Chapter 5

Deflection measurement of beam

5.1 General

In this chapter, the deflection has been calculated using sensor and it has been verified with the reading of dial gauge as well as it has been theoretically verified. Deflection is another important parameter of beam. When a beam is subjected to load, the beam deflects from its original shape. In other words, it is a distance or an angle to which the beam is displaced. It is often caused by internal loading such as bending moment and axial force.

5.2 Measurement of deflection using sensors

Deflection can be measured through accelerometer sensor by using the value of angle. Once an angle or slope is known at the particular point of beam, it can be used to calculate the deflection in the beam.

Another simple sensor for measuring the deflection of beam is ultrasonic sensor. This sensor is used to measure the distance of object by using the properties of wave. In our approach ultrasonic sensor was used to find the deflection of beam.

Case study

A simply supported steel beam of dimension (70*2.5*0.3 cm) was instrument with ultrasonic sensor at the midpoint of beam, and the sensor was fixed below the midpoint of the beam on the board. The dial gauge was set up from the top of the beam at its midpoint. In order to avoid the obstruction between bottom of beam and sensor, the two hangers were placed at a distance of 20cm from left support and right support respectively. The dial gauge was set to zero. Before applying the two point load on beam using two hangers, the initial output of ultrasonic sensors was recorded and it was verified using scale. Initially the distance shown by sensor was 17 cm which means the distance between the sensor and bottom of the beam is 17 cm. Firstly, 0.502 kg and 0.503 kg weight were applied on two hangers at 20 cm from left and right support respectively The output value of sensor and dial gauge readings were recorded. To increase the deflection in the beam the two weight were increased to 1.503 kg and the reading of dial gauge and the output of sensor was recorded.

Further, the two-point loads were increased to 2.470 kg and again the reading of dial gauge and output of sensor were recorded.

It was seen that, once the deflection of beam crossed or equal to 1cm the output of sensor was decreased from 17cm to 16cm.

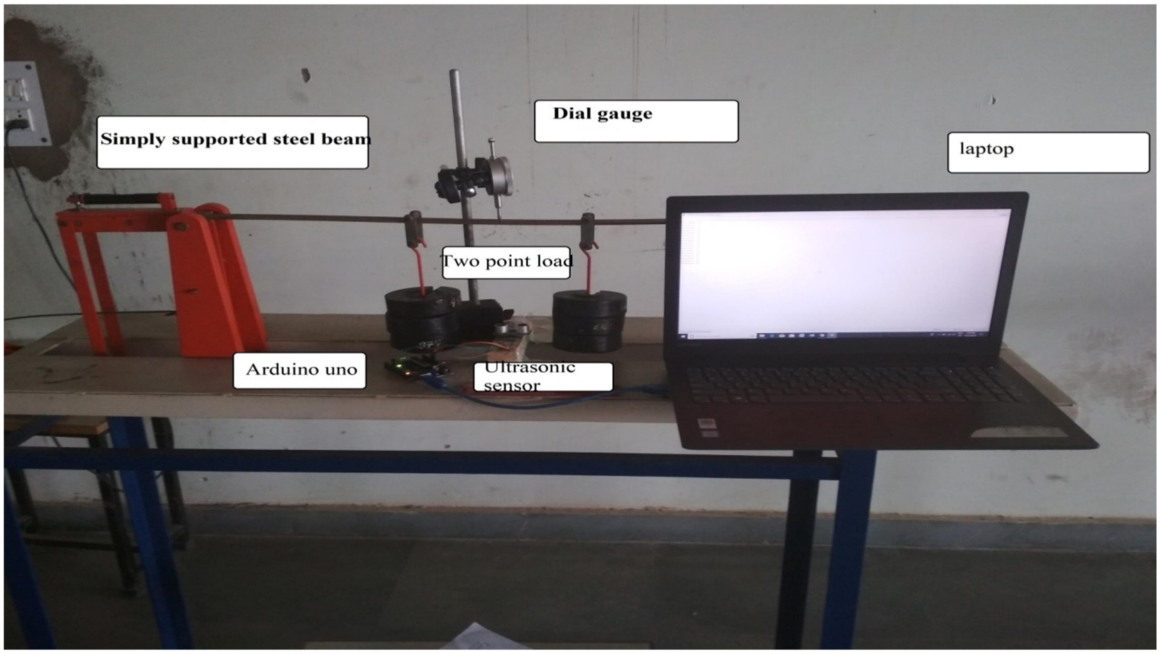


Figure 5.1 Experimental setup for deflection measurement

Table 5.1 Compare of deflection value of ultrasonic sensor and dial gauge reading for steel beam under two same point load

S.no	Load (Kg)		Sensor (Initial output in cm)	Sensor (Final output in cm)	Deflection value by sensor in cm	Dial gauge reading In cm
	P1	P2				
1	**0**	**0**	**17**	**17**	**0**	**0**
2	**0.502**	**0.502**	**17**	**17**	**0**	**0.48**
3	**1.503**	**1.503**	**17**	**16**	**1**	**1.45**
4	**2.470**	**2.470**	**17**	**15**	**2**	**2.40**

5.3 Theoretical calculation of beam deflection

For theoretical calculation of deflection of steel beam, following are the dimensions and properties of beam-

Width of beam = 2.5cm

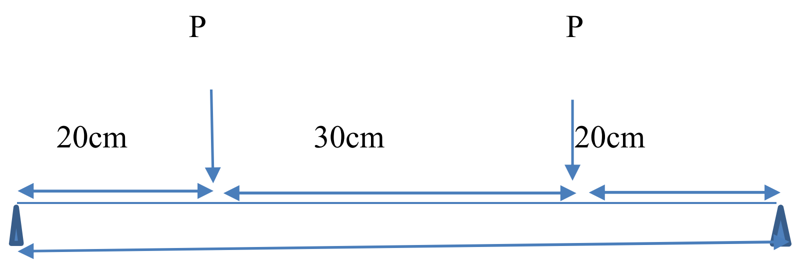
Depth of beam =0.3cm

Span length = 70cm

Young modulus of steel = 2*10^6 kg/cm^2

Moment of inertia = BD^3/12

I = (2.5*0.3^3)/12 = 5.625*10^-3cm^4



$\sum$ Fy = 0,

Ra + Rb = 2P

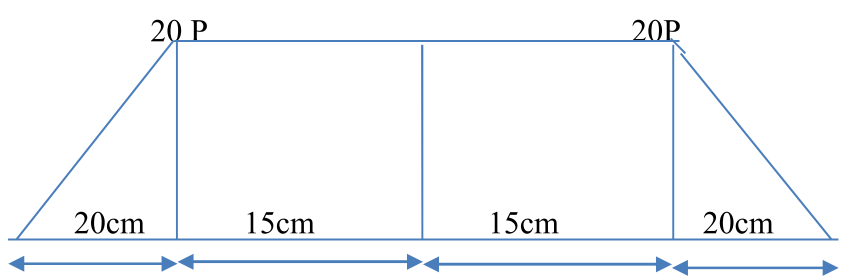
Taking moment about support b

Ra *70 = P*50 + P*20

Ra = P

Rb = P

BMD



Deflection at mid- point (35cm from left support)

$$\Delta mid = .5*20*20P*2*20/3EI$$

$$\Delta mid = 0.9703\ P$$

Table 5.2 Comparison of theoretical value of deflection with the value obtained from Ultrasonic sensor

S.no	Load (Kg) P	Theoretical deflection value in cm $\Delta mid = 0.9703\ P$	Sensor value in cm
1	**0**	**0**	**0**
2	**0.502**	**0.46**	**0**
3	**1.503**	**1.38**	**1**
4	**2.470**	**2.28**	**2**

Result

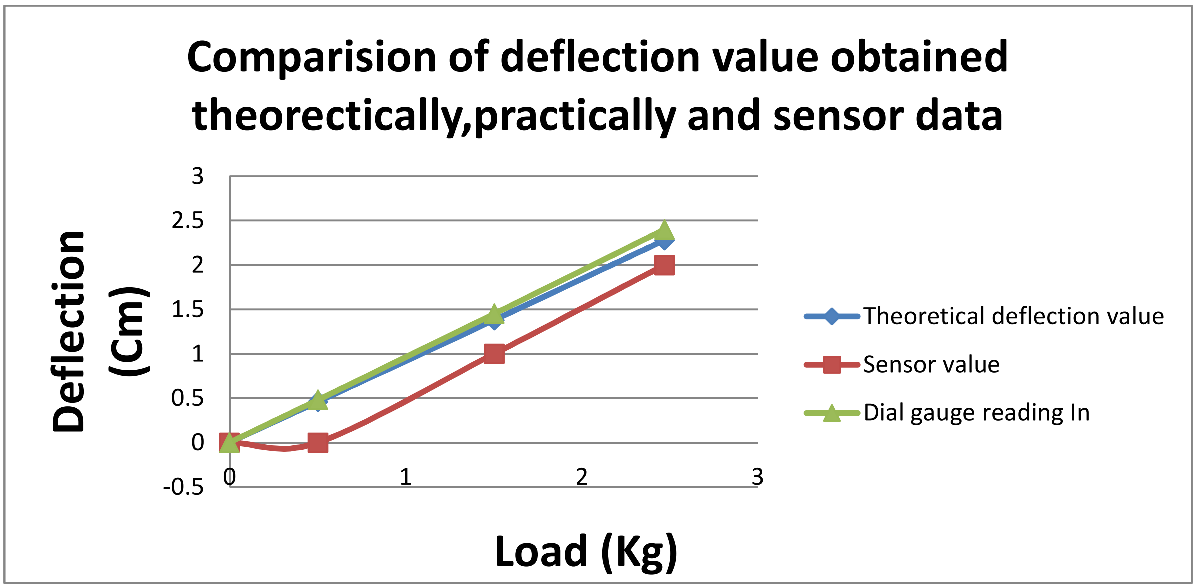


Figure 5.2 Graph showing linear response of deflection with load

The value of deflection obtained from sensor was verified with the dial gauge reading as well as theoretically. The graph have been plotted which shows the linear response between deflection and load. However, there were some instrument error in dial gauge which could be the possible reason for not matching the exact deflection value with those obtained from sensor