13]. A. Nazari, J.G. Sanjayan, June 2015, "Stress intensity factor against fracture toughness in functionally graded geo-polymers", Elsevier, Archives of Civil and Mechanical Engineering, ACME-321.

[14]. B.L. Karihaloo, H.M. Abdalla and T.Imjai, 2003, "A Simple method of determining the true specific fracture energy of concrete", Magazine of Concrete Research, 55, No.5, October 471-481.
[15]. Bhushan L. Karihaloo, 1995, "Fracture Mechanics & Structural concrete", Longman Scientific & Technical.

[16]. Praveen and Ankit Sharma.2013.“Structural Behavior of Fibrous Concrete Using Polypropylene Fibres”, International Journal for research in applied sciences and engineering technology.

[17]. Prasad, M., Rajive, C and Grover, Rakesh.2013.A comparative study of polypropylene fibre reinforced silica fume concrete with plane cement concrete. International Jr of engineering research and science & technology.

[18]. Gurunaathan,K., Seenibasan,G. and Thirugnanam,G.S.2014.Experimental study on strength and durability properties of fibre reinforced concrete. Proceedings Of The Int Conference on Advances In Civil, Structure and Mechanical Engineering.

[19]. Muhammad Nawazish Husain and Parveen Aggarwal.2014. “Application of recron 3s fibre in improving silty subgrade behaviour IOSR Journal Of Mechanical And Civil Engineering.

[20] cetindia.org

[21]. Showkath Ali Khan Zai .. "NEXT GENERATION STEEL FIBER REINFORCED SBR-LATEX MODIFIED NANO BASED CARBON CONCRETE" , International Journal of Research in Engineering and Technology, 2017

[22]. Roesler, J.. "Concrete fracture prediction using bilinear softening" , Cement and Concrete Composites, 200704

[23]. Revathi.R .. "FLEXURAL BEHAVIOUR OF INTERIOR R.C.BEAM COLUMN JOINT WITH 17 < 20 words AND WITHOUT SLAB UNDER CYCLIC LOADING" , International Journal of Research in Engineering and Technology, 2014

[24]. Trivedi, N., R. K. Singh, and J. Chattopadhyay. "Size independent fracture energy evaluation for plain cement concrete : SIZE INDEPENDENT FRACTURE ENERGY EVALUATION" , Fatigue & Fracture of Engineering Materials & Structures, 2015.

[25]. N. Trivedi, R.K. Singh, J. Chattopadhyay. "A comparative study on three approaches to investigate the size independent fracture energy of concrete" , Engineering Fracture 1% 10 1% 11 1% 12 1% .

[26]. Naik Partha Uday “Experimental Determination of Fracture Energy by RILEM Method”.