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A Study On Simultaneous Use Of Coconut Fibre In Soil Reinforcement-A Review

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ABSTRACT – Coconut fiber or coir fiber and is obtained from the coconut shell. Coconut fiber is very cheap, economical and easily available in the market .It can be used to impart the various engineering properties such as shear strength, tensile strength, bearing capacity and many other properties by using various proportions and size of the coir fiber The fiber has a high degree of water retention and is rich in micronutrients. By introducing the coconut coir fibers in the soil the development of the frictional forces increases between the soil particles and the reinforcement fibers. In this paper the author has worked on using various proportions of coconut fiber to the clayey soil

.The tests conducted on the clayey soil are Liquid Limit, Plastic Limit, Standard Proctor Test and California Bearing Ratio (CBR). The percentages of the coconut fiber used in the soil are 0%, 0.3, 0.5%, 0.8% ,1.1% and 1.4%. The various parameters which were investigated in this research are dry density, optimum moisture content etc. It is concluded that the best results of OMC and MDD are obtained at 1.4% of coconut coir fiber .For CBR tests the highest values are also obtained at 1.4% of coconut fiber respectively. Hence the above proportion can be adopted in the road pavement designs,reinforcement of foundation soils etc.

KEYWORDS: CBR, liquid limit, plastic limit,standard proctar test

I. INTRODUCTION

Historically, the coconut was known as Nux indica (the Indian nut) and also the Nargil tree, the tree of life. Western literature has also mentioned the Malayalam name Tenga for the coconut palm which relates to Tamil „Tennai", believed to be of Sri Lankan origin. Its geographical dispersion was aided by travelers and traders. Botanically, the coconut palm is a monocotyledon and belongs to the order Arecaceae, family Palmae and the species is known as Cocos nucifera Linn. T he Philippines, Indonesia, India and Sri Lanka account for 78% of coconut production. The most important and economically valuable product of coconut palm is its fruit popularly known as the „nut". It is comprised of an external exocarp, a thick fibrous organic product coat known as the husk and underneath lies the hard defensive shell. Coating the shell is a white albuminous endosperm or 'coconut meat' and the internal pit is filled with a reasonable sweet fluid called 'coconut water'. In this section, use of coconut fiber/coir fiber in composites is discussed. Filtering electron microscopy (SEM) is completed to understand why the mechanical properties of composites arranged from treated and untreated coir are extraordinary and furthermore to understand the impact of fiber treatment on the fiber– lattice interfacial grip. The coconut palm includes a white 'meat' which has a rate by weight of 28 enclosed by a defensive shell and husk which have a rate by weight of 12 and 35 individually. The husk from the coconut palm involves 30% weight of fiber and 70% weight of essence material. it demonstrates the sythesis of the coir fibers (Verma et al ., 2013). The vital properties of coconut fiber are:

- *It is a renewable resource and CO 2 -neutral material.*
- *The fiber is abundant, non-toxic, biodegradable, low density and low cost.*
- *The fiber has a high degree of water retention and is rich in micronutrients.*

Coconut (Cocos nucifera) plays a significant role in the economy of India. Apart from the importance of copra and coconut oil, which is widely used in the manufacturing of soaps, hair oil, cosmetics and other industrial products, the husk is a source of fiber which supports a sizable coir industry. The tender nut also supplies coconut water. oconut is grown in more than 90 countries in an area of 14.231 million ha with a total production in terms of copra equivalent of 11.04 million MT. Indonesia (25.63%), the Philippines (23.91%), and India (19.20%) are the major coconut-producing countries of the world. The coconut palm can tolerate a wide range of soil conditions, although a variety of factors such as drainage, soil depth, soil fertility and layout of the land have an influence on the growth of the palm. The major soil types that are best for the growth of coconut in India are laterite, alluvial, red sandy, loamy, coastal sandy and reclaimed soils with a pH ranging from 5.2 to 8.0. Coconut palms require a continuous supply of water, which can be provided by rainfall of the order of 2000 mm per annum, or from groundwater (at a depth of 1–3 m), although they cannot tolerate waterlogging . The palms grow best at average temperatures of around 26–27°C, so they cannot grow above 750 m. Growth is stimulated by a suffi cient supply of chlorine in the soil, and the coconut can withstand up to 1% salt in the soil. These conditions are generally found in tropical and subtropical coastal regions with little rainfall. Coconut palms can also grow on deep alluvial soil. The quality of the seeds is very important to the yield from the palm. The seeds should originate from a healthy and productive stock plant. Two main groups are cultivated in the commercial sector: the tall plants of the Typica group, whichgenerally need to be cross-fertilized, and dwarf types of the Nana group, where self- pollination is prevalent. S tock plants that are suitable seed providers produce 100 nuts per year, 12–14 syncarpy of differing ages, and up to 180 g copra per nut. The fully ripened nuts which are intended to provide seeds are harvested after 11–12 months. The nuts germinate quicker at the lower end, or in the middle, of the syncarpy and should not be allowed to fall but should be cut down, and carefully lowered. Following the harvest, the produce should be stored for a short break in a covered and well- ventilated place. B efore sowing, the nuts are sorted and only those containing water are used. The shell is cut away on the germinating side of the nut to facilitate germination and then the nuts are soaked in water for 14 days before being sown in loose soil which can drain easily. The nuts are laid in the soil lengthways at a distance of 45 cm with the upper side still visible. Coconut fi bers are used as mulching material between the rows.The nuts can also be sown in a glasshouse with 95% humidity. On smallholdings, the nuts are often set out in shaded areas, lightly dug in and then covered with organic material (Augstburger et al .2000). Although coconut is grown in more than 90 countries, the Philippines, Indonesia, India and Sri Lanka contribute about 78% of the world ‟ s production. In 2007–08, India contributed 27.86% of global coconut production.

II. OBJECTIVES

1. *To study the coconut fibre*
2. *To find the Results on use of coconut fibre for soil Stabilisation.*
3. *To compare the results with together use of fibres and separate use.*
4. *To determination of CBR value of Coconut Reinforced Soil.*
5. *Comparison of the CBR values of the reinforced and unreinforced soils.*

III. LITERATURE REVIEW

(Augstburgeret al ., 2000). Although coconutis grown in more than 90 countries, the Philippines, Indonesia, India and Sri Lanka contribute about 78% of the world‟s production. In 2007–08, India contributed 27.86% of global coconut production. Table 10.2 shows each country ‟ s area, production and productivity of coconut in 2006–07

Maury etal. (2007) In this paper coir fibers is used for soil stabilization .Coir fibers are mixed insoil by manual mixing The %age of coir fiber in each soil sample was gradually increase like 0.25%,0.50%0.75%, 1 % and various test are performed like UCS and CBR.

- *Soaked CBR value found to increase from 4.75% to 9.22%, unsoaked CBR values found to increase from 8.72% to 13.55%.*
- *UCS value found to increase from 2.75kg/cm^2 to 6.33kg/cm^2 It was concluded thatthe usage of coir fibre reinforced soil improved the properties of soil and its strength.*

Hatta and Akmar (2008) arranged polystyrene/polypropylene (PS/PP) reinforced coconut and jute fiber composites utilizing the infusion shaping technique. They outlined composites by fixing the fiber content at 10 wt% with the proportions of 100/0, 75/25, 50/50, 25/75 and 0/100 by weight of the coconut fiber/jute fibers. They watched that the expansion of 10 wt% of fiber (coconut and jute) expanded the elastic properties of the composites. It was discovered that the elasticity for composites reinforced with 10 wt% jute fibers displayed better performance characteristics over the composites strengthened with 10 wt% coconut fibers, in spite of the fact that support was seen to lessen the effect quality of the materials

Ayrilmis et al . (2011) evaluated the physical, mechanical and flammability properties of coconut fi ber-reinforced polypropylene (PP) composite panels. They selected four levels of coir fiber content (40, 50, 60 and 70% by weight) and the fi bers were mixed with the PP powder and 3 wt% maleic anhydride grafted PP (MAPP) powder. By increasing coir content it was found that the water resistance and the internal bond strength of the composites were decreased. However, the flexural strength, tensile strength and hardness of the composites increased by increasing the coir fiber content up to 60 wt%. The flame retardancy of the composites improved with increasing coir fiber content.

Chaple et al. (2011) This journal describes the coir fibers reinforced clayey soil properties .In this clay soil is mixed with coir fiber in increase proportion of %age and tests are conducted to determine the effect of fiber on bearing capacity and settlement of square footing in clayey soil .It is observed that bearing capacity increases and settlement decreases due to coir reinforced clayey soil.eIt was also observed that maximum bearing capacity of soil was when it is mixed with coir in the proportion of 0.50%

Dharmendra Kumar In the 21th century application of jute fibre in civil construction work has attend pace especially for subgrade of flexible pavement. Savastano et al. (2000) used waste jute fibers as reinforcement for cement-based composites in construction work instead of concrete. Dhariwal (2003) carried out performance study on California bearing ratio (CBR) of fly ash reinforced with jute and non-oven fibers. Sanyal (2005) studied soil improvement by using jute fibre and applied Jute Geotextiles in Rural Roads. Chandra et al. (2008), studied CBR and shear values of Jute fibre for preparation of fibre reinforced flexible pavements. Saran (2010) gives brief discussion about the reinforced soil and its engineering applications. Islam and Iwashita, (2010) used jute reinforced material to construct earthquake resistance building for low income stack holders. Aggarwal and Sharma (2010), used bitumen coated jute with different fibre lengths and varying percentages to reinforce soil and found that jute fiber reduces the MDD with the increases the OMC. They obtained Maximum CBR value (2.5 times than plain soil CBR) with 10 mm long and 0.8% jute fiber. Islam and Ivashita (2010) showed that jute fibers are effective for improving the mortar strength as well as coherence between block and mortar. Singh (2012) studied improvement in CBR value of soil reinforced with jute and coir fiber in comparative manner and suggested dominance of jute fibre. Singh and Bagra (2013) studied the influence of different length and diameter of Jute fiber on the CBR value of Itanagar, A.P., India soil used in the construction of embankments and pavement subgrade and results were compared with that of unreinforced soil. Pandey et al. (2013) studied soil stabilization using pozzolanic material and Jute fibre.

Kundan Meshram et.al –Now-a-days, geotextiles are widely used in highway engineering, to solve a variety of problems related to drainage, separation and reinforcement of pavement structure. Geotextiles made of natural fibres such as coir, jute etc., are emerging as alternatives to polymeric geotextiles. Coir net is readymade material, cheap, easy laying in field and biodegradable. Under the traffic loads, the soil sub- base is subjected to compression in the vertical direction accompanied by tension in the lateral direction. Also, during dry weather conditions, cracks develop at the soil surface due to tensile stresses induced as a result of drying and shrinkage. During wet weather conditions, water starts to rise in the sub-base by capillary action from soil sub- grade. Materials like coir, lime etc. are needed to improve the compressive as well as the tensile strength and the permeability characteristics of the sub-base for a better performance of the pavements.

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[22]. The unreinforced beams D150,0% and D200,0% showed relatively lower flexural strength than the reinforced beams. The beams showed flexural strengths of 1.7 kN and 1.95 kN respectively. Both the unreinforced beams had a brittle failure and showed negligible deflections prior to failure. Due to brittle failure, the measurement of deflection was not possible during the test and the load deflection curves for unreinforced beams could not be obtained. The load deflection curves for reinforced beams are plotted as shown in figure 5.1.

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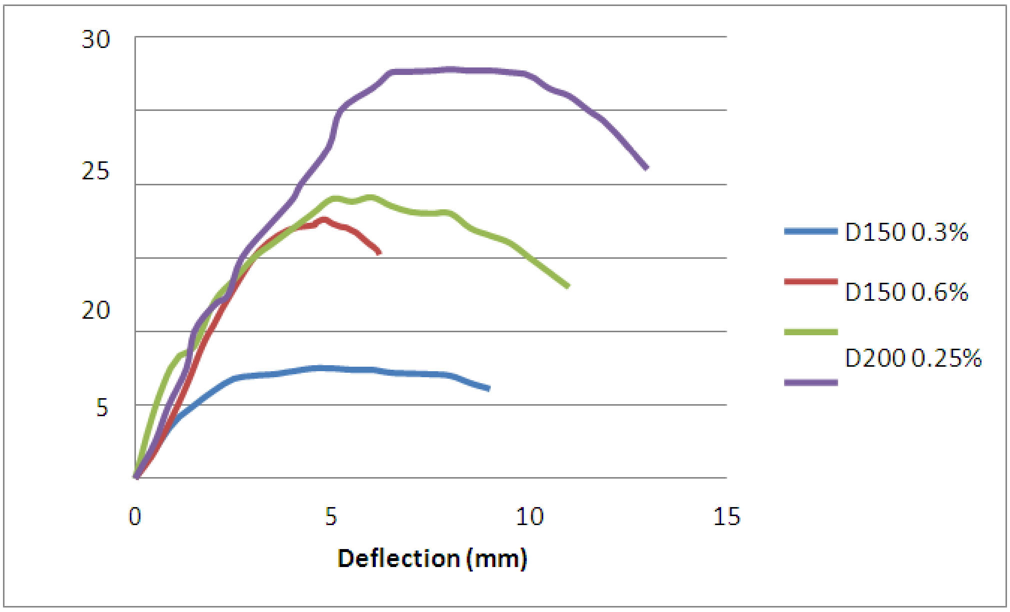

Fig.5. 1: Load vs Deflection curves of RCC beams

With the increase in percentage of steel from 0.25% to 0.5% in beams of depth 200 mm, peak load increases from 19.1 kN to 27.8 kN and maximum deflection increases from 11 mm to 13 mm. In case of beams of depth 150 mm, by increasing percentage of steel from 0.3 % to 0.6% the peak load increases from 7.5 kN to 17.6 kN whereas the maximum deflection decreased from 9 mm to 6.2 mm.

The crack formation in the unreinforced samples was instant and the failure was abrupt and hence the crack width measurement was not possible for unreinforced beam samples. However, the reinforced beams showed considerable deflections and the crack widths were measured after regular intervals of load. The plot of load versus crack width for beam samples of depth 150 mm and 200 mm of various percentages of steel reinforcement is shown in figure 5.2.

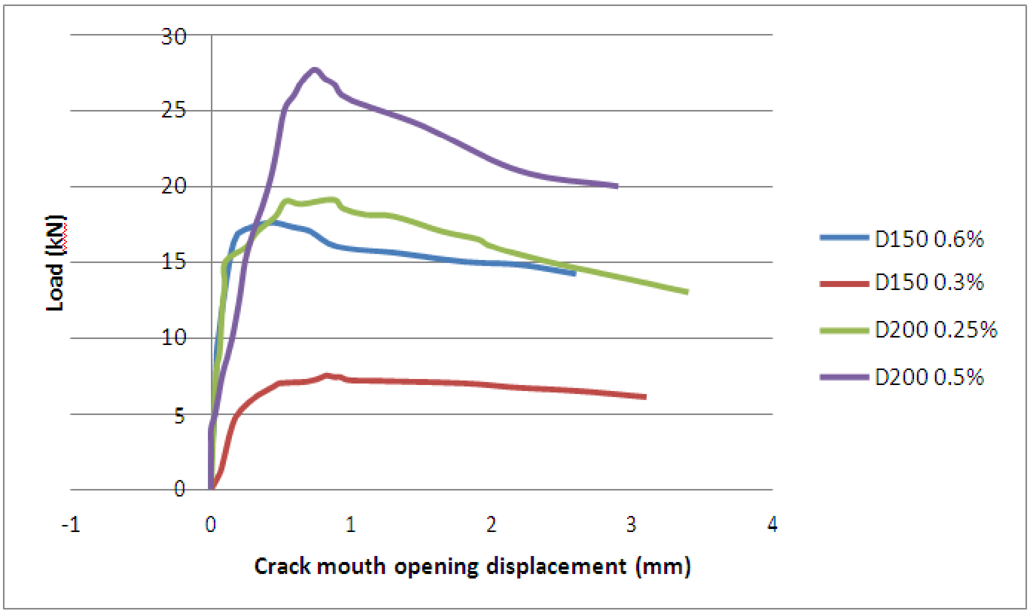

Fig.5. 2: Load vs crack width curves for different beam samples

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As the percentage of reinforcement is increased, the crack mouth opening displacement gets decreased. This is due to increased stitching action of cracks by reinforcement and thus restricts the widening of cracks with increase in loads.

Table 5. 1: Readings for beam D150 0.3%

Load (kN)	Deflection (mm)	CMOD (mm)
0	0	0
2	0.5	0.09
5	1.5	0.19
7	3	0.49
7.5	5	0.82
6.5	8.5	2.6
6.1	9	3.1

Table 5. 2: Readings for beam D150 0.6%

Load (kN)	Deflection (mm)	CMOD (mm)
0	0	0
5.7	1.2	0.03
9	1.7	0.04
12	2.3	0.08
15	3	0.13
17	4	0.2
17.6	4.8	0.44
16	5.9	0.9
15	6	2.2
14.2	6.2	3.1

Table 5. 3: Readings for beam D200 0.25%

Load (kN)	Deflection (mm)	CMOD (mm)
0	0	0
4.8	0.5	0.02
8	1.4	0.04
12	2.2	0.08
15	3.6	0.1
18	4.5	0.46
19.1	6.2	0.87
17	8.5	1.65
15	10.3	2.4
13	11	3.4

Table 5. 4: Readings for beam D200 0.5%

Load (kN)	Deflection (mm)	CMOD (mm)
0	0	0
5	0.85	0.03
10	1.5	0.15

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15	2.7	0.24
20	4.2	0.41
25	5.2	0.52
27	625	0.65
27.8	8	0.74
26	11	0.86
25	11.5	1.1
20	13	2.9

INTERPRETATION OF RESULT

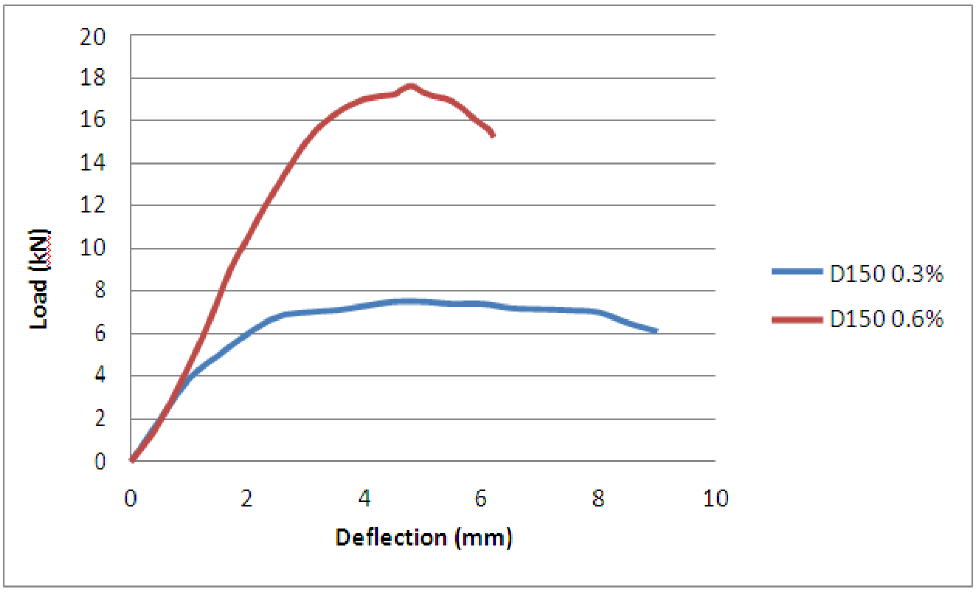

Fig.5. 3: Load deflection curves for beams D150 0.3% and D150 0.6%

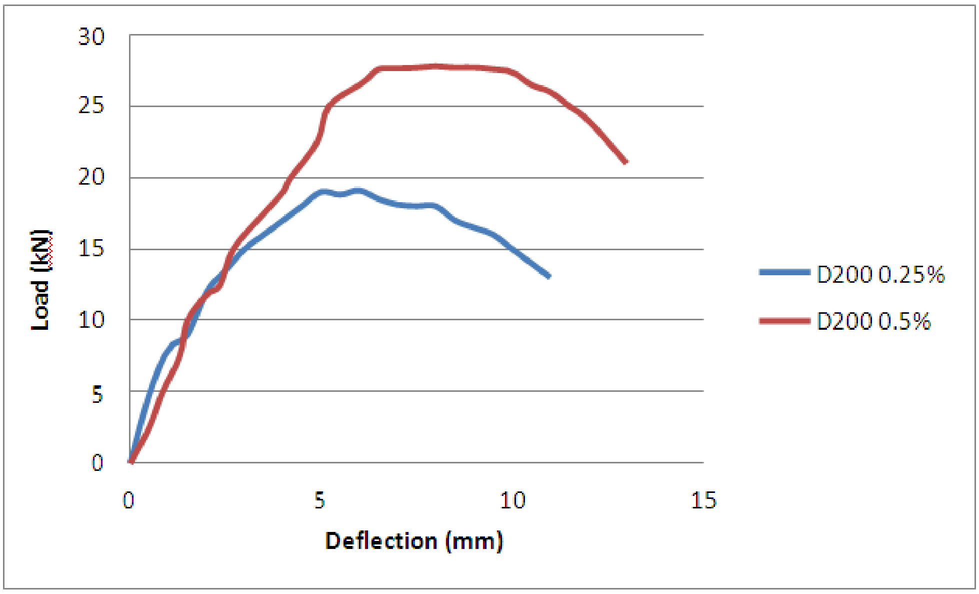

Fig.5. 4: Load deflection curves for beams D200 0.25% and 0.5%

With the exception of beam M30,D150, 0.6%, which failed in shear, all the beams failed in flexure when a central crack propagated in the region of the highest applied moment. In case of beams of depth 150mm, the peak load increases from 7.5 kN to 17.6 kN but the deflection decreases from 9mm to 6mm.With increasing reinforcement ratio in beams of depth 200 mm, the peak load increases and the maximum deflection at the peak load Δmax also increases.

The ductility factor based on the deflection ratio Δmax/Δy was calculated. From the tabulated results, it can be seen that the ductility appears to increase with increasing reinforcement ratio and beam size. It is worth noting that these trends only apply for lightly reinforced concrete beams that exhibit flexural failure. The beam behaviour is expected to become brittle with increasing reinforcement ratio and the onset of shear failures in beam like M30,D150,0.6%.

Table 5. 5: Ductility factor for different beam samples

Beam	Deflection at yielding Δy (mm)	Total deflection at failure load Δmax (mm)	Ductility factor μ = Δmax/Δy
D150 0.3%	3.3	8.9	2.61
D150 0.6%	2.9	6.2	2.13
D200 0.25%	3.8	10.6	2.78
D200 0.5%	4.4	13.25	3.01

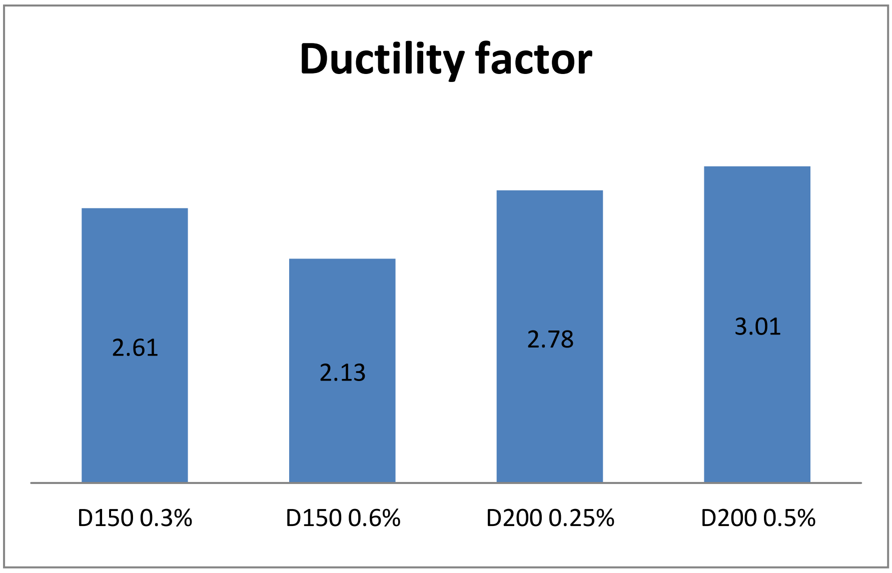

Fig.5. 5: Ductility factors for beam samples

FRACTURE BEHAVIOUR

The reinforcement bridges the crack and exerts a force that opposes crack opening. In this section, crack profile observations are presented to investigate the fracture evolution in reinforced concrete. The unreinforced beams of depths (150mm and 200mm) were tested to establish the baseline concrete fracture properties. This helps to understand the effect of the reinforcement on the fracture behaviour of concrete. The unreinforced specimens failed due to a crack propagating from above the crack tip. In the reinforced specimens this crack starts as a single slightly curved shape but, with increasing load, the crack propagation continues along two branches. The localised zone advances in a single narrow band exhibiting some deviations from a straight line due to the heterogeneity of the concrete and aggregate interlock until it bifurcates into two branches. It was found that the branched localised zone was created in the beams at a load of around 7 kN in beam D150 0.3%, 17.5 kN in beam D200 0.25%, and 19 kN in beam D200 0.5%. The beam D150 0.6% failed in shear and did not show any branching and hence will not be discussed

Table 5. 6: Measurements associated with crack branching

Beam	CMOD at branching (mm)	Max. CMOD (mm)	% CMOD that occurs after branching
D150 0.3%	0.51	3.1	83.5%
D200 0.25%	0.61	3.4	82.1%
D200 0.5%	0.37	2.9	87.2%

Based on the results in Table 5.6 it can be seen that most of the CMOD in the tested beams happensafter branching (or steel yielding as the two phenomena are connected) 80% to 90% of the CMOD was noticed in the tested beams after crack branching and thus indicating that the CMOD increases substantially close to the peak load. This indicates that before branching, the crack process is primarily about crack propagation whereas, after branching, crack opening dominates. The bifurcation leads to the failure in the compression zone in lightly RC beams.

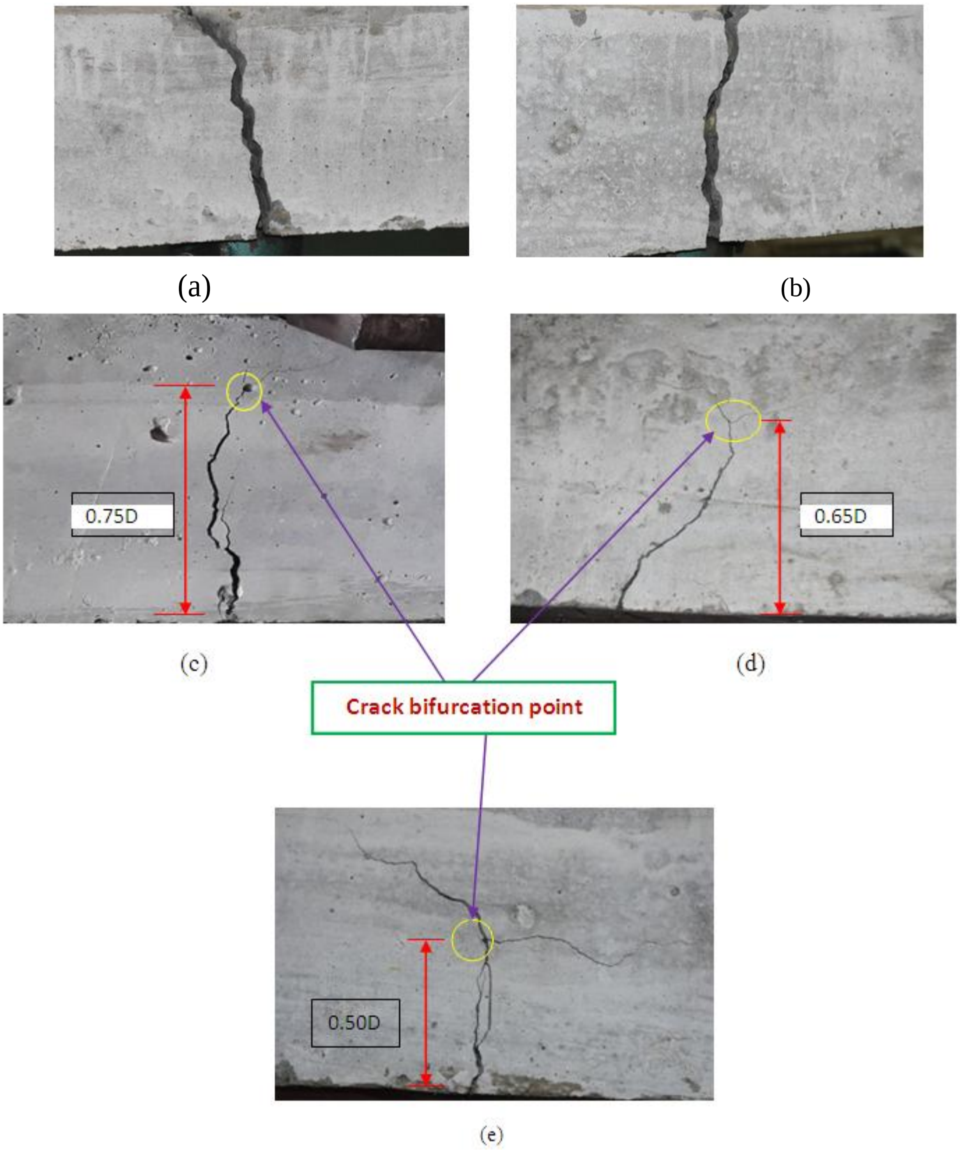

Fig.5. 6: Single flexural cracks without any branching in unreinforced beams (a) D150,0% (b)D200,0%. Crack branching at different depths in beams (c) D150,0.3% (d) D200,0.25% (e) D200,0.5%

With increasing load, the branched localised zone develops and its length increases. The bifurcation took place at a depth of 0.75, 0.65 and 0.5 of the effective depth of beams D150 0.3%, D200 0.25% and D200 0.5% respectively.

Table 5. 7: Relative depth of crack branching

Beam	Relative depth of branching
D150 0.3%	0.75
D200 0.25%	0.65
D200 0.5%	0.50

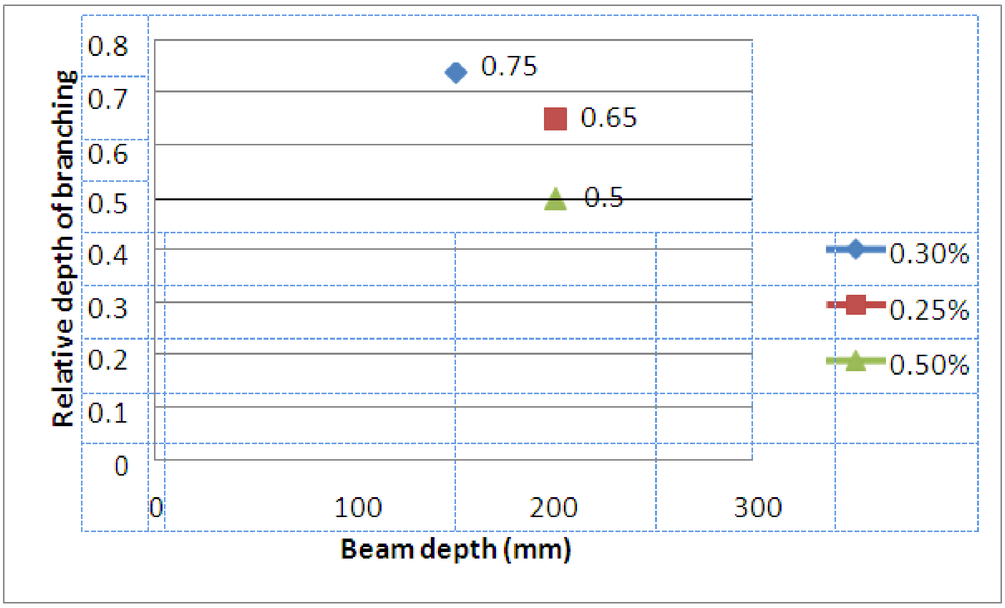

Fig.5. 7: Plot of relative depth of branching vs beam depth

The beam depth is plotted against the relative depth at which bifurcation took place. In the larger beams (of depth 200mm and length 1200mm) branching occurs at a lower relative height than in the smaller beams(of depth 150mm and 1000mm). After the onset of branching, localisation continues to develop at the tips of the two branches until one of the branches dominates and leads tofinal failure. It was noted that the crack branching in beam D200 0.5% occurred at a relatively lower depth than that of D200 0.25 %.But there cannot be a clear trend in terms of the effect of the reinforcement ratio on the effective depth of branching. This is thought to be due to the different failure modes exhibited by the specimens. That is; the shear failure in beam D150, 0.6% and flexural failure in rest of the samples. This makes it difficult to make a clear conclusion about the effect of reinforcement on crack branching, and hence, on beam ductility. More specimens are required to be able to compare beams with similar failure modes. However, the reinforcement ratio does seem to have an effect on the branching angle. The different bifurcation angles for the beams are shown in Fig 5.6. It is of note that with increasing reinforcement ratio, the bifurcation angle seemed to become wider. For example, the bifurcation angle of beam D200,0.25% is relatively narrow when compared with the bifurcation angle of beam D200,0.5% which has higher reinforcement ratio.

Crack branching generates a larger surface area that absorbs energy and hence more energy is needed for fracture to propagate. In the larger beams, branching occurred at a lower relative height than in the smaller beams. This means that for lightly reinforced beams, by increasing the beam size, a more ductile behaviour can be obtained. Crack branching occurred in all the reinforced beams but was not noted in the unreinforced concrete beams and the beam D150, 0.6% which failed in shear. In reinforced concrete, the reinforcement provides an effective confinement to the crack path. The bifurcation occurs when the tip splits into two cracks.

The aim of the current work is to investigate experimentally the phenomenon of branching and provide evidence that it is associated with the presence of reinforcement (or confinement effects). The results of the experimental program showed this within the range of the tested properties and within the tested sizes. The load deflection behaviour of the experimental reinforced concrete beams show a capacity for post-peak deflection which is reflected in the ductility factors presented in Table 5.5. As the crack bifurcation is associated with ductility, it is postulated that a better understanding of crack branching and the incorporation of the experimental observations into theoretical models would give a better prediction of the cracking process and a better estimation of the ductility. This could lead to an improved evaluation of the minimum flexural reinforcement required for ductile behavior.

IV. CONCLUSION AND FUTURE SCOPE

An experimental investigation on the cracking process in RC beams was undertaken with a focus on the localised zone and crack branching phenomena. The following conclusions can be drawn based on the experimental results:

- In unreinforced concrete beams the shape of the crack is in the form of a single curved band indicating the development of damage in the material. Softening behaviour ensues after the peak load where the load decreases with increasing vertical deflection. A considerable increase in the crack mouth opening occurs during the softening stage.
- In reinforced concrete, the crack initially propagates in the shape of a single narrow slightly curved band. However, the presence of the reinforcement prevents premature fracture and results in the development of crack branching where the single crack bifurcates. The combination of this bifurcation and cracking results in the failure of the compression zone.
- It has been found that the larger the beam size, the lower the relative depth at which branching takes place. The crack path is therefore influenced by depth of the compressive stresses.
- In reinforced concrete, the bifurcation angle was fairly narrow in beams with lower reinforcement ratios. With increasing reinforcement ratio, the bifurcation angle becomes wider.
- Crack branching generates a larger surface area that absorbs energy. Hence more energy is needed for the crack to propagate and this affects the ductility of RC beams. It was found that increasing the beam size or the reinforcement ratio increases the ductility of RC beams according to a conventional definition of ductility

RECOMMENDATIONS FOR FUTURE WORK

- In this project work, the considered parameters affecting crack propagation and ductilty are beam depth and reinforcement ratio. The other parameters like concrete grade can also be taken into consideration also to see the effect on crack propagation.
- Although the fracture properties of reinforced concrete at the structural scale have been studied, there is a need for further detailed investigations of cracks in reinforced concrete to better understand the nature of the fracture process and improve existing models. Improving existing models does not necessary mean making them more complex. However, it does involve enhancing our understanding of the behaviour in a way that is translated to new applications without missing the important features. The recent advances in image processing techniques as well as in high-resolution digital cameras can provide advanced tools to measure fracture properties and provide insight into the cracking process. Such real observations can lead to the development of new models or the improvement of existing models.

The experimental observations of the fracture process of RC beams need to be incorporated into analytical solutions for reinforced concrete cracking to develop better predictions for the cracking process of RC beams. This could lead to an improved estimation of theminimum reinforcement requirements for flexural members and associated ductility.

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