Shock Loading

⚠ CAUTION

CALCULATIONS ARE PROVIDED AS GUIDELINES ONLY. THEY SHOULD NOT REPLACE A STRUCTURAL ENGINEERING EVALUATION OF THE APPLICATION BY A REGISTERED PROFESSIONAL ENGINEER WHO IS FAMILIAR WITH LOCAL BUILDING CODES.

Shock loading can affect a scale's design, especially for conveyor applications or floor scale conversions. It is caused by an abrupt change in the weight placed on a scale, for example, when an object is dropped on the scale. If shock forces are strong enough, you will need to install higher capacity load cells. To estimate a shock force, you must know the weight of the object being dropped, the vertical distance it is dropped, and the empty weight of the scale structure. You must also know the spring rate of the nominal load cell capacity. The spring rate constant for a load cell is its rated capacity divided by load cell deflection at rated capacity. For crane loading applications, you need to know the crane's rate of descent.

Determine the nominal load cell capacity by multiplying the scale's gross capacity by 1.25 and then dividing by the number of supports. Then use one of the following equations to estimate the shock forces caused by dropped or lowered weights.

Equation for Dropped Weight:

$$F = W1 * \left(1 + \sqrt{\frac{(1 + 2 * H) * K}{W1 + W2}} \right) + W2$$

Equation for Lowered Weight:

$$F = W1 * \left(1 + \sqrt{\frac{(1 + V^2) * K}{(W1 + W2) * G}} \right) + W2$$

Where:

- F = Shock Force (pounds)
- $W1$ = Weight being Dropped or Lowered (pounds)
- $W2$ = Dead Weight of Platform (pounds)
- K = Spring Rate of Load Cells (pounds/inch), see Table 4-2
- V = Velocity at which Object is Lowered (inches/second)
- G = Gravity (384 inches/second^2)
- H = Height from which Object is Dropped (inches)

Load Cell Capacity	Spring Rate (K)
250 lb	17,857
500 lb	50,000
1,250 lb	125,000
2,500 lb	250,000
5,000 lb	416,667
10,000 lb	833,333
20,000 lb	555,556
30,000 lb	833,333
45,000 lb	692,308
75,000 lb	1,500,000
100,000 lb	3,333,333
200,000 lb	6,666,666

Table 4-2: Nominal Spring Rates for METTLER TOLEDO Load Cells

Once you have calculated the shock force for a scale, determine how that force will be distributed over the load cells. If an object is dropped in the center of a four-module scale platform, the shock force will probably affect all four load cells equally. If it is dropped on one side of the platform, the shock force could be concentrated on two load cells. Divide the shock force by the number of load cells it will be concentrated on to estimate the shock loading per load cell. Then compare that shock load with the allowable download ratings per weigh module listed in Appendix 5. If the shock loading is too large for the nominal load cell capacity, you will need to use higher capacity weigh modules.

Instead of increasing weigh module capacities, you might consider one of the following ways to reduce the shock loading:

- Place objects onto the scale without dropping them.
- Add mass to the scale platform.
- Use a shock-absorbing material such as (1) Fabreeka® pads, (2) coil springs, (3) railroad ties, or (4) build a sandbox (foundry).

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Vibration

If a scale vibrates constantly, it might not come to rest long enough to capture an accurate weight reading. METTLER TOLEDO indicators have built-in filtering systems that can eliminate most of the effects of vibration. When installing a weigh module system, you should take steps to reduce any external or internal vibration that the indicator cannot eliminate.

External Vibration: A scale can be affected by vibration from its foundation or from the surrounding environment. We recommend finding the source of the vibration and correcting it to eliminate its effect on the scale. Cutting the floor slab or separating the scale support frame from surrounding structures can also prevent external vibration from affecting a scale's stability.

Internal Vibration: Vibrations produced inside a tank are normally caused by sloshing liquid or agitation. In large tanks, sloshing can produce low-frequency vibrations that are difficult to eliminate at the scale indicator. You can reduce sloshing by installing baffles in a tank. If an agitator and its drive motor are permanently attached to a scale, you might need to incorporate isolation pads (such as Fabreeka®, available from METTLER TOLEDO) in the mounting of the weigh modules to minimize the internal vibration. To improve weighing accuracy, make sure the agitator is stopped while weight readings are taken.

It is difficult to analyze the effects of vibration that is caused by wind. If high accuracy is required, we recommend shielding the scale from wind. Any time a tank is located outdoors, it should be designed to minimize vertical forces resulting from wind.

