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Health Monitoring of Flat Slab Using NI Labview

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***Abstract:** Structural health monitoring techniques are widely used for detection of risky zone or faults or defects on the body whether it may be Building, bridges, steel structure like truss and towers, and also in the machines and in equipments like plane, trains etc. Wired techniques are mostly useful for the bodies which are small and in which the structure is physically in touch with the sensors whereas in wireless technique, the sensors are not in physically in touch with the structure. Sensors are then to be fixed at appropriate location of the designed flat slab. For monitoring the considered flat slab program is done using NI LabVIEW. The sensors are connected to the computer via My DAQ. The slab is then monitored for the working loads and the data is obtained in the form of graphs.*
***Keywords:** Health Monitoring, Sensor, Strain, Temperature, Corrosion.*

I. INTRODUCTION

Civil infrastructures, which include bridges, buildings, pipeline, furnace and transition lines, begin to deteriorate once they are built and operated. Maintaining safe and non-viable civil infrastructures for daily use is important to the well-being of all of us. Knowing the integrity of the structure in terms of its age and operation, and its level of safety to withstand infrequent but high forces such as overweight trucks, earthquakes, tsunami, and hurricanes is important and necessary. The process of determining and tracking structural integrity and identifying the nature of damage in a structure is often referred to as health monitoring

II. MATERIALS USED

The various material used in the preparation of concrete specimen are collected and studied for various parameters. The following materials are used for making the flat slab specimen. Ordinary Portland Cement: conforming to IS456:200-53 grade

1) Graded Fine Aggregate
2) Graded Coarse Aggregate
3) Water
4) HYSD Bars
5) Super plasticizer

a) Ordinary Portland Cement

The cement is the binding material. It consist of grinding the raw materials.

b) Fine Aggregate

The material smaller than 4.75 mm size is called fine aggregates. River sand conforming to grading zone of IS 383-1970 was used as fine aggregate

c) Coarse Aggregate

Locally available well graded granite aggregates of size passing through 16mm.the maximum size of the well graded coarse aggregate is 20mm.

d) Water

Portable water has been used for casting the specimen. The water is free from oil, acids, alkalis and has a water soluble chloride content of 140 mg/lit. as per IS456:2000, the permissible limit for chloride is 500 mg/lit for reinforced concrete.

e) Steel

High Yield Strength Deformed bars of Fe 415 conforming to IS 1786 has used.

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f) Super Plasticizer

Super plasticizer Bostic 2 in 1 has been use in our concrete mix to increase the workability of the mixture as well as to decrease the water requirement. This in turn decreases the water cement ratio increasing the compressive strength of the concrete. The admixture is added at the rate of 200ml/50kg of cement.

g) Sensors

The following parameters are analyzed in the considered flat slab.

- Temperature – LM35 (Continuous Monitoring)
- Strain - Electrical Strain Gauge (Continuous Monitoring)
- Corrosion – Determined by open circuit potential using Half-cell and calomel reference electrode. (Non Continuous Monitoring)

Fig 2.1 Temperature sensor

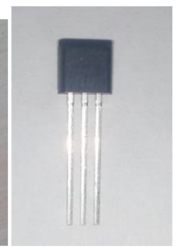

Fig 2.2 LM35 IC

Fig 2.3 Strain guage

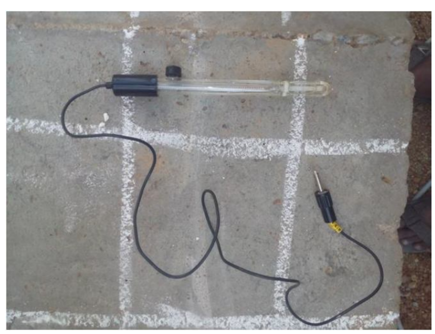

Fig 2.4 Calomel Electrode

III. MIX DESIGN

The design mix can be arrived as per IS code

A. Dimension Of Flat Slab

Let us consider a floor of size 20m x 20m, in which let the size of the interior flat slab panel is 5m x5m and live load be 4 kN/m^2. The flat slab panel without column drop and drop panel is designed

B. Mix Proportions

Cement = 610 kg/m^3
Water = 140 kg/m^3

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Fine aggregate = 670 kg/m^3
Coarse aggregate = 1124 kg/m^3
Water- Cement Ratio = 0.4
The Mix proportion is 1:1.1:1.8

IV. LABVIEW PROGRAM

The MyDAQ instrument is connected to the computer and then programming is done. In this program two MyDAQ assistant nodes are created. One node is split into two, one for temperature sensor and the other for steel strain gauge. The other node is connected to the concrete strain gauge via the inbuilt multimeter probes.

V. SENSOR OUTPUT

A. Temperature And Strain Monitoring

The output from the sensor is displayed in a graphical form in the front panel of LabVIEW. Temperature value of the slab varied from 30^{0}C to 40^{0}C during the testing period. The considered specimen is loaded and unloaded at two different loads. The loads of 500kg & 1000kg (5 KN/M &10 KN/M) are provided on the slab. The loading and unloading readings for both the loads are noted down and depicted in the graphical form as shown below from Figures (5.1), (5.2), (5.3), (5.4)

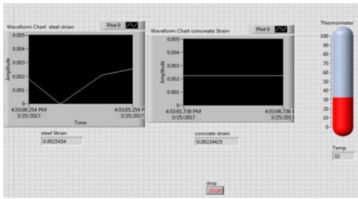


Fig 5.1 Strain corresponding to 500kg(5KN/M) while loading

Fig 5.2 Strain corresponding to 500kg(5KN/M) while unloading

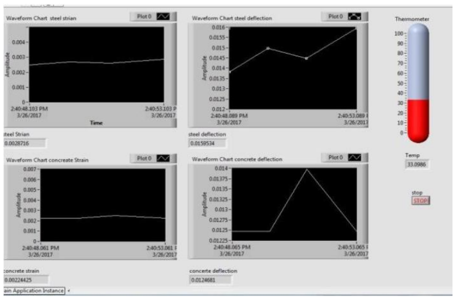


Fig 5.3 Strain corresponding to 1000kg (10KN/M) while loading

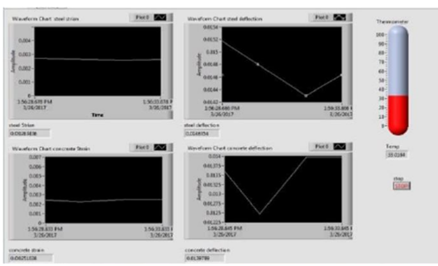
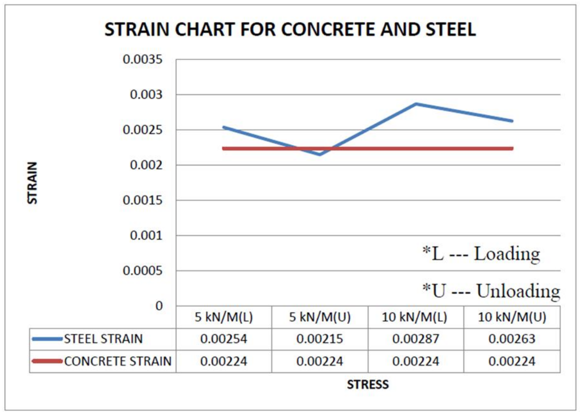


Fig 5.4 Strain corresponding to 1000kg (10KN/M) while unloading

The strain value for different loading conditions were tabulated and has been depicted as in the graphical form as follows,



Graph 5.1 showing strain values of steel and concrete at various loading conditions.

B. Corrosion Determination

For corrosion detection, which is not a continuous process half-cell and calomel electrode in sodium hydroxide medium has been used. The percentage of corrosion based on corrosion is provided in the Table (5.1).

Table 5.1 The potential risk of corrosion based on potential difference readings

Potential difference levels (mv)	Chance of reinforcement being corroded
Less than -500mv	Visible evidence of Corrosion
-350 to -500mv	95%
-200 to -350mv	50%
More than -200mv	5%

The changes in the potential will be very small. The values that are obtained from the multimeter will be in the form of millivolts. This millivolt value will be indicated with a negative sign. The higher the value the lower will be chance of corrosion in that particular location.

This potential difference is in indirect relation with resistance value of the reinforcements inside the slab specimen. Thus higher the resistance there will be large chances of corrosion in that particular steel. In order to get exact potential difference the surface of the slab that is to be tested must be prepared well in advance as per ASTM C 876 standards.

Fig 5.5 Prepared slab for measuring the potential difference at various locations of the slab using calomel reference electrode.

The potential difference at various points has been noted down and has been illustrated in the form of a grid as shown in the Figure (5.6).The figure also indicates the region of maximum potential difference which denotes a 50% change of corrosion by the yellow coloured circles.

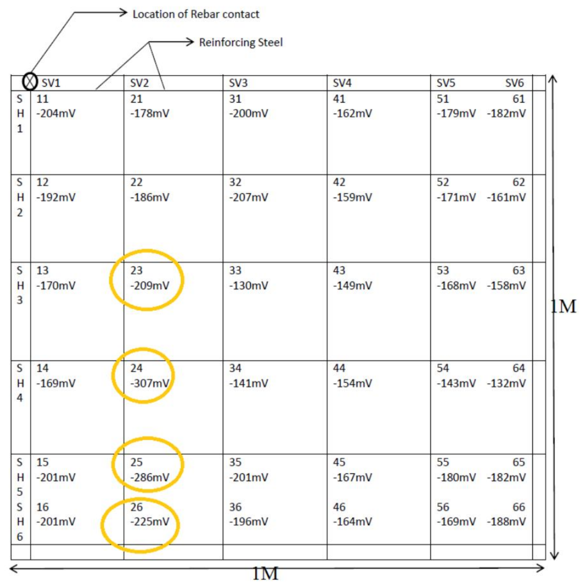


Fig 5.6 Potential Difference at various locations of the slab

VI. CONCLUSION

The considered flat slab model has been successfully monitored continuously under various working loads and it seems that the slab is safe as per the Indian Standard norms.

The slab is designed to withstand only 5kN/M of load. When 5kN/M load is applied to the flat slab (ie. Maximum load is provided,500kg) the deformation is very little.

The strain value obtained was under the tolerable limit. So the load has been doubled to 10 kN/M (1000kg / 1 ton), in this case the strain value obtained is 0.0028, which is lesser than the acceptable 0.0035 range. The equivalent deflection value obtained by using sensor to that of 10kN/M load is 0.014mm, which when compared by the deflectometer gave a value of 0.01mm thus by using electrical strain gauge much accurate results could be obtained to the ranges upto 10-3 decimal points.

The corrosion monitoring of the flat slab specimen also holds to be quiet normal as per ASTM C876-91 (Reapproved 1999) codal provision.

Thus structural health monitoring proves to be an effective method to analyze the life of the structure without any destructive tests and it proves well to be an effective alternate for non-destructive testing methodologies. Indeed SHM systems are gaining more important day by day especially on public structures like Bridge, Towers, Transportation means for the human safety and environmental sustainability approach too.

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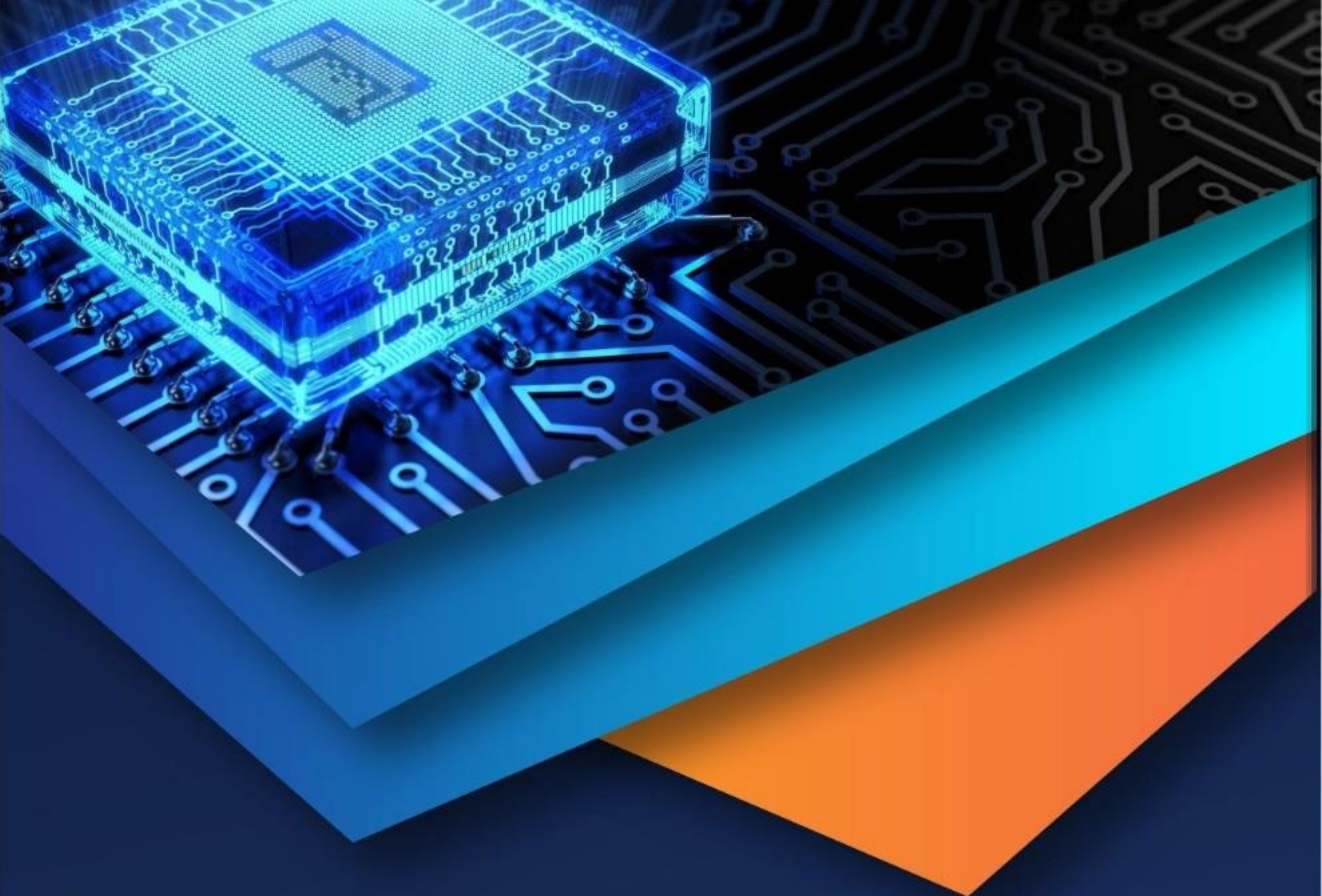

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