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AN EXPERIMENTAL STUDY ON THE SENSOR BASED STRUCTURAL HEALTH MONITORING SYSTEM FOR BRIDGE STRUCTURES

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***Abstract*— Civil Engineering structures like bridges, sky scrapers and dams are play a very important role in our society. It will decide the economic growth of a country. These structures are very important structures. It is necessary to ensure the safety of these structures. To assess the integrity of the structures and to ensure the safety of the structures Structural Health Monitoring is used. From this Structural Health Monitoring preventive measures can be taken to enhance the life of the structures. In this study, Structural Health Monitoring of concrete bridge using LVDT, strain gauges and sensors are focused. A STAAD Pro model of concrete bridge is created and analyzed for several loading position and the bridge is designed for critical loading condition. A concrete pier with beam deck of the bridge is designed and cast. An experimental investigation was carried out on the concrete model to determine the ultimate load, deflection, stress and strain observations.**

***Index Terms*—Sensor, Structural Health Monitoring, Bridge Structures, Experimental Study.**

I. INTRODUCTION

Structural Health Monitoring (SHM) is the process of detecting damages in the structures by placing instruments in the structures. *SHM* is used to assess the *integrity* of the structures and to *ensure the safety* of the structures. It is very much useful to detect the damages before it reaches a critical state. Civil Engineering structures like bridges, tall buildings, dams are playing a vital role in human life. These structures are very important for the society. So we need to ensure the safety of these structures by adopting Structural Health Monitoring system in these structures.

II. ANALYSIS OF BRIDGE MODEL

STAAD Pro model of concrete bridge is created and analyzed for several loading position and the bridge is designed for critical loading condition. After completing the simulation analysis a prototype model is designed.

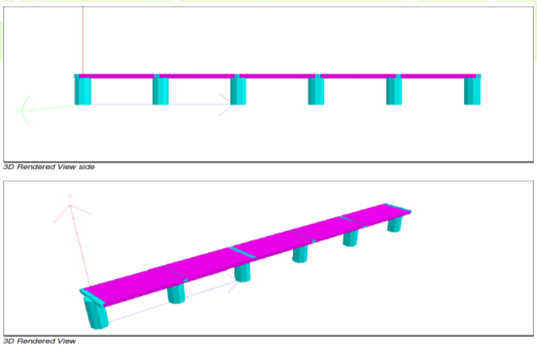

Fig 1: STAAD Pro Model

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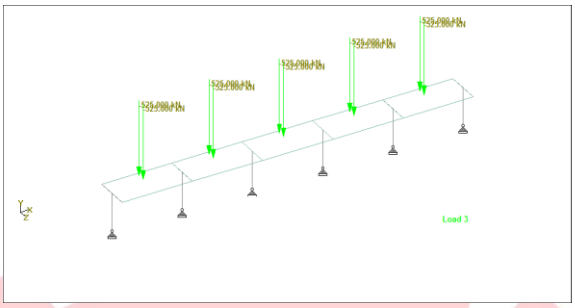

Fig 2: Loading on Model

III. DEVELOPMENT OF SIMILITUDE MODEL

Length Scale Factor (SL) = LP/LM is calculated and this length scale factor is used to get the similitude dimensions. The bending scale factor is calculated using the relation moment in Prototype /Moment in model. This Scale Factor is applied to the real time bridges which having the same geometry and loading conditions.

DETAILING OF BRIDGE MODEL

Fig 3: Model Detailing

The prototype model of concrete bridge cast for the critical load obtained. A single pier with beam deck of the bridge is designed. Three numbers of samples were cast and are kept in curing tank. The model is to be tested for deflection, stress and strain.

Fig 4: Casting of Model

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Fig 5: Cast Model

IV. EXPERIMENTAL WORK LOAD VS DEFLECTION BEHAVIOUR

Load vs. Deflection behavior analyzed by giving load to the model and Linear Variable Differential Transformer (LVDT) fixed on the bottom of the beam deck around 100 mm from the end.

Fig 6: Model Testing for Deflection

A. Test for Strength Degration with Time

Strength degradation obtained based on the degradation of young's modulus of concrete with time. Bending strain obtained from the test results correlated with the corresponding stress values with the time.

Fig 7: Testing for Strain

B. Continuous Strain Monitoring

Strain values are recorded continuously for the constant loading condition and Short term creep values are taken from the continuous monitoring. (Sustained loading)

Fig 8: Continuous Monitoring

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Continuous monitoring is for identifying strain behavior for this structure for the applied case of general loading.

V. RESULTS AND DISCUSSION

A. Load Vs Deflection

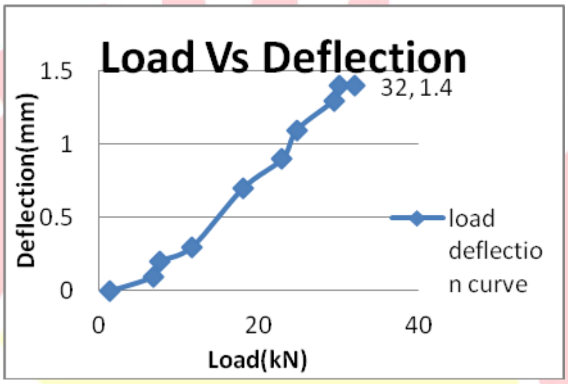

Fig 9: Load Vs Deflection Observation of Deck Beam

Figure 9 illustrates the variation of deflection with increase in load condition. From the graph it is found that the deflection increases linearly with increase in load. The maximum deflection of the model is 1.4 mm which is permissible according to the design. Limiting deflection of the model according to the design is 2.39 mm.

B. Load Vs Strain

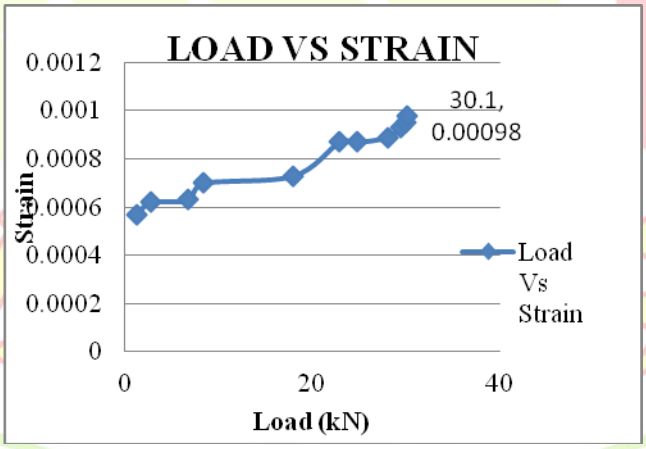

Fig 10: Load Vs Strain

Figure 10 illustrates the change in strain due to change in the applied load. The strain increases gradually as the load increases. The model performs like elastic until 10kN. Strain hardening starts from 10kN and it becomes inelastic strain after 30kN.

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C. Stress Vs Strain

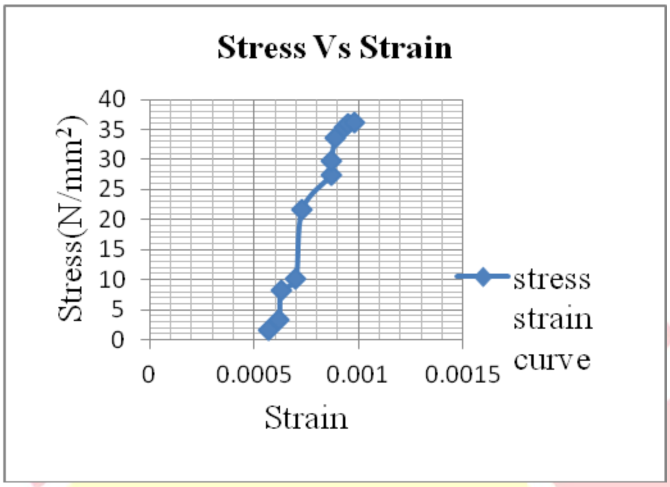

Fig 11: Stress Vs Strain

Figure 11 Shows that the stress and Strain relationship. Strain is linear with respect to the stress. The strain increases gradually as the Stress increases.

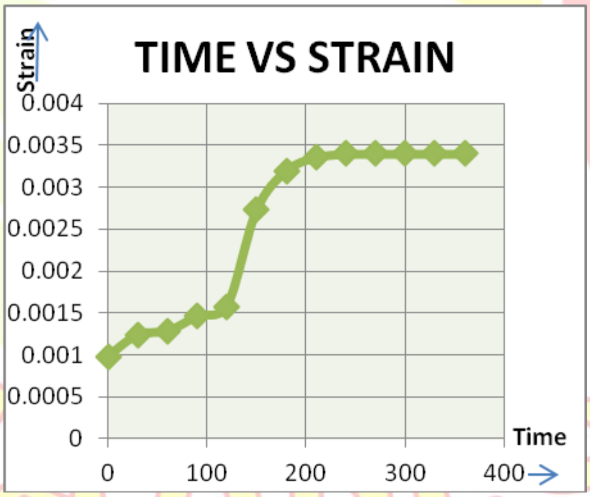

Fig 12: Time Vs Strain

Figure 12 illustrates the degradation of model as the passage of time. The strength loss in concrete is determined with respect to time. At the cracking load the percentage of deformation in Young's modulus of Concrete is given by % Reduction = (E-E50)/E. Here by it is found that whenever the strength loss is around 12.6% the crack may start and that is the critical situation which the alarm should be on for the same geometry and loading conditions

VI. CONCLUSION

From the experimental work the following conclusions were made,

- From the results it is observed that the stress strain relationship was linear.
- The strength loss in concrete is determined with respect to time.
- Here by it is found that whenever the strength loss is around 12.6% the crack may start in the prototype having the same geometric and loading of the created model.
- The results help to calculate the critical warning responses of the real time structure and the critical sections for sensor instrumentation

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