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Damage analysis of Reinforced Concrete Beams using Piezoelectric Sensors

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Abstract*: Identification of crack or damage inside a structure is not possible with traditional methods. In this study piezoelectric sensors are introduced into structure using before placement of concrete and to be in precise sensors act as artificial aggregate. Specimen is taken under three point bending test. A damage characteristic of the beam is studied by using high-voltage pulse emitter, to give a electric signal and recording is made. Extensometer is used to measure the crack and images of the crack should be captured. Final results are plotted in digital image processing to conclude the damage characteristics.

Keywords*: Piezoelectric sensors, artificial aggregate, damage analysis, digital image processing.

I. INTRODUCTION

Concrete is a heterogeneous material, which in its lifetime undergoes different types of loads and stresses. Usually concrete structures fail due to some chemical actions and sometimes due to internal deterioration. Many researchers have been carried out to study the failure and damage characteristics of concrete. One of it was live detection of cracks and damages inside beam using transducers.

Piezoelectric sensors are adopted in this study due to its advantages and proximity in study of crack characteristics. A setup of high-voltage emitter is used to excite the sensor image processing capacity.

Predefined compressive strength and tensile strength of the beam is taken and load is applied on the beam to its ultimate and crack is developed and characteristics are studied.

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II. EXPERIMENTAL STAGES

A.Materials and Reinforcement :

53 grade ordinary Portland cement and river sand is taken as fine aggregate. 12mm size coarse aggregate are used, to ease the placement and for light vibration to compact.

Two steel bars of 12mm diameter is placed at bottom and two steel bars of 6mm diameter are placed in top. 3mm stirrups are used as tie bars.

B.Embedding of sensor in beam :

Piezoelectric sensors are soldered to the rebar at a distance of 200mm distance between each sensor. Care is taken while placing and compaction of concrete.

Piezoelectric sensors are connected in series with high-voltage purifier and recorder. A digital image processor is attached to a amplifier to the to study the type of wave in the beam.

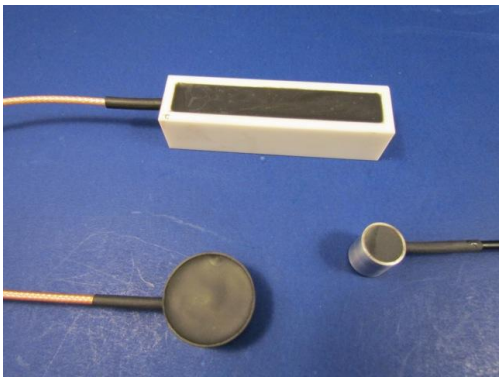

FIG 1: PIEZOELECTRIC SENSOR

III. TEST RESULTS

A.Three point bending test :

To develop crack in the beam, most accurate test or loading to be done is three point bending test. In this test beam specimen prepared is taken under 150KN jack and load values are gradually increased. After setting up the beam in position, loading is given in the mean time high-voltage pulser is turned on to excite the crack procedure.

Waves developed by sensor are digitized in amplifier and recorded in recorder. Slowly cracks were are developed and crack width is measured using extensometer. A sensor exactly predicts where the crack is developed and up to which level it is propagated.

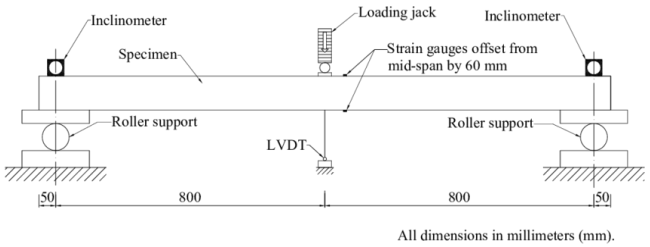

Fig 2: Three point bending test setup

B. **Identification and image processing**:

Images of the cracks are captured using high quality camera to find the crack thickness. Images captured are filtered to find out the thinnest crack developed.

Initial crack was developed at 10.2KN and ultimate failure of beam occurred.

Damage index graph of beam is shown in Fig 1

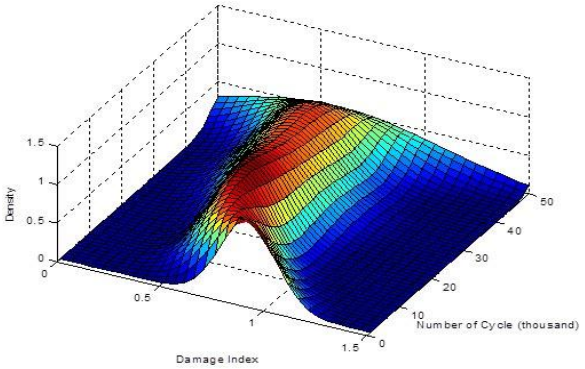

Fig 3: Damage index of Beam with time and loading

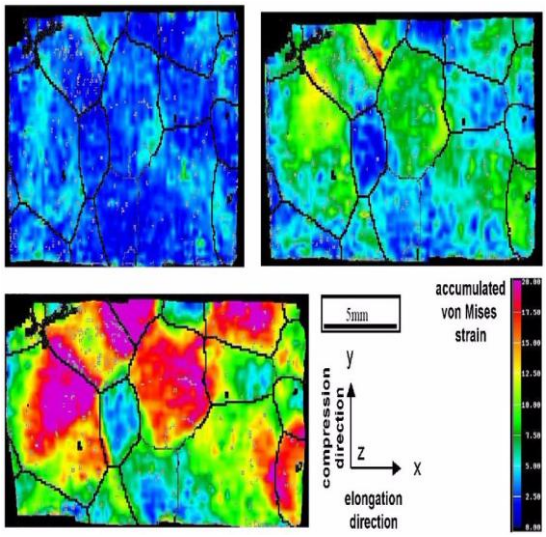

Fig 4: Crack propagation inside the beam

Cracks developed in the beam are shown in fig 2 and 3. Images were taken in high magnification using lenses. Width of the crack is measured using extensometer and cracking load values predicted and practical cracking developed is nearly same. Ultimate load values predicted from ANN model is used by taking inputs in to count.

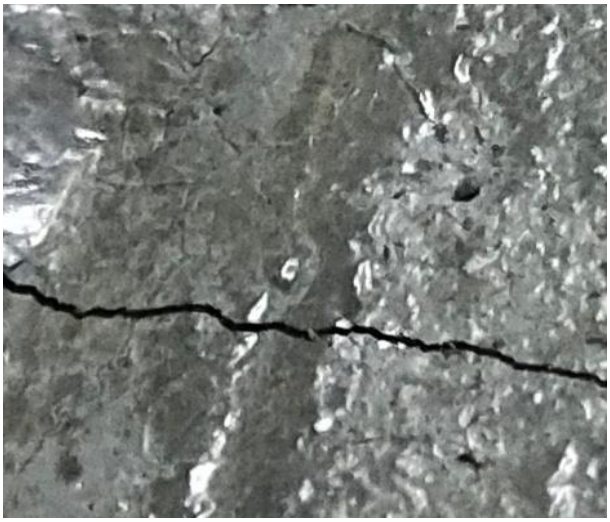

Fig 5: crack developed under high magnification

Fig 6: crack developed at third stage of loading

IV. CONCLUSIONS

From the test results following inferences are can taken

- Three point bending test is most suitable to evaluate the crack propagation.
- Embedding piezoelectric sensor as an aggregate has given a good results.
- Images captured have a great correlation with the damage indicator and resultant values are easy to read and study can be further extended.
- High voltage pulser has indicated the damage analysis, before the crack is developed outside the beam.
- Digital image of the wave shows the cracking load before the actual crack developed in the beam.
- This method can be highly adopted at the structures those have a high risk of earthquakes.

REFERENCES

1. M. Talha Junaid, Abdalla Elbana, Salah Altoubat, Zaid Al-Sadoon, Experimental study on the effect of matrix on the flexural behavior of beams reinforced with Glass Fiber Reinforced Polymer (GFRP) bars, Composite Structures,Volume 222, 2019, 110930, ISSN 0263-8223, https://doi.org/10.1016/j.compstruct.2019.110930.
2. Zhihua Xiong, Yuqing Liu, Yize Zuo, Haohui Xin, Experimental evaluation of shear behavior of pultruded GFRP perforated connectors embedded in concrete, Composite Structures, Volume 222, 2019, 110938, ISSN 0263-8223, https://doi.org/10.1016/j.compstruct.2019.110938.

3. Marco Rossini, Antonio Nanni, Composite strands for prestressed concrete: State-of-the-practice and experimental investigation into mild prestressing with GFRP, Construction and Building Materials, Volume 205, 2019, Pages 486-498, ISSN 0950-0618, https://doi.org/10.1016/j.conbuildmat.2019.02.045.
4. V Kissman, Lenin Sundar, An experimental study on strengthening of RC column with GFRP, Materials Today: Proceedings, 2019, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2019.05.430.
5. Zein Saleh, Matthew Goldston, Alex M. Remennikov, M. Neaz Sheikh, Flexural design of GFRP bar reinforced concrete beams: An appraisal of code recommendations, Journal of Building Engineering, Volume 25, 2019, 100794, ISSN 2352-7102, https://doi.org/10.1016/j.jobe.2019.100794.
6. G.Ganesh Naidu, M.Sri Durga Vara Prasad, U.Upendra Varma, S.Sandhya, Effect of R.O. Waste Water on Properties of Concrete, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-3, September 2019, https://doi.org/10.35940/ijrte.c5201.098319
7. G. Ganesh Naidu, M.Sri Durga Vara Prasad, A. Venkata Sai Pavani, Impact of Chloride Attack on Basalt Fibre Reinforced Concrete International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-12, October 2019, https://doi.org/10.35940/ijitee.l3502.1081219

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