Avery Weigh-Tronix

The Weigh Bar® Principle of Operation

The Weigh Bar® designed to overcome the shortcomings of the load cell and to provide the user with a rugged, highly reliable and linear load sensing device at reasonable cost. More than twenty years of extensive use in industrial, farm and transportation applications has demonstrated that the Weigh Bar has met these requirements. The unique patented principle of the Weigh Bar is the primary reason for this success. The costly problems of temperature compensation and sensitivity to extraneous loads associated with the load cell have been eliminated. Also the unreliable so-called hermetic seal in the load cell has been virtually eliminated in the Weigh Bar. The fully potted Weigh-Tronix Weigh Bar has Factory Mutual approval for installation in hazardous environments.

To fully understand the above claims, it is necessary to know how the Weigh Bar works. While there is more than one configuration of the Weigh Bar, we will use the cantilevered beam-type Weigh Bar to demonstrate its principles of operation.

WEIGH BAR PRINCIPLE OF OPERATION

By using a round cantilevered beam as a Weigh Bar, we can demonstrate the first principle, the elimination of the moment arm in weighing or force measurement.

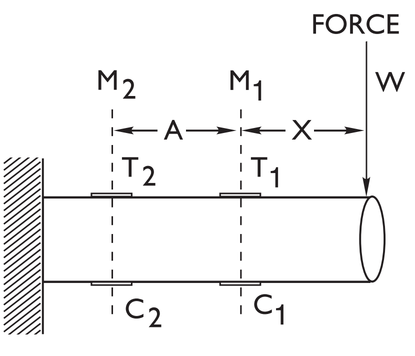

FIGURE 1

Four strain gauges are applied to the Weigh Bar as noted by C_1, C_2, T_1 and T_2 in the above diagram. (This principle could be demonstrated with either the two T gauges or the two C gauges; however, four gauges are used in our Weigh Bar design to obtain an amplification factor and simplify the electronics that connect to the Weigh Bar. Four gauges permit us to build a complete balanced Wheatstone bridge.) If you consider, say, the top set of gauges and measure the strain at the T_1 position, then you have a relationship of the strain to the bending moment due to the applied load at that point. This moment, M_1 is equal to WX. If we do the same thing at the T_2 position, we have $M_2 = W (A + X)$ or $M_2 = WX + WA$. Now, if we subtract M_1 from M_2, we have $M_2 - M_1 = WA$. The quantities drop out since one assumes a negative sign when you subtract. By subtracting moments (which we physically do electrically) you are left with the WA quantity where A is a fixed or know distance established at the factory. The A dimension represents an amplification factor on W and it is allowed for in the overall electronic amplification. The benefits of subtracting moments are very important; also, the benefit of using a beam to measure loads is important. The benefits of subtracting moments are:

1) The Weigh Bar is insensitive to end loading (See Figure 2).
2) The Weigh Bar is insensitive to torsion loads (See Figure 3)
3) The Weigh Bar is not affected by moment arm variations (variation in "X") as shown above.

The benefits of using a beam to measure loading are:

1) The Weigh Bar is insensitive to side loading (See Figure 4)
2.) More deflection results in the Weigh Bar than in a load cell for a given applied load. This allows us to incorporate mechanical stops in an application where overloads occur whether they be due to shock or just plain overloading.

As a result of the above benefits, the Weigh Bar is a load-sensing device that is insensitive to all loading except the load that is applied in the desired direction. It is a linear device that does not require additional mechanical protection—such as check links or stay rods. It is a highly rugged device and is capable of operation in extremely severe environments.

End loading effect

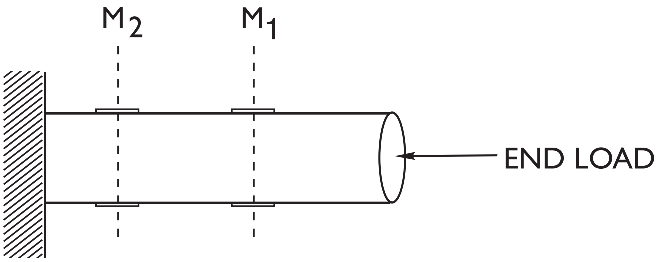

FIGURE 2

When an end load is applied to the Weigh Bar, the Weigh Bar is subjected to a uniform compressive strain throughout its length. Since the gauges at M_1 and M_2 see the same strain and since we are subtracting what the gauges at M_1 are doing from what the gauges at M_2 are doing, the net result electrically is zero.

Side loading effect

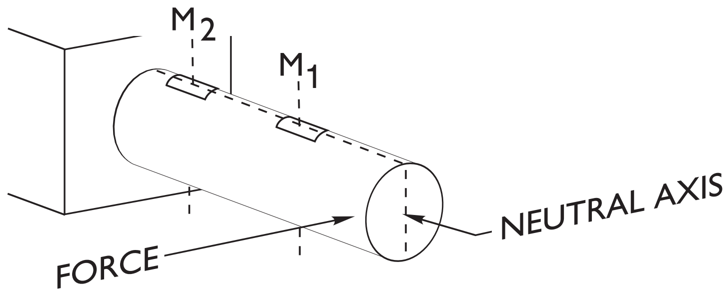

FIGURE 4

When a side load is applied to the Weigh Bar, it acts as a beam, but at a 90-degree angle. When this occurs, the neutral axis of the beam (the point in the beam where neither tension or compression occur) falls directly under the center of the strain gauges. No apparent strain is seen by the gauges—resulting in a zero output from the side load.

Torsion effect

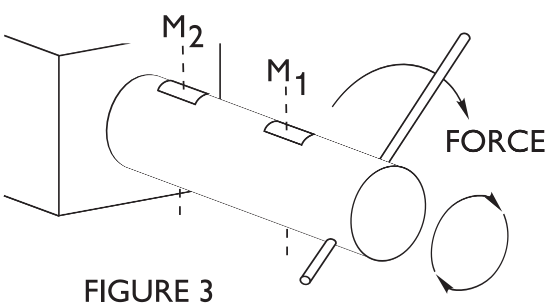

FIGURE 3

When torque is applied to the Weigh Bar, a uniform torsional shear strain is developed through the length of the bar. Since the gauges at M_1 and M_2 see the same strain and since we are subtracting what the gauges at M_1 are doing from what the gauges as M_2 are doing, the net result electrically is zero.

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