

WORKSHEET 4

LOADS AND REACTIONS

**An introduction to the relationship
between load and reactions using the
Push Me Pull Me models on Expedition
Workshed**



INTRODUCTION

When a load is applied to a structure, reactions arise at the supports to keep the structure in equilibrium.

Practically, we need to know the type, magnitude and direction of the reactions in order to evaluate the suitability of our supports or foundations.

STATICS: LOADS AND REACTIONS

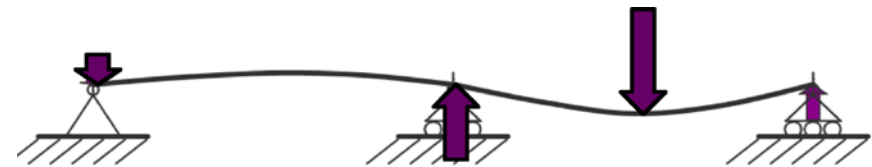
For simple isostatic structures, the reactions can be evaluated by solving the equilibrium equations simultaneously (Fig. 1). For hyperstatic structures, the equilibrium equations are solved again but this time kinematic compatibility is also considered.

Even though the evaluation of the reactions requires mathematical manipulation, it is very helpful if one can estimate the direction and magnitude of the reaction forces and moments.

Quiz: Why is it important to evaluate the reactions of a loaded structure?



Fig. 1. The 2D equilibrium equations necessary to find the reactions of an (isostatic) simply supported beam.



$$\begin{aligned}\sum F_x &= 0 \\ \sum F_y &= 0 \\ \sum M &= 0\end{aligned} \quad + \quad \text{Compatibility, e.g. } \Delta_y (LHS) = 0$$

Fig. 2. The equations necessary to find the reactions of a (hyperstatic) continuous beam.

CANTILEVER EXAMPLE

A cantilever is the simplest single-support isostatic structure.

Find the cantilever on the Expedition Workshed website:

WORKSHED > MODELS > MPM > CANTILEVER BEAM

In order to maintain equilibrium, when a downward load is applied at the right-hand side it is balanced by an equal and opposite reaction force at the support on the left-hand side. Furthermore, a reaction moment is also necessary to balance the couple of the point load and the reaction force as can be seen in Fig. 4.

Another way to work out the direction of the reaction force, the sense of the reaction force and the sense of the reaction moment is to look at the deflected shape. Considering that the left-hand side does not deflect downwards nor does it rotate clockwise, it can be deduced that the resistance is provided by an upward reaction force and an anticlockwise reaction moment.

Quiz: Why isn't there a horizontal reaction at the left-hand support?



Fig. 3. Cantilever Push Me Pull Me model on Expedition Workshed.

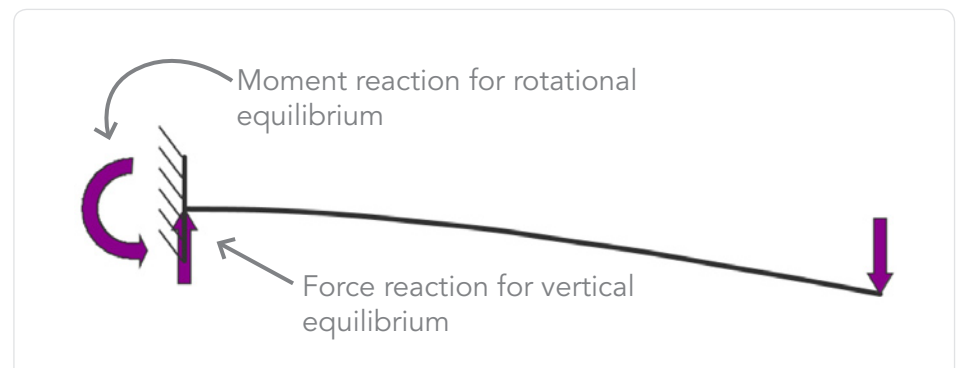
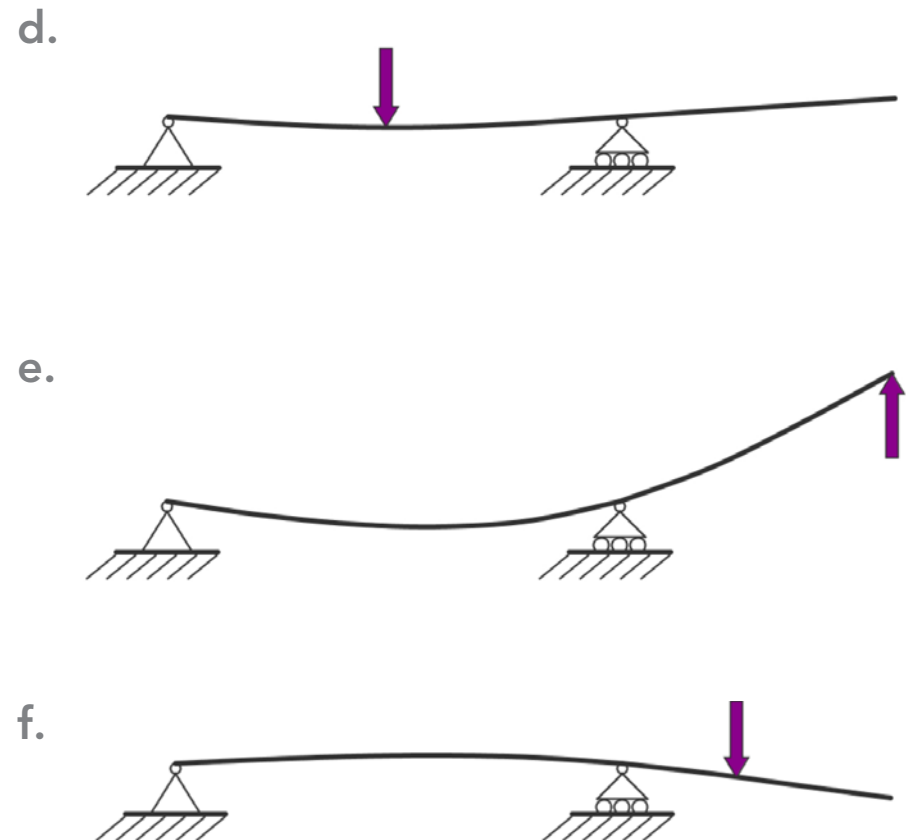
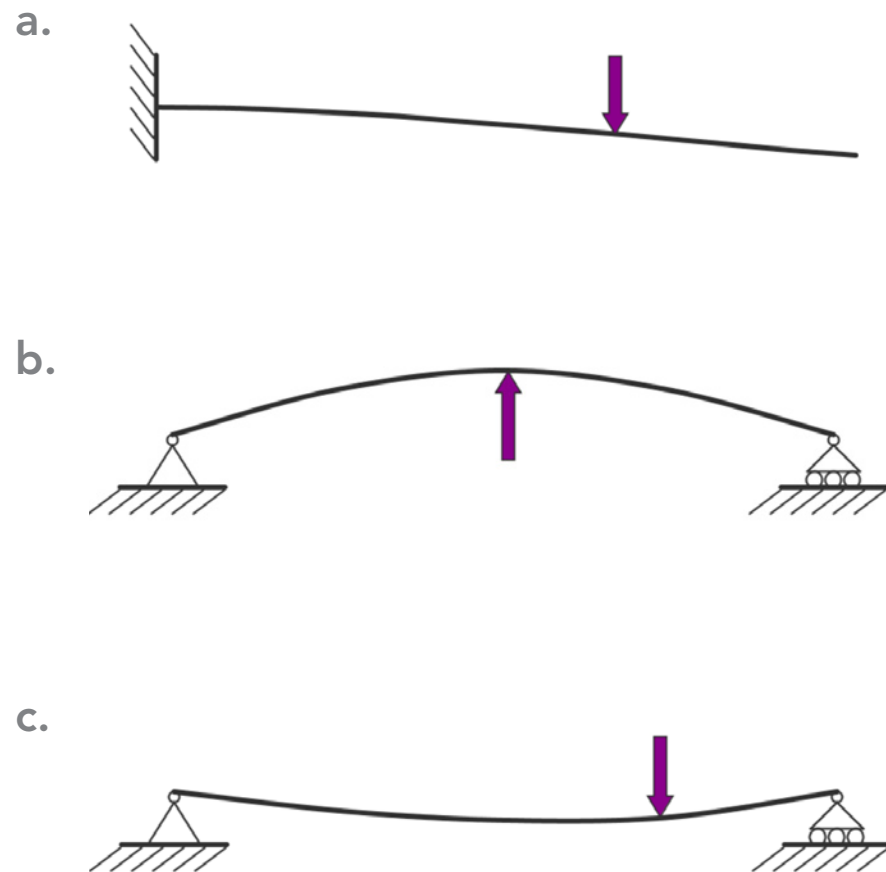


Fig. 4. Deflected shape of the cantilever model when a load is applied at the right hand end.

QUESTION TIME

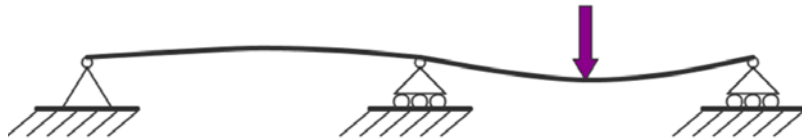
1. For each of the structural diagrams below can you work out the direction of the support reactions when a load is applied as shown by the purple arrow?

Use the Push Me Pull Me models to verify your answers.

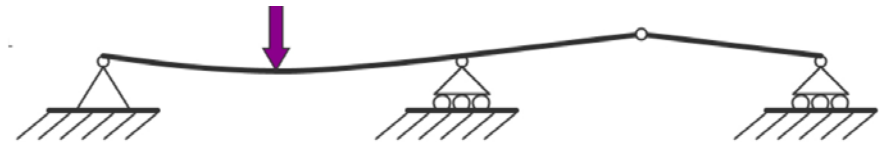


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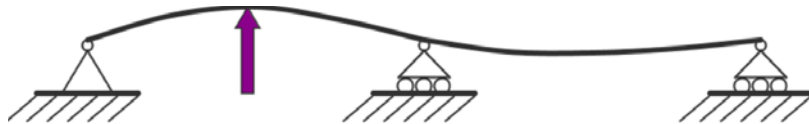
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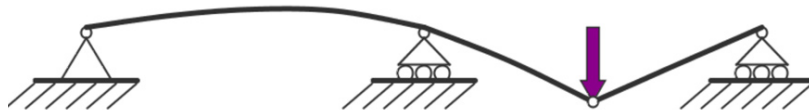
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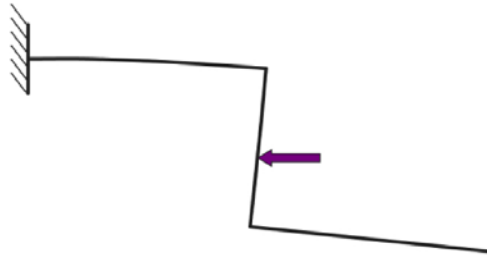


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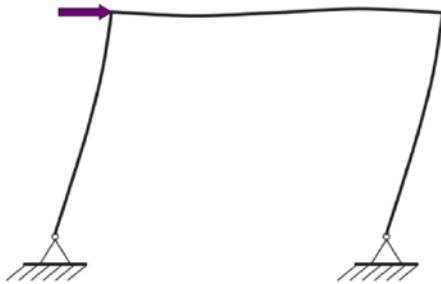
2. Continue on, but this time for frames.

Keep using the Push Me Pull Me models to check your answers.

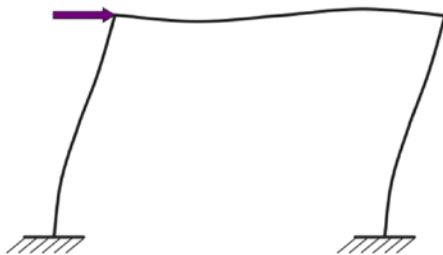
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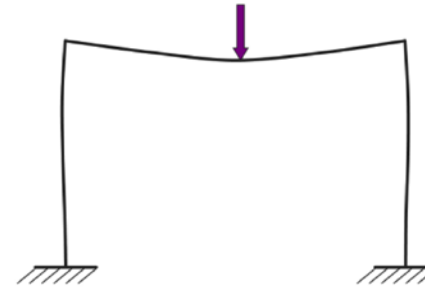
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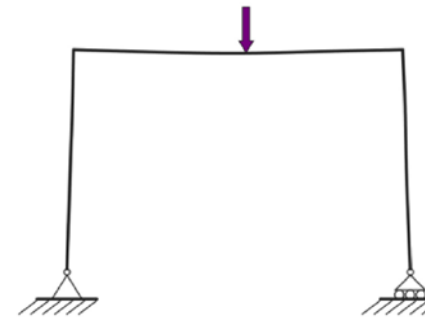
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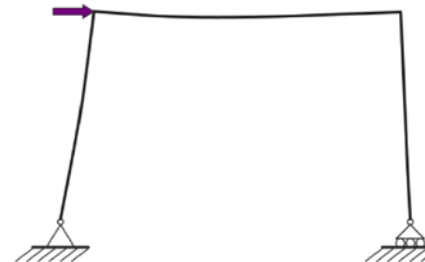
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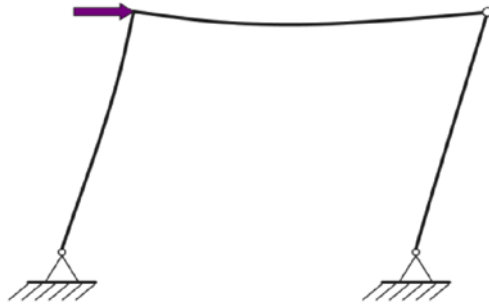


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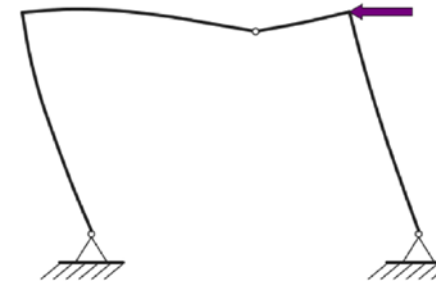


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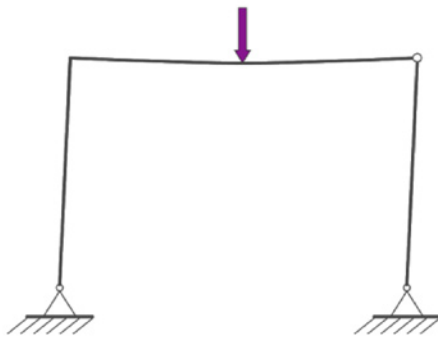
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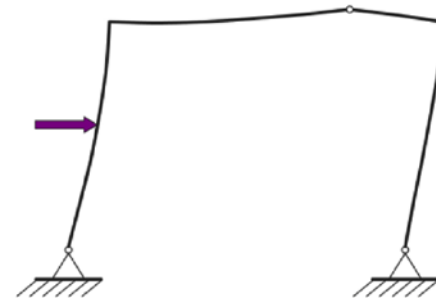
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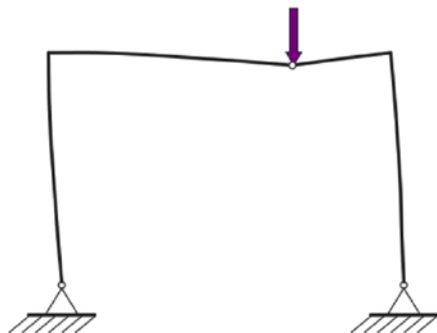
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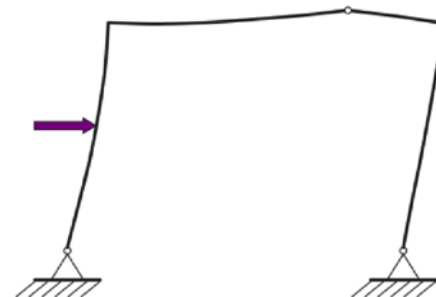
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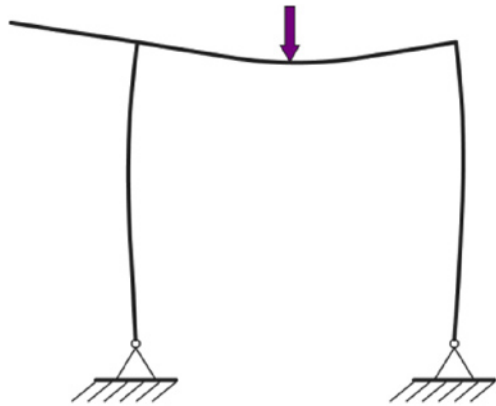


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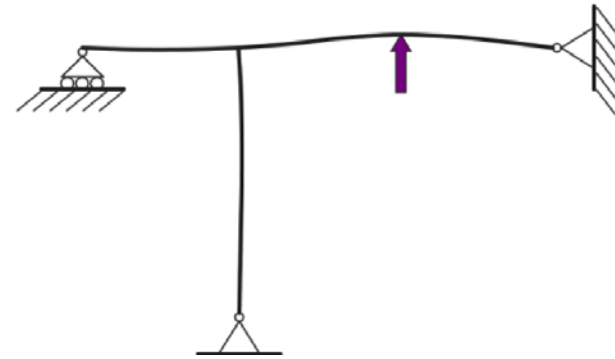


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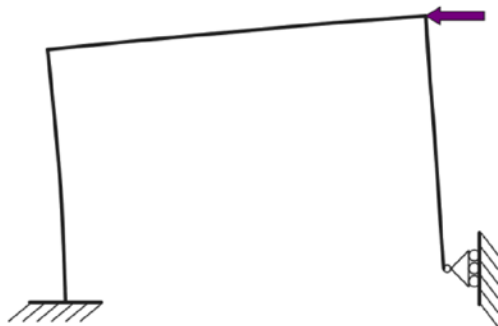
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