REINFORCED FIBROUS CONCRETE FOR STRUCTURES IN EARTHQUAKE PRONE ZONES

by

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SUMMARY

Two continuous beams (two span) with reinforced concrete and two continuous beams with fibrous concrete at the expected zones of hinge formation were tested under monotonic loading condition. The investigation revealed that the load carrying capacity, stiffness and ductility were larger for the beams with fibrous concrete in hinging zones than the conventional reinforced concrete beams. The crack widths and spalling and disintegration of concrete are lower in the partial fibrous beams than the conventional reinforced concrete beams.

INTRODUCTION

The resistance of fiber reinforced concrete to shock loads that are caused due to explosion etc and its inherent shatter resistance that reduces disintegration of broken fragments make it an useful material for the structures in earthquake prone zones.

The aim of the present study is to examine the behaviour of reinforced fibrous concrete when it is subjected to reversed cyclic loading such as those experienced by catastrophic earthquakes. As part of this investigation the preliminary work which was limited to monotonic loading is reported in this paper. The overall ductility in framed structures is a function of the rotational capacity of hinging zones. Favourable overall behaviour could be anticipated if the hinging zones have adequate deformation capacity while the rest of the structure is either elastic or in an elastic cracked state. Therefore it is while to introduce fibers in the hinging zones where ductility demand is keenly felt.

EXPERIMENTAL INVESTIGATION

<u>Details of test specimens and test set up</u>: The particulars of beams tested are shown in Table 1. For beams PFRCCI and PFRCC II fibrous concrete using steel fibers (0.4mm dia) having aspect ratio (l/d) equal to 100 and 1% by volume was used at the hinging zones only as shown in Table 1. The test set up may be seen in Fig.1. The loads were simultaneously applied on the beams through the mid points of each span.

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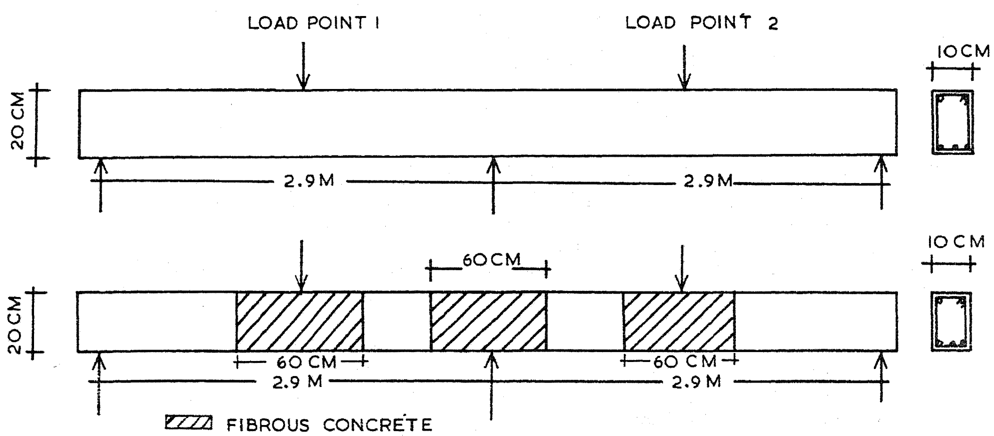
5. The crack widths in the hinging zones of the fibrous concrete beams (PFRCC beam) were less compared the crack widths at the same location in conventional R.C. beam (RCC beam) at comparable load levels.

TABLE I

S.No.	Description	Designation	Size in Cm	Mix	Reinforcement Details	Details of fibers	Zones of Fibrous concrete
1.	Conventional R.C.Beam	RCCI	10x20x600	M200	Main steel 10mm Ø -3No. at bottom	-	-
2.	-do-	RCCII	-do-	M200	Hanger bans 6mm Ø -2No. at top	-	-
3.	Reinforced partial Fibrous Concrete beam	PFRCCI	-do-	M200	Shear stirrups -6mmØ -2 legged at 10cm c/c	0.4mmØ l/d=100 Steel Fibers	at the hinging zones 60cm along length
4.	-do-	PFRCCII	-do-	M200		''	-do-



Load deflection behaviour: Fig.2 shows the load deflection curves for all the four beams tested. The deflection measurements were taken at the centre of each span. The load-deflection curves show that the PFRCC beams are stiffer at working load than the RCC beams by 25•/•. The ultimate load was higher for PFRCC beams compared to RCC beams by 15•/•. The ultimate load could be sustained even for larger deflections in the case of PFRCC beams whereas there was considerable reduction of ultimate load with increasing deflections in the case of RCC beams. The PRRCC beams were found to be at least 50•/• more ductile than the conventional beams. Fig.3 shows the strain distribution across the hinging zones of two typical beams. The shift in the neutral axis is more for the RCC beams than in the PFRCC beams for the same load increments. This is because the contribution of fibrous concrete in the tension zone. This can be considered to be a favourable behaviour of the critical hinging zone. The narrowing of the compression zone is delayed in the case of PFRCC beams which has contributed to their larger section ductility leading to greater energy absorption for the member.

FAILURE MODE OF BEAMS

All the beams were reinforced with sufficient shear reinforcement in order to supress a premature shear failure. As expected all the beams developed plastic hinges and a ductile flexural failure was witnessed. The cracking and disintegration of concrete in the damagdd tension zones were quite significant for RCC beams whereas it was considerably less in PFRCC beams. Crack widths in PFRCC beams in the hinging zones were found to be less compared to crack widths in the same regions of the RCC beams for comparable load levels. At ultimate load stage the cracks in tension zones of RCC beams opened up considerably due to excessive deformation and spalling of concrete fragments were inevitable. On the other hand the PFRCC beams showed shatter resistance and exhibited more even crack distribution.

CONCLUSIONS

1. The stiffness of the beams with fibrous concrete in the hinging zones (PFRCC beams) was higher by 25•/• than the conventional reinforced concrete beams (RCC beams) at about the service load.
2. The ultimate load carrying cap city for the beams with fibrous concrete at hinging zones (PFRCC beams) was larger by 15•/• when compared with conventional R.C. beams (RCC beams).
3. The PFRCC beams were found to be at least 50•/• more ductile than the conventional beams.
4. The cracking and disintegration of concrete from the damaged tension zone was quite significant for conventional R.C. beams (RCC beams) whereas it was considerably less in partial fibrous concrete beams (PFRCC beams).

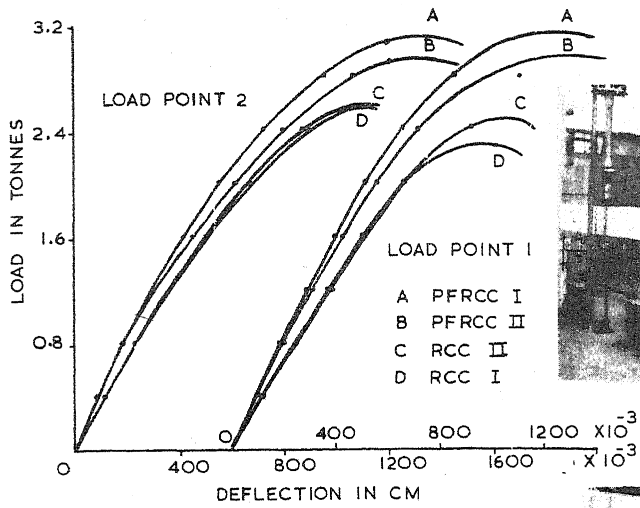
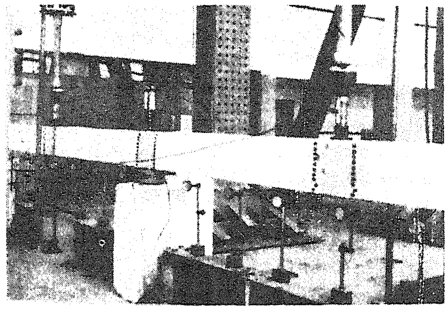
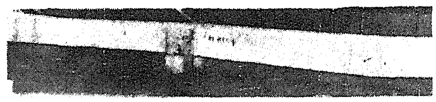
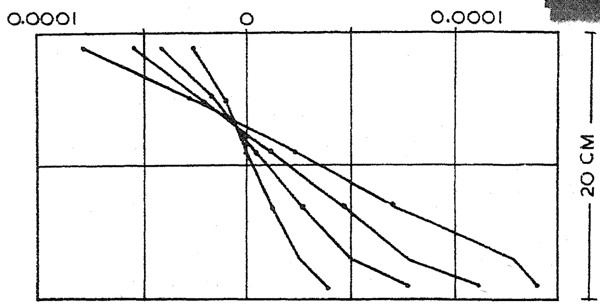


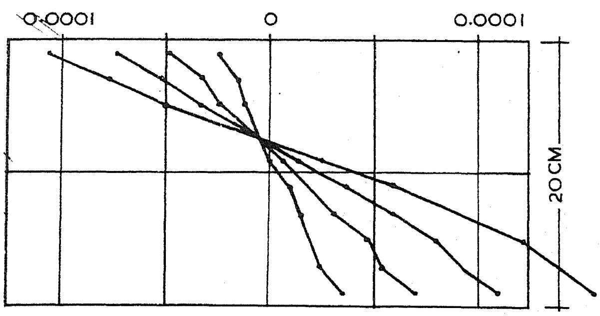
FIG. 2 LOAD-DEFLECTION







RCC



PFRCC

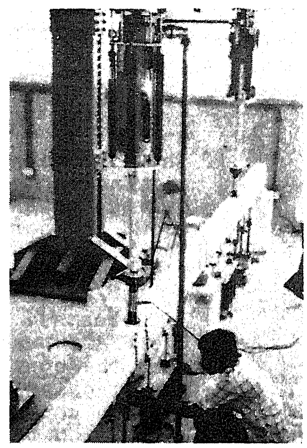


FIG. 3 STRAIN DISTRIBUTION ACROSS DEPTH

FIG. 1 TEST SET UP