3D Axes Model (to Aid with the Understanding of Stiffness Analysis Sign Convention)

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This model shows the sign convention adopted for stiffness analysis and the 'right-hand-rule' sign convention used for torsion.

When performing structural analysis on non-beam structures, it is necessary to use the '**joint convention**.' In this sign convention, clockwise rotations and moments are taken as positive. [1]

However, the sign convention adopted for **stiffness analysis** is slightly more complicated. It is assumed that when one is at the origin, looking out onto the positive axis, then the positive moment/rotation is clockwise. [2]

This means that for a 2D diagram, where the positive axis would be projecting outwards towards the person looking at it, it appears that the positive moment/rotation is actually anti-clockwise. This seems to contradict the joint convention and may confuse people.

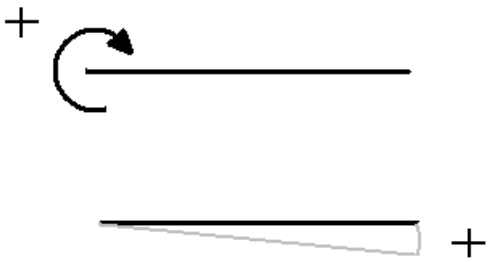

Figure 1: Joint convention

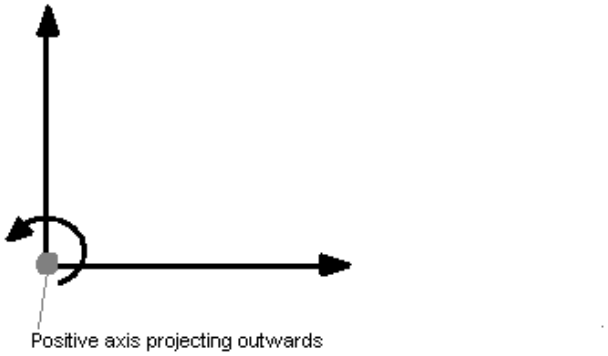

Figure 2: 2-D diagram - positive moment appears anti-clockwise

In order to explain the concept of standing at the origin looking out towards to positive axis, a diagram of a 3D set of axes is often used.

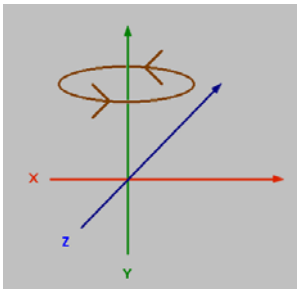

Figure 1: Source [3]

However, this is difficult to interpret and may still be confusing. It is much easier to explain this concept by using a 3D model.

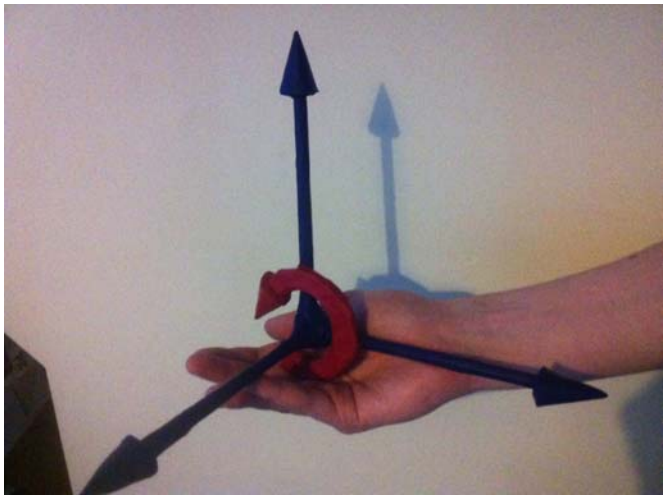

Figure 2: 3D model, front view

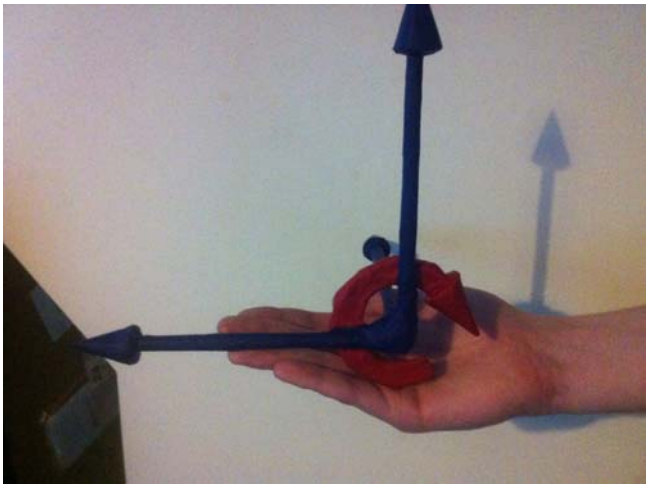

Figure 3: 3D model, view from origin

It is easily seen from the model that the positive moment appears anticlockwise when viewed from the front (from the end of the axis), but the moment is clockwise when viewed from the origin.

This model was made using pencils and paper mache.

References

[1] C. S. Reddy, Basic Structural Analysis, 2nd ed., New Delhi: Tata McGraw-Hill Publishing Company Limited, 1981.

[2] D. H. Surya Patnaik, Strength of Materials: A New Unified Theory for the 21st Century, Burlington: Elsevier, 2004. "

[3] Math Helper Library," [Online]. Available: http://junction404.com/mathhelper/eulerangle.html. [Accessed 17 2 2013].