STRCTURAL DAMAGE DETECTION USING IoT

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Introduction:

Structural damage detection (SDD) is the evaluation of structure to detect, locate and assess the damage. Each structure is often unique regarding its material, shape, and its behaviour often change due to their age, usage or environmental factors. Key structures such as bridges, power utilities, nuclear power plants and dams particularly require continuous monitoring and provide necessary maintenance in time. In construction industry maintenance should begiven utmost importance and focus. Structural Health Monitoring is the latest technique employed all over the world, especially the buildings exposed to harsh environments. Sensors are used to collect the data from the structure from which we can identify the deterioration and suggest the method to rectify. As the complexity of the structures increases therefore a efficient and cost effective method is required for this purpose.

A more effective SDD should provide monitoring results in real-time and online; immediate response can be carried out to avoid further loss and damage of the structure and detailed structural behaviour data can be used in design or study in the future. SDD is a process of proper detecting incipient damages in a structure, with the help of sensors and data acquisition systems, we can monitor, detect and estimate the residual life of the structure. Internet of Things (IoT) is the hot-topic of research. While IoT is in its peak with Communication Engineering and Information Technology, it is still in its infancy with applications to Civil Engineering structures. Structural damage detection is the evaluation of structure to detect, locate and assess the damage. SDD has become a challenging task with the increase in development and construction of structures along with the complexities involved in them. The demand for SDD has also increased due to an increase in the necessity to ensure safety of the structures as well as the human lives associated with it. Each structure is often unique regarding its material, shape, and its behaviour often changes due to their age, usage or environmental factors. Key structures such as bridges, power utilities, nuclear power plants and dams particularly require continuous monitoring and provide necessary maintenance in time.

Computer application in the construction industry is minimal. A tool to study the safety and serviceability of concrete structures is scarce. For studying the real-time behaviour of concrete structures, IoT becomes vital depicts the consents of the inhabitants and possessions that can be linked at any given time, at any place, with any person, using some network plus some broadband utility. The Ambient Intelligence, insidious computing and omnipresent computing concepts are basically adopted in the IoT.

Objectives:

1. To identify and quantify structural damage using an accelerometer that employs raw vibration signals from the structure.
2. To make real time, online monitoring structural damage detection.
3. To make a cost effective Structural Damage Detection (SDD) system and to utilize in day to day infrastructure and modern housing.
4. To give a measure of the quality of the structural element.

Methodology:

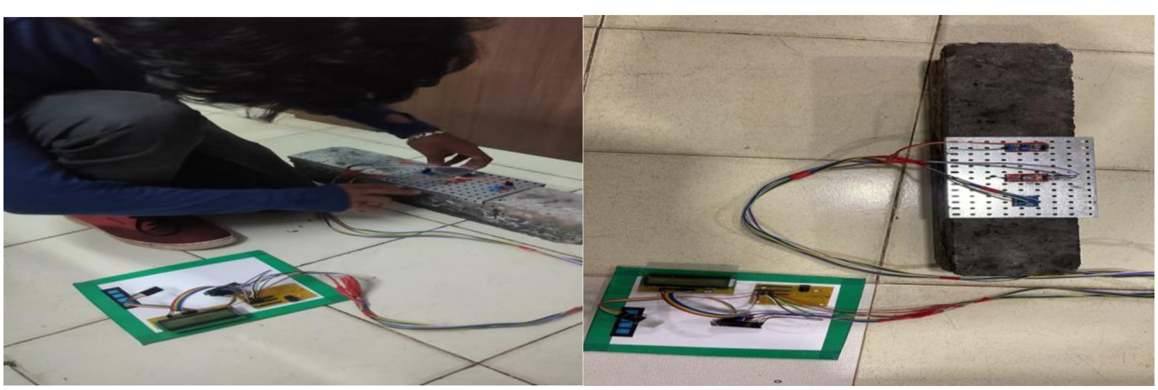
1. We are using a sensing module which mainly detects the vibration in the structure and then the data will be transmitted to the Arduino.
2. When the sensor is placed in the structure, it detects the vibration and sends the information to the arduino. Arduino is programmed in such a way that if the vibration is more than the preset value it alerts the user.

Software:

The Arduino IDE(integrated development environment) provides platform to write This code is uploaded to the Arduino uno board which is physical board. Both the software package and the board are referred to as “Arduino”.

Results:

Below figures show the testing of the beam



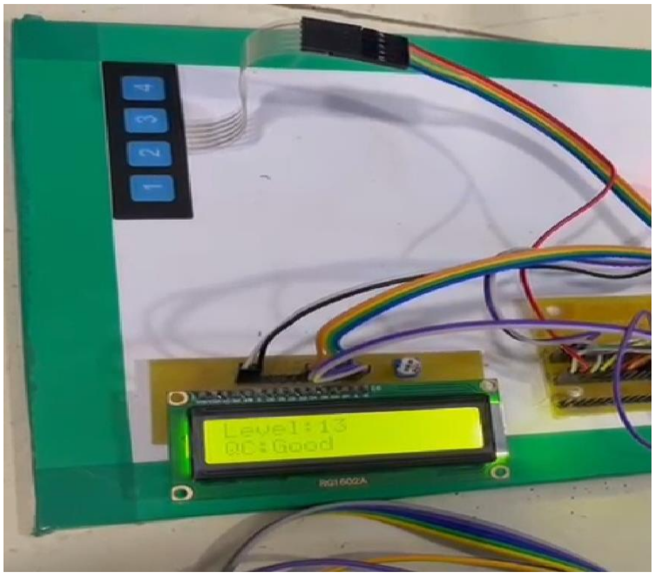


Figure depicts the result given by the apparatus

TABLE: Quality Of The Beam Based On The Value Obtained In The Apparatus

Quality of the beam	Range of analog value turned into digital value
0-20	Good
21-30	Moderate
>30	Damaged

The values given here have no standard unit. These units were found by the trial and error simultaneously done by us. These values are digital values obtained in the apparatus display which are actually the electrical impulses sensed by the vibration sensor,which is then converted to analog value by the microcontroller and again converted into digital value for better understanding.

It was noticed that the values mentioned here were in accordance with the quality of the beam that was being tested in the trial-and-error experiments,hence these values were given as the range forthe beam quality.

In this test, we have tested two beams, out of which, one if the beam is perfectly fine, and reinforced with 6mm dia steel bars along with 3 stirrups of 6mm dia steel.Let this beam be beam 1. The other beam is a beam without any reinforcements, along with internal faults induced by hitting. Let this beam be beam 2. These are the values that we obtained:

TABLE 1. Test values of Beam 1.

SI NO.	Face of the beam	Value obtained	Pemissible Limits	OUTPUT obtained on screen
1	Top	15	10-22	GOOD
2	Bottom	17	10-22	GOOD

3	Side	20	15-25	GOOD

Table 2. Test values of Beam 2.

SI NO.	Face of the beam	Value obtained	Permissible limits	OUTPUT obtained on screen
1	Top	28	30	Moderate
2	Bottom	32	30	Damaged
3	Side	35	30	Damaged

Another feature that makes our project complete is the getting of output on our mobiles. We can connect to the apparatus using Bluetooth, through which the output can be read using ThinkSpeak app.

Conclusion:

1. Adequate results have been obtained as per the actual quality if the beam, the values obtained while conducting the tests on both the beams were in accordance with the quality of the beam.
2. We can also get an output on our phones,which fulfills online monitoring needs.
3. This model turns out to be very economical and cost effective,compared to all the other present day technologies involving structural damage detection.
4. The quality of the beam can overall be assessed easily.

Scope for Future Work

1. More number of sensors can be added and the apparatus size can be increased in order to get a better output in structures of larger sizes.
2. More of the parameters determining the quality of a structural element can be studied according for quality detection, and the necessary sensors can also be implemented in the apparatus.
3. More advancements are needed in order to separate the damage caused by the environmental factors from the actual physical damages.
4. More scope exists in structures that vibrate continuously due to ever acting loads, eg. bridges. Hence, by proper studies, adequate apparatus can be applied to monitor any sudden complications.