Development of Electronic system for analysis of concrete structure failure

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Abstract— **Concrete is the one of the most important material in civil engineering construction. A concrete is the homogeneous material made up of cement sand and aggregate. This ingredient of concrete gives better rigidity to the body of concrete. Due to better rigidity concrete strong in compression but weak in tension. When this concrete exposed to excessive loading it undergoes deformation which result in formation of cracks on the surface of concrete and also the excessive stresses and strains are developed. This parameter is responsible for failure of concrete structure. So, its necessity to determine the deformation, stresses and strains. To determine the concrete structure failure parameter, we develop the electronic system.**

Using staingaguge sensors in the system we can determine the stress, strain and deformation developed on the concrete structure

Keywords—*deformation, stress, strain, tension, concrete*

Introduction

There are different parameters affect on the concrete structure such as stress, strain and deformation. Stress is defined as the deforming force per unit area of the object. There are different types of stresses such as Tensile stress in which the forces try to increase the length of material, Compressive stress is the forces try to compress a material the while shear stresses which act parallel or tangential to the plane under consideration.

Strain is amount of relative deformation caused by force acting on an object. There are various types of strain observed such as Tensile strain or Longitudinal strain which is the ratio of increase in length to the original length while Shear Strain is the change in shape to the original shape.

Deformations are the any changes in the shape or size of an object due to-an applied force or a change in temperature. There are various types of deformation may occurs due to type of material, size and geometry of the object, and the forces applied.

In The design and construction of any structure, it is always desirable to compare the actual stresses in the structure with those obtained from analysis. Also, it is wise for very important structures such as dams, high rise buildings and long span bridges to continuously monitor the residual stress levels as an early warning system to prevent a disaster. There are many methods of assessing residual stresses and depending on the material which is used in the structure, the proper method can be chosen

While analysis of stresses in cantilever beams we are using two technique i.e. analytical analysis and experimental analysis. The flat plate having cross section 25×5 mm and 395mm in length used as a beam. This beam is fixed at one end and load is applied at other end. In analytical analysis load of 1.256kg (load with pan load) is applied at the end of beam and stresses at a distance of 15mm, 115mm,215mm, 315mm from support is calculated with the help of empirical relation and also calculate the tip deflection with different load range.

In experimental technique, load is applied at the end of beam having 1.256 kg (load with pan load) the strain gauges are located at a distance of 15mm, 115mm , 215mm, & 315mm from the support. We are observing o/p voltage in strain gauges and see the effect of stress and strain at a required position of strain gauge over a cantilever beam at different load.

The strain gauge measures the deformation (strain) as an electrical signal, because the strain changes the effective electrical resistance of the wire. A load cell usually consists of four strain gauges in a Wheatstone bridge configuration. Load cells of one strain gauge (Quarter Bridge) or two strain gauges (half bridge) are also available.

In this proposed system, we are using the strain gauge sensor which is very useful to calculate the different parameters affecting on the concrete structure. The parameters are to determine the deformation of the concrete structural member, strain developed in the concrete structural member and stress developed in the concrete structural member.

PROPOSED SYSTEM

The general block diagram of proposed system is as shown in below figure.

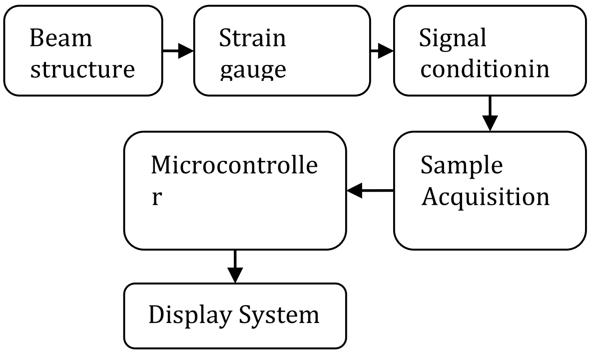

Figure 2.1: Proposed System

The proposed system is used for analysis of concrete structure and measure the stress and strain. Load cell sensor is key equipment in this study. In the design and construction of any structure, it is always desirable to compare the actual stresses in the structure with those obtained from analysis Load cell is transducer that is used to create an electrical signal whose magnitude is proportional to the being measured force. Signal conditioning circuit require for manipulating an analog signal in such way that it meets the requirements of the next stage for further processing. Sample acquisition system collect the temperature samples and converting the resulting samples into digital numeric values that can be manipulated by a computer. Microcontroller From the analysis of change in resistance period for successive samples storage will be obtained and number of sample will be stored. Using analytical tools and equations analysis of stress, strain, and deformations takes place.. Display system displays the Stress stain curves which are used for estimation strain and strain. Figure 2.2 shows some stress strain relation. These curves were then examined for calculation of the stress, strain and deformation developed in the structure. In the graph initial point is starting with linear region the curve is straight line trough out most of the region. Stress is proportional with strain and Material to be linearly elastic. From point A to B it forms the YEILD stress,

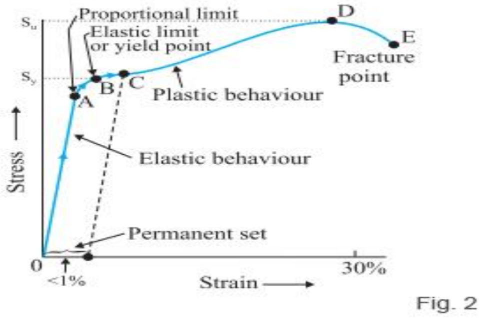

Figure 2.2 Stress Strain Curve

From point B to C it forms the plastic deformation. From C to D forms strain hardening region. At point D shrinkage propensity from the experimentation of thermal analysis. Computer analysis of the cooling curve can provide quantitative information on solidification, such as latent heat of solidification, evolution of fraction solid, amounts of phases.

1. Estimation of sress and strain**:**

1.1Design Specification

Material: Steel

Young's Modulus E = 207 Gpa.

Length of bar element L=125mm.

Dist. between gauge position & point of load application.

L_g = 115 mm.

Width of element w = 25mm.

Thickness of the element t = 3mm.

Gauge Factor G= 2.15.

Max. Loading capacity: 50 N.

1.2 Check max. Stress (at fillet*)*

Moment of Inertia I: $wt^3/12$

= 5.625×10^{-11} m^4.

I / c = 3.75×10^{-8} m^3.

Bending moment M = 50 * 0.125

= 6.25 Nm.

Stresses in bar □ = Mc/I = 166.5 Mpa.

Factor of Safety: 4.2 Which is more than satisfactory.

At the gauges,

Stress s= 166.5* 0.115/0.125.

= 153.2 Mpa.

Strain □ = s / E

= 153.2/207000 * 10^6

= 740 με

The above design is safe to measure the Load up in the range 0 N to 50 N

Figure 2.3 Experimental setup for the measurement of stress

But for a given application……

If the load cell utilization range is high compared to its maximum capacity (used with small factor of safety), the "signal level" is high (a large microvolt output), but the load cell(s) is subject to mechanical overloads and load cell failures.

If the load cell(s) capacity utilization is too small (used with large factor of safety), the signal level is low (a low microvolt output) and the weigh meter reading will tend to drift because sensed value is to small and the system may have an unstable zero (the zero reading drifts too much).While designing, both above factors need to be focused for its optimum performance.

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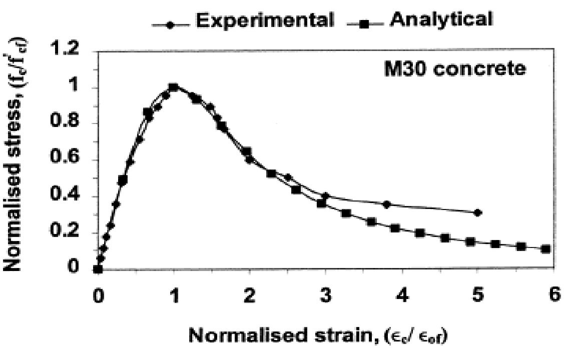

Figure 3.2:Eexperimaental and Analytical graph of stress and strain

Load capacity	**Load(N)**	**Max principal Stress**	**Yield Strength(MPa)**	**F.O.S**
50N	5	4.73	250	52

TABLE : *RESULT OF LOAD CELL*

2. Conclusion

Concrete structures are suffering from stress, strain and deformation due to overloading on the beam and column. With the help of electronic system these parameters can be recorded. In proposed system we are suggesting stain gauge as sensor for measuring of deformation. By comparing the readings overstress can be detected. This will help in detection and prevention of failure of concrete structure.

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