Mechanics Corner

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Corrections To
Mass On Multiple Spring Supports

1 Correction

The previous post, #48 titled Mass On Multiple Spring Supports had several typographical errors. Strangely, they are all in the brief introductory example regarding the loads on the four legs of a table, at least these are the only ones that have been called to my attention. As many of you know, I am older than dirt, and my typing skill is degrading; this leads to errors at times. I apologize for misleading anyone. Fortunately, one reader notified me that there were errors.

The introductory example dealt with a simple table on four legs, something such as shown here in Figure 1. No figure was given with the previous discussion, so that may be a part of the difficulty in understanding the problem.

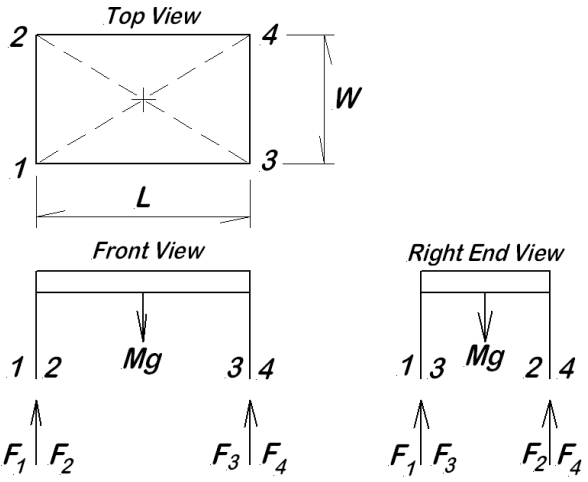

Figure 1: Three Views of a Table On Four Legs

The table top is a uniform rectangle, $L \times W$ (note that capital letters are used here where lower case were used previously), with total weight Mg. The weight acts at the center of mass which is located at the centroid of the table top. The floor supporting the table is level, and all four legs are of equal length. The problem is to determine the load in each of the legs.

The four legs are numbered 1, 2, 3, and 4, with 1 and 2 at the left end while 3 and 4 are at the right end. Corners 1 and 3 are at the front of the table, while 2 and 4 are at the rear.

The leg forces are numbered in the same way the legs are numbered, so that F_1 is the force in leg number 1 and so forth.

There are no horizontal forces acting. When we apply the equations of statics, we get

$$\sum F_{Vert} = F_1 + F_2 + F_3 + F_4 - Mg = 0$$

$$\sum M_{FrontEdge} = W\left(F_2 + F_4\right) - \frac{W}{2}Mg = 0$$

$$\sum M_{LeftEnd} = L\left(F_3 + F_4\right) - \frac{L}{2}Mg = 0$$

where

L = length of the table along the front edge

W = width of the table front to back.

We have only three equations of statics (shown above) and four variables to be determined (F_1, F_2, F_3, F_4). The problem is *statically indeterminate*. We might be tempted to write additional moment equations, but they will simply be linear combinations of the two equations we already have; there are no additional independent equations available.

While the load analysis of table legs is rarely a serious engineering problem, static indeterminacy is an everyday occurrence. How can we deal with it? The modern answer is "make an FEA model to solve the problem." Is this not using a sledge hammer to swat a fly? And yet, that answer alludes to the fundamental problem. Statically indeterminate systems can only be solved by considering the deflections involved. But here we encounter trouble because we assumed all the parts were rigid. This assumption is incompatible with reality, and prevents a solution.

2 Conclusion

While I hope that this corrects all of the errors, there is always the possibility that some remain. Please notify me (via a Comment or by an Internal Message) if you find others. The main point of the post, the mass supported on multiple springs, remains valid.