A STUDY ON REPAIR EFFECTIVENESS OF DAMAGED RC BEAMS WITH CIRCULAR OPENINGS USING CFRP SHEETS

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Keywords:

RC Beams, circular opening, repair, CFRP, strength, serviceability.

Introduction:

To accommodate utility services like water supply, sanitary lines, electricity and computer network, transverse openings are provided on the RCC beams. The transverse openings through beams are a source of potential weakness. Usually, these openings are non-designed and made non-technically. For old buildings, the necessary layout of pipes and ducts are decided through providing an opening in an existing beam, the decision of creating opening in existing beam, jeopardizes the existing beam due to the reduction in both strength and stiffness of the beam and excessive cracking at the opening due to high stress concentration. Openings that are circular, square, or nearly square in shape may be considered as small openings provided that the depth (or diameter) of the opening is about less than 40% of the overall beam depth. The provision of openings, however, produces discontinuities or disturbances in the normal flow of stresses, thus leading to stress concentration and early cracking around the opening region. Similar to any discontinuity, special reinforcement, enclosing the opening close to its periphery, should therefore be provided in sufficient quantity to control crack widths and prevent possible premature failure of the beam. Replacing cost of these RC beam structural elements is overwhelming. Carbon Fibre Reinforced Polymer (CFRP) sheet is one of the promising repairing materials to deal with deteriorating infrastructure. This is a suitable repair technique in terms of low cost and fast processing time.

Objectives:

The main aim of this research is to investigate the effect of repairing damaged RC beams with circular opening using externally bonded CFRP sheets.

1. The main objective is to compare the performance of beams with pre-formed and beams with repaired post cut openings at the shear zone by performing the four-point bending test.
2. To investigate the enhancement in the load carrying capacity and cracking load of the beams with post openings repaired by CFRP sheets and ordinary cement mortar.
3. To study the failure modes developed around the post cut openings repaired by CFRP sheets and cement mortar under static loading.
4. In the four-point bending test, the load-deflection curve and crack width will be measured separately.

Methodology:

1. Procurement of materials - Cement, fine & coarse aggregates, steel bars and CFRP sheets
2. Basic tests on materials as per Indian Standards - Sieve analysis, water absorption and specific gravity for fine and coarse aggregates & specific gravity, fineness, standard consistency, soundness and setting time tests on cement.
3. Casting - Mix design of M20 grade of concrete was done for 3 cubes, 3 cylinders and 3 prisms with 9 RC beams of dimension 200mm X 150mm X 2400mm which were designed for flexural and shear reinforcement.

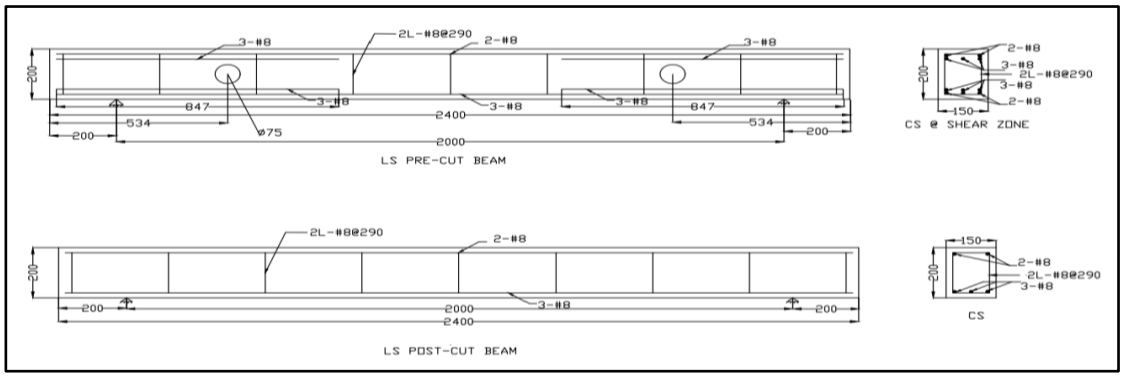

Fig 1. Reinforcement detailing

4. Out of 9 beams,
    - 3 beams designed for pre-formed opening at neutral axis of diameter 75mm
    - 3 beams with post-cut opening at neutral axis of diameter 75mm and repaired with cement mortar and
    - 3 beams with post-cut opening at neutral axis of diameter 75mm and repaired with externally bonded CFRP sheets.

Fig 2. Bar bending of steel reinforcement

Fig 3. Shuttering for beams with post-cut opening

Fig 4. Shuttering for beams with pre-cut opening

Fig 5. Casting of beams

Fig 6. Beam with pre-formed holes

Fig 7. Curing of beams

Fig 8. Casting cylinders and prisms

5. Testing - All beams will be subjected to two-point loading under static loading. Increase in deflection with increment in static loading, Deflection at first crack, Ultimate load and Development of cracks with crack widths are to be recorded. Load vs Deflection curve to study beam behaviour will be plotted.

Conclusion:

The results for 7 days, 14 days and 28 days tests on cubes, cylinders and prisms are shown below.

Sl no.	Specimen	Date of casting	Date of testing	Result (N/mm^2)
1	Cube	18-05-2022	25-05-2022	13.516
2		18-05-2022	01-06-2022	21.364
3		18-05-2022	15-06-2022	22.230
1	Cylinder	18-05-2022	25-05-2022	1.240
2		18-05-2022	01-06-2022	1.940
3		20-05-2022	17-06-2022	2.280
1	Prism	20-05-2022	27-05-2022	2.630
2		20-05-2022	03-06-2022	3.500
3		24-05-2022	-	-