

structmech

A TikZ command set for structural mechanics drawings

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1 Intro

structmech is a collection of several commands to draw basic elements in structural mechanics with TikZ. It can be used to draw illustrations that may be used for teaching and excising purposes. The GPL v3 license is used for this package.

2 Options

Use following command to load the package.

Syntax `\usepackage[key=val]{structmech}`

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Available options are:

1. axial: Define the axial force color. `axial=colorValue`. Any predefined color value is acceptable.
2. rotation: Define the rotation arc color. `rotation=colorValue`. Any predefined color value is acceptable.
3. node: Define the nodal force/displacement color. `node=colorValue`. Any predefined color value is acceptable.
4. fill: Define the fill patch color. `fill=colorValue`. Any predefined color value is acceptable.
5. convention: Define the sign convention. Value `convention=sign` draws all quantities along positive direction and indicate negative quantities with minus sign $-$. Value `convention=direction` label all numbers as positive but draw the negative quantities along negative directions.

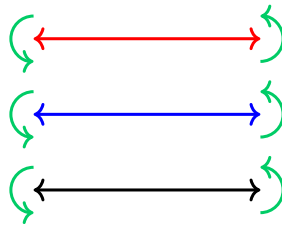
Use following command to change option values.

Syntax `\setstructmech{axial=red}`

Some examples.

Example

```
\setstructmech{axial=red}
\BasicForce{0,3}{3,3}{ }
\setstructmech{axial=blue}
\BasicForce{0,2}{3,2}{ }
\setstructmech{axial=black}
\BasicForce{0,1}{3,1}{ }
```



3 Nodal Forces/Displacements

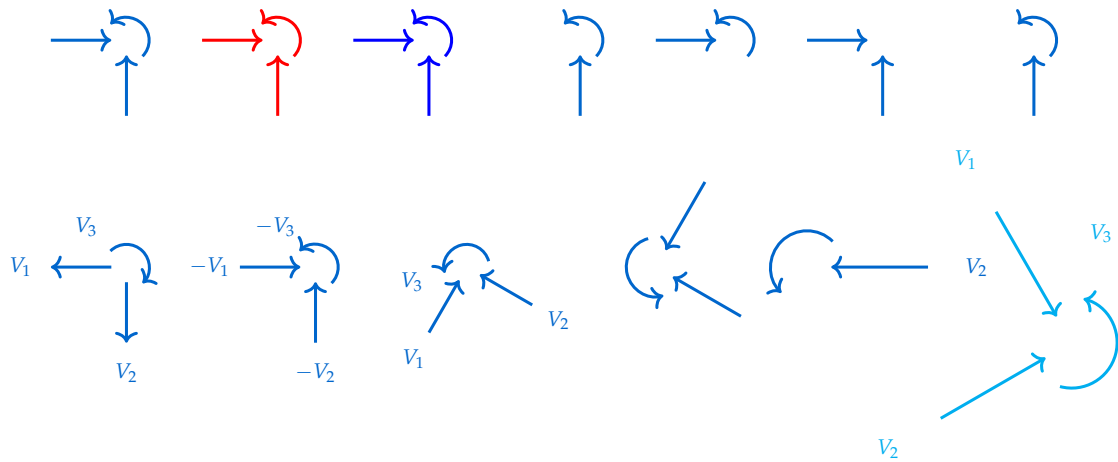
Syntax `\NodalForce[1]{2}[3][4][5]{6}[7]`

1. [1] — Color of arrows, optional. Any existing color value, either build-in (refer to xcolor) or user-defined color is acceptable. Default value is `CC0066`.
2. {2} — Node coordinates. Accept two coordinates of the target node in the form of `x,y`.
3. [3] — Label for horizontal force/displacement, optional. If not assigned or left blank, only the arrow (without label) will be drew. Assign `N` for drawing nothing along horizontal direction.
4. [4] — Label for vertical force/displacement, optional. If not assigned or left blank, only the arrow (without label) will be drew. Assign `N` for drawing nothing along vertical direction.
5. [5] — Label for rotational force/displacement, optional. If not assigned or left blank, only the arrow (without label) will be drew. Assign `N` for drawing nothing along rotational direction.
6. {6} — Rotation angle, optional. Default value is `0`.
7. [7] — Scale, optional.

```

\NodalForce{0,0}
\NodalForce[red]{2,0}
\NodalForce[blue]{4,0}{}{}
\NodalForce{6,0}[N]
\NodalForce{8,0}{}[N]
\NodalForce{10,0}{}{}[N]
\NodalForce{12,0}[N]{}
\setstructmech{convention=direction}
\NodalForce{0,-3}[-V_1][-V_2][-V_3]
\setstructmech{convention=sign}
\NodalForce{2.5,-3}[-V_1][-V_2][-V_3]
\NodalForce{4.5,-3}[V_1][V_2][V_3]{60}
\NodalForce{7,-3}{150}[1.3]
\NodalForce{9,-3}[N][V_2]{90}[1.6]
\NodalForce[cyan]{12.5,-4}[V_1][V_2][V_3]{-60}[2]

```



4 Member Forces/Displacements

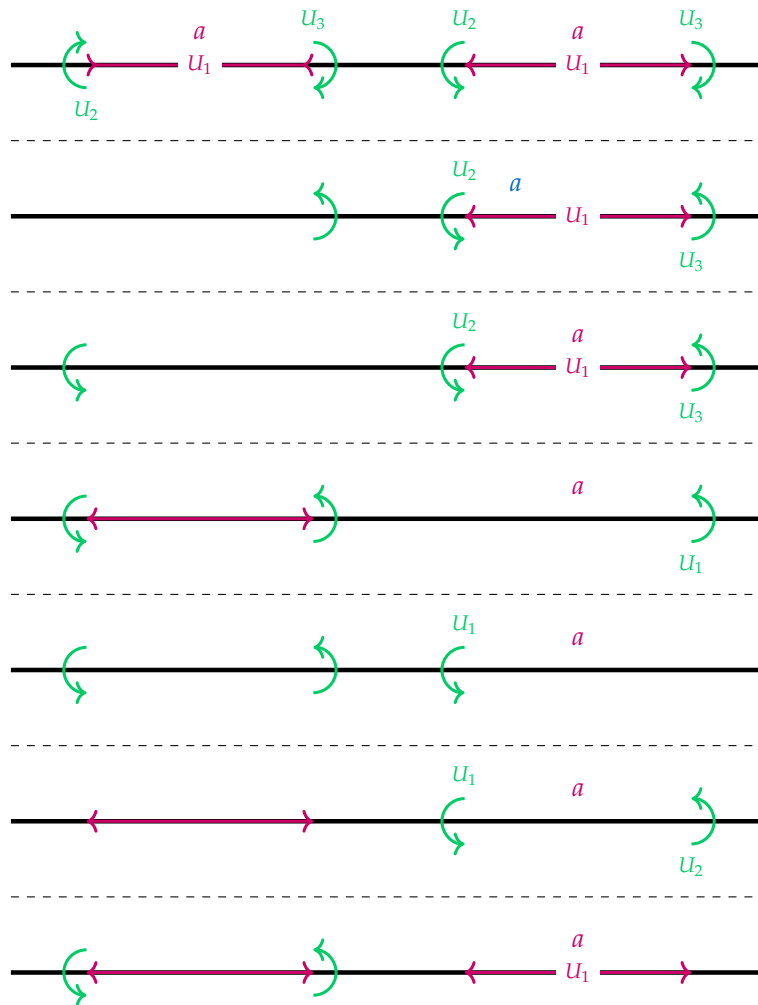
```
\BasicForce[1]{2}{3}{4}{5}[6][7][8]
```

- [1] — The number of forces to draw, optional. **1** for axial force only, **2L** for lower end bending moment only, **2H** for high end bending moment only, **2** for both two end moments, **3** for all three force components. Default value is **3**.
- {2} — The coordinate for the lower end in the form of **x,y**.
- {3} — The coordinate for the high end in the form of **x,y**.
- {4} — Label for the member, leave blank if not required.
- {5} — Further adjustment of the member label, optional, parameters used for TikZ positioning are acceptable, such as **right=2mm** or **anchor=north**. The default value is **above=2mm**, leave blank if not required.
- [6] — Label for first force drew. Available for all four values for **#1**, leave blank if not required.
- [7] — Label for second force drew. Available for **#1=2**, leave blank if not required.
- [8] — Label for third force drew. Available for **#1=3**, leave blank if not required.
- Note the color is configured in the package option.

```

\BasicForce{0,0}{3,0}{ }
\BasicForce[1]{0,2}{3,2}{ }
\BasicForce[2]{0,4}{3,4}{ }
\BasicForce[3]{0,6}{3,6}{ }
\BasicForce[2L]{0,8}{3,8}{ }
\BasicForce[2H]{0,10}{3,10}{ }
\BasicForce[1]{5,0}{8,0}{a}[U_1]
\BasicForce[2]{5,2}{8,2}{a}[U_1][U_2]
\BasicForce[2L]{5,4}{8,4}{a}[U_1]
\BasicForce[2H]{5,6}{8,6}{a}[U_1]
\BasicForce{5,8}{8,8}{a}[U_1][U_2][U_3]
\BasicForce{5,10}{8,10}{a}{above left=2mm and 6mm,0066CC}[U_1][U_2][U_3]
\setstructmech{convention=direction}
\BasicForce[3]{0,12}{3,12}{a}[-U_1][-U_2][-U_3]
\BasicForce[3]{5,12}{8,12}{a}[U_1][U_2][-U_3]
\setstructmech{convention=sign}

```



5 UDL

```
\UDL[1]{2}{3}[4]{5}
```

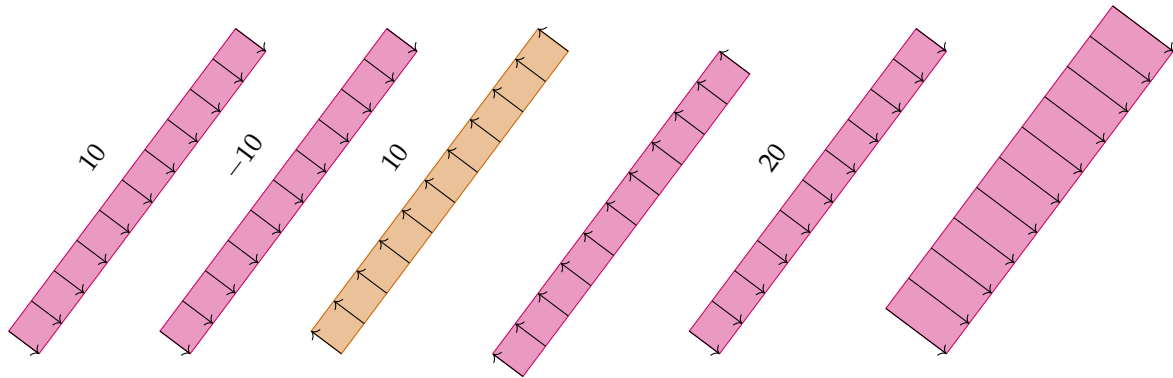
1. [1] — Flip the side **F**, optional.
2. {2} — Coordinate for lower end node, in form of **x,y**.
3. {3} — Coordinate for higher end node, in form of **x,y**.

4. [4] — Label, optional.

5. {5} — Scale, optional.

Example

```
\UDL{-4,0}{-1,4}[10]
\UDL{-2,0}{1,4}[-10]
\setstructmech{fill=CC6600,convention=direction}
\UDL{0,0}{3,4}[-10]
\setstructmech{fill=CC0066,convention=sign}
\UDL[F]{2,0}{5,4}
\UDL{5,0}{8,4}[20]
\UDL{8,0}{11,4}{2}
```



6 Supports

6.1 Hinge Support

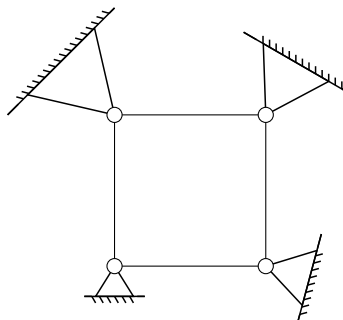
Syntax

```
\HingeSupport[1]{2}{3}
```

1. [1] — Rotation angle, optional.
2. {2} — Node coordinate, in form of x, y .
3. {3} — Scale, optional.

Example

```
\HingeSupport{0,0}
\HingeSupport[75]{2,0}{1.5}
\HingeSupport[150]{2,2}{2}
\HingeSupport[225]{0,2}{2.5}
```



6.2 Fixed Support

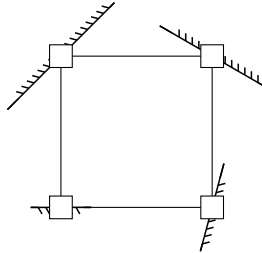
Syntax

```
\FixedSupport[1]{2}{3}
```

1. [1] — Rotation angle, optional.
2. {2} — Node coordinate, in form of x, y .
3. {3} — Scale, optional.

Example

```
\FixedSupport{0,0}
\FixedSupport[75]{2,0}{1.5}
\FixedSupport[150]{2,2}{2}
\FixedSupport[225]{0,2}{2.5}
```



6.3 Roller Support

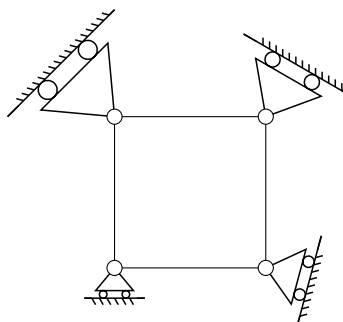
Syntax

```
\RollerSupport[1]{2}{3}
```

1. [1] — Rotation angle, optional.
2. {2} — Node coordinate, in form of x, y .
3. {3} — Scale, optional.

Example

```
\RollerSupport{0,0}
\RollerSupport[75]{2,0}{1.5}
\RollerSupport[150]{2,2}{2}
\RollerSupport[225]{0,2}{2.5}
```



6.4 Slider Support

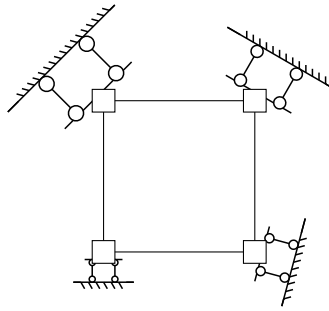
Syntax

```
\SliderSupport[1]{2}{3}
```

1. [1] — Rotation angle, optional.
2. {2} — Node coordinate, in form of x, y .
3. {3} — Scale, optional.

Example

```
\SliderSupport{0,0}
\SliderSupport[75]{2,0}{1.5}
\SliderSupport[150]{2,2}{2}
\SliderSupport[225]{0,2}{2.5}
```



6.5 Sleeve Support

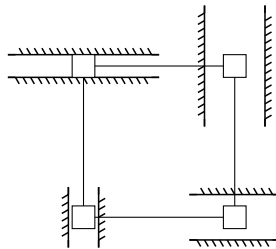
Syntax

```
\SleeveSupport[1]{2}[3]{4}
```

1. [1] — Rotation angle, optional.
2. {2} — Node coordinate, in form of x, y .
3. [3] — Gap width, optional.
4. {4} — Scale, optional.

Example

```
\SleeveSupport{0,0}
\SleeveSupport[75]{2,0}{1.5}
\SleeveSupport[150]{2,2}{2}
\SleeveSupport[225]{0,2}[.12]{2.5}
```



6.6 Rigid Constraint

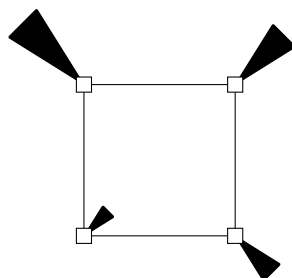
Syntax

```
\Rigid[1]{2}{3}
```

1. [1] — Rotation angle, optional.
2. {2} — Node coordinate, in form of x, y .
3. {3} — Scale, optional.

Example

```
\Rigid{0,0}
\Rigid[-90]{2,0}{1.5}
\Rigid[0]{2,2}{2}
\Rigid[90]{0,2}{2.5}
```



7 Coordinate System Frame

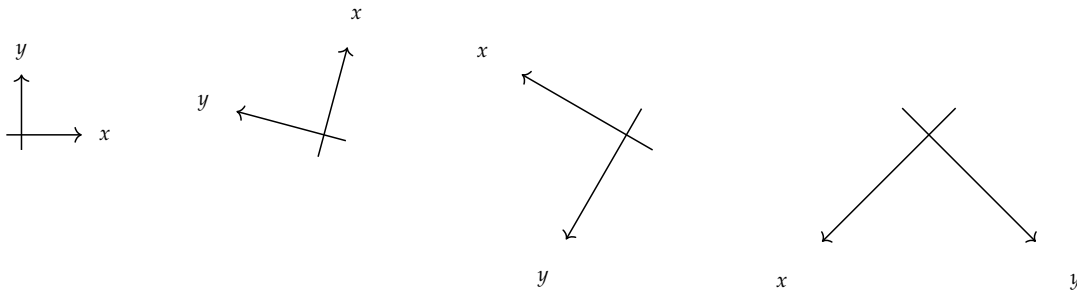
Syntax

```
\CoordOrigin[1]{2}{3}
```

1. [1] — Rotation angle, optional.
2. {2} — Node coordinate, in form of x, y .
3. {3} — Scale, optional.

Example

```
\CoordOrigin{0,0}
\CoordOrigin[75]{4,0}{1.5}
\CoordOrigin[150]{8,0}{2}
\CoordOrigin[225]{12,0}{2.5}
```



8 Internal Force Diagram

8.1 Linear Internal Force

Syntax

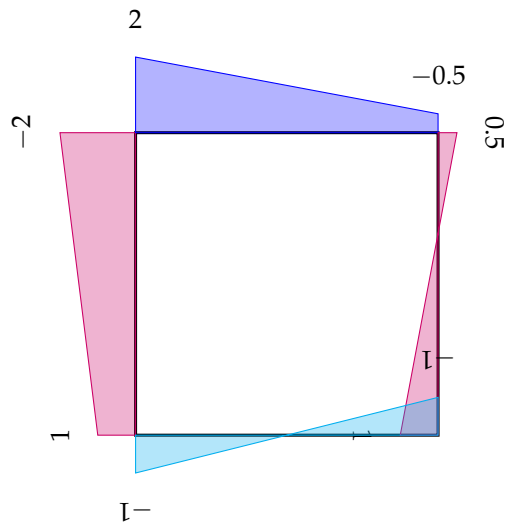
```
\IForceA[1]{2}{3}{4}{5}{6}
```

1. [1] — Fill color, optional
2. {2} — Node coordinate of lower end, in form of x, y .
3. {3} — Node coordinate of higher end, in form of x, y .
4. {4} — Bending moment value of lower end, can be negative.
5. {5} — Bending moment value of higher end, can be negative.
6. {6} — Scale, optional.

Caveat: it shall be noted that all internal forces follow the sign convention that is adopted in finite element method, instead of the one used in material mechanics. All quantities are defined in the local coordinate system, and the anticlockwise moment is taken as positive value.

Example

```
\IForceA{0,0}{0,4}{1}{-2}{0.5}
\IForceA[blue]{0,4}{4,4}{2}{-0.5}{0.5}
\IForceA{4,4}{4,0}{0.5}{1}{0.5}
\IForceA[cyan]{4,0}{0,0}{-1}{-1}{0.5}
```

8.2 Parabolic Internal Force

Syntax

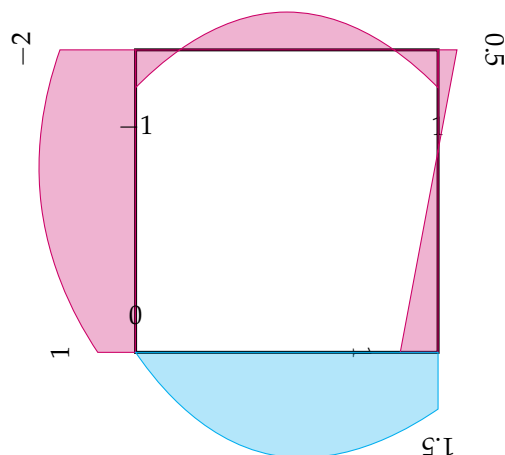
```
\IForceB[1]{2}{3}{4}{5}{6}{7}
```

1. [1] — Fill color, optional
2. {2} — Node coordinate of the lower end, in form of x, y .
3. {3} — Node coordinate of the higher end, in form of x, y .
4. {4} — Bending moment value of the lower end, can be negative.
5. {5} — Bending moment value of the higher end, can be negative.
6. {6} — The difference of the moment value of the centre point.
7. {7} — Scale, optional.

It should be noted that parameter #6 defines the difference of the true moment value and the corresponding value of an assumed linear distribution. The positive value indicates that the parabola bends towards the local positive direction. Since this command draws a parabola, the load should be a uniformly distributed load. So this value #6 is $\pm \frac{wl^2}{8}$, the sign depends on the direction of the UDL.

Example

```
\IForceB{0,0}{0,4}{1}{-2}{1}{0.5}
\IForceB{0,4}{4,4}{-1}{1}{2}{0.5}
\IForceB{4,4}{4,0}{0.5}{1}{0}{0.5}
\IForceB[cyan]{4,0}{0,0}{1.5}{0}{2}{0.5}
```



9 Beam Deformation (Perpendicular)

Syntax

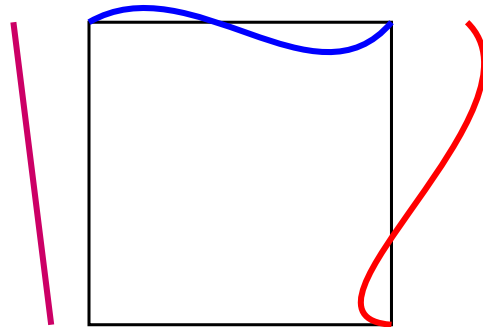
```
\BeamDeformP[1]{2}{3}{4}[5]{6}[7]{8}
```

1. [1] — Line color, optional
2. {2} — Node coordinate of the lower end, in form of x, y .
3. {3} — Node coordinate of the higher end, in form of x, y .
4. {4} — Perpendicular displacement of the lower end, can be negative, leave zero if not required.
5. [5] — Rotation value of the lower end, can be negative, optional.
6. {6} — Perpendicular displacement of the high end, can be negative, leave zero if not required.
7. [7] — Rotation value of the high end, can be negative, optional.
8. {8} — Scale, optional.

This command draws deformation based on local coordinate system. The translations are perpendicular to the member cord.

Example

```
\BeamDeformP{0,0}{0,4}{.5}{-1}  
\BeamDeformP[blue]{0,4}{4,4}{0}[30]{0}[50]{1}  
\BeamDeformP[red]{4,4}{4,0}{.5}[30]{0}[50]{2}
```



10 Beam Deformation (Rotation Only)

Syntax

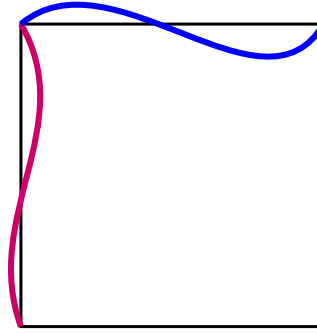
```
\BeamDeformR[1]{2}{3}[4][5]{6}
```

1. [1] — Line color, optional
2. {2} — Node coordinate of the lower end, in form of x, y .
3. {3} — Node coordinate of the higher end, in form of x, y .
4. [4] — Rotation value of the lower end, can be negative, optional.
5. [5] — Rotation value of the high end, can be negative, optional.
6. {6} — Scale, optional.

Caveat: if the nodal translations are expressed as global values, they can be readily combined into parameters #2 and #3, so there is no need to provide another command to plot the deformation in the global coordinate system.

Example

```
\BeamDeformR{0,0}{0,4}[20][30]  
\BeamDeformR[blue]{0,4}{4,4}[20][30]{2}
```



11 Implementation

```

1  %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
2  %% Copyright (C) 2018 Theodore Chang
3  %%
4  %% This program is free software: you can redistribute it and/or modify
5  %% it under the terms of the GNU General Public License as published by
6  %% the Free Software Foundation, either version 3 of the License, or
7  %% (at your option) any later version.
8  %%
9  %% This program is distributed in the hope that it will be useful,
10 %% but WITHOUT ANY WARRANTY; without even the implied warranty of
11 %% MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
12 %% GNU General Public License for more details.
13 %%
14 %% You should have received a copy of the GNU General Public License
15 %% along with this program. If not, see <http://www.gnu.org/licenses/>.
16 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
17 % structmech: A TikZ command set for structural mechanics drawings
18 %                                     v0.1 by tlc
19 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
20 \NeedsTeXFormat{LaTeX2e}
21 \ProvidesPackage{structmech}[2018/04/07 structmech: A TikZ command set for structural mechanics
22   drawings]
23 \RequirePackage{tikz}
24 \RequirePackage{tikz-3dplot}
25 \RequirePackage{ifthen}
26 \RequirePackage{xparse}
27 \RequirePackage{xstring}
28 \RequirePackage{kvoptions}
29 \usetikzlibrary{backgrounds,calc,positioning,arrows.meta,decorations.pathreplacing,decorations.
30   pathmorphing,shapes.arrows}
31 \definecolor{0066CC}{RGB}{0,102,204}
32 \definecolor{00CC66}{RGB}{0,204,102}
33 \definecolor{CC0066}{RGB}{204,0,102}
34 \definecolor{CC6600}{RGB}{204,102,0}
35 \DeclareOptionX<structmech>{axial}[CC0066]{\def\axialColor{#1}}
36 \DeclareOptionX<structmech>{rotation}[00CC66]{\def\rotColor{#1}}
37 \DeclareOptionX<structmech>{node}[0066CC]{\def\nodalColor{#1}}
38 \DeclareOptionX<structmech>{fill}[CC0066]{\def\fillColor{#1}}
39 \DeclareOptionX<structmech>{convention}[sign]{\IfStrEq{#1}{sign}{\def\convention{#1}}{\IfStrEq
40   {#1}{direction}{\def\convention{#1}}{}}
41 \ExecuteOptionsX<structmech>{axial,rotation,node,convention,fill}
42 \ProcessOptionsX<structmech>
43 \tikzset{
44   BMD/.style={draw=0066CC,fill=0066CC,fill opacity=.4},
45   NOFILL/.style={fill=none,fill opacity=1},
46   RotBasic/.style={\rotColor,line width=.4mm,->},
47   FIXED/.style={postaction={draw,decorate,decoration={border,pre length=1mm,post length=1mm,angle
48     =-60,amplitude=1mm,segment length=1mm}}}
49 }
50 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
51 % Command Zero: Set options.
52 % \setstructmech{1}
53 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
54 \NewDocumentCommand{\setstructmech}{m}{\ExecuteOptionsX<structmech>{#1}}
55 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

```



```

116         {\draw[\axialColor,line width=.4mm,<->](#2)--(#3)node[midway,fill=none
117         ,#5]{$#4$}node[midway,fill=white]{\footnotesize$#6$};}
118     {\StrLeft{#6}{1}[\SS]\IfStrEq{\SS}{-}
119         {\draw[\axialColor,line width=.4mm,>-<](#2)--(#3)node[midway,fill=
120         none,#5]{$#4$}node[midway,fill=white]{\footnotesize$\StrDel
121         [1]{#6}{-}$};}
122         {\draw[\axialColor,line width=.4mm,<->](#2)--(#3)node[midway,fill=
123         none,#5]{$#4$}node[midway,fill=white]{\footnotesize$#6$};}
124     }
125 }
126 {\IfEq{#1}{2L}
127 {
128     \draw[\axialColor,draw=none](#2)--(#3)node[midway,fill=none,#5]{$#4$};
129     \IfNoValueTF{#6}
130     {\draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
131     {\IfStrEq{\convention}{sign}
132     {\node[fill=none,\rotColor]at($(#2)+(\Angle+90:.6)$){\footnotesize$#6$};\
133     draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
134     {\StrLeft{#6}{1}[\SS]\IfStrEq{\SS}{-}
135     {\node[fill=none,\rotColor]at($(#2)+(\Angle-90:.6)$){\footnotesize
136     $\StrDel[1]{#6}{-}$};\draw[RotBasic]($(#2)+(\Angle-90:.3)$)arc[
137     EndRotC];}
138     {\node[fill=none,\rotColor]at($(#2)+(\Angle+90:.6)$){\footnotesize
139     $#6$};\draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
140     }
141 }
142 {\IfEq{#1}{2H}
143 {
144     \draw[\axialColor,draw=none](#2)--(#3)node[midway,fill=none,#5]{$#4$};
145     \IfNoValueTF{#6}
146     {\draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
147     {\IfStrEq{\convention}{sign}
148     {\node[fill=none,\rotColor]at($(#3)+(\Angle-90:.6)$){\footnotesize$#6$};\
149     draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
150     {\StrLeft{#6}{1}[\SS]\IfStrEq{\SS}{-}
151     {\node[fill=none,\rotColor]at($(#3)+(\Angle+90:.6)$){\footnotesize
152     $\StrDel[1]{#6}{-}$};\draw[RotBasic]($(#3)+(\Angle+90:.3)$)arc[
153     EndRotD];}
154     {\node[fill=none,\rotColor]at($(#3)+(\Angle-90:.6)$){\footnotesize
155     $#6$};\draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
156     }
157 }
158 {\IfEq{#1}{2}
159 {
160     \draw[\axialColor,draw=none](#2)--(#3)node[midway,fill=none,#5]{$#4$};
161     \IfNoValueTF{#6}
162     {\draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
163     {\IfStrEq{\convention}{sign}
164     {\node[fill=none,\rotColor]at($(#2)+(\Angle+90:.6)$){\footnotesize$#6$};\
165     draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
166     {\StrLeft{#6}{1}[\SS]\IfStrEq{\SS}{-}
167     {\node[fill=none,\rotColor]at($(#2)+(\Angle-90:.6)$){\footnotesize
168     $\StrDel[1]{#6}{-}$};\draw[RotBasic]($(#2)+(\Angle-90:.3)$)arc[
169     EndRotC];}
170     {\node[fill=none,\rotColor]at($(#2)+(\Angle+90:.6)$){\footnotesize
171     $#6$};\draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
172     }
173 }
174 {\IfNoValueTF{#7}
175 {\draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
176 {\IfStrEq{\convention}{sign}
177 {\node[fill=none,\rotColor]at($(#3)+(\Angle-90:.6)$){\footnotesize$#7$};\
178 draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
179 {\StrLeft{#7}{1}[\SS]\IfStrEq{\SS}{-}
180 {\node[fill=none,\rotColor]at($(#3)+(\Angle+90:.6)$){\footnotesize
181 $\StrDel[1]{#7}{-}$};\draw[RotBasic]($(#3)+(\Angle+90:.3)$)arc[
182 EndRotD];}
183 {\node[fill=none,\rotColor]at($(#3)+(\Angle-90:.6)$){\footnotesize
184 $#7$};\draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
185 }

```

```

172     }
173   }
174   {}
175   \IfEq{#1}{3}
176   {
177     \IfNoValueTF{#6}
178     {\draw[\axialColor,line width=.4mm,<->](#2)--(#3)node[midway,fill=none,#5]{$#4$};}
179     {\IfStrEq{\convention}{sign}
180      {\draw[\axialColor,line width=.4mm,<->](#2)--(#3)node[midway,fill=none
181       ,#5]{$#4$}node[midway,fill=white]{\footnotesize $#6$};}
182      {\StrLeft{#6}{1}[\SS]\IfStrEq{\SS}{-}
183       {\draw[\axialColor,line width=.4mm,>-<](#2)--(#3)node[midway,fill=
184        none,#5]{$#4$}node[midway,fill=white]{\footnotesize $\StrDel
185         [1]{#6}{-}$};}
186       {\draw[\axialColor,line width=.4mm,<->](#2)--(#3)node[midway,fill=
187        none,#5]{$#4$}node[midway,fill=white]{\footnotesize $#6$};}
188     }
189     \IfNoValueTF{#7}
190     {\draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
191     {\IfStrEq{\convention}{sign}
192      {\node[fill=none,\rotColor]at($(#2)+(\Angle+90:.6)$){\footnotesize $#7$};\
193       draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
194      {\StrLeft{#7}{1}[\SS]\IfStrEq{\SS}{-}
195       {\node[fill=none,\rotColor]at($(#2)+(\Angle-90:.6)$){\footnotesize
196        $\StrDel[1]{#7}{-}$};\draw[RotBasic]($(#2)+(\Angle-90:.3)$)arc[
197         EndRotC];}
198       {\node[fill=none,\rotColor]at($(#2)+(\Angle+90:.6)$){\footnotesize
199        $#7$};\draw[RotBasic]($(#2)+(\Angle+90:.3)$)arc[EndRotA];}
200     }
201     \IfNoValueTF{#8}
202     {\draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
203     {\IfStrEq{\convention}{sign}
204      {\node[fill=none,\rotColor]at($(#3)+(\Angle-90:.6)$){\footnotesize $#8$};\
205       draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
206      {\StrLeft{#8}{1}[\SS]\IfStrEq{\SS}{-}
207       {\node[fill=none,\rotColor]at($(#3)+(\Angle+90:.6)$){\footnotesize
208        $\StrDel[1]{#8}{-}$};\draw[RotBasic]($(#3)+(\Angle+90:.3)$)arc[
209         EndRotD];}
210       {\node[fill=none,\rotColor]at($(#3)+(\Angle-90:.6)$){\footnotesize
211        $#8$};\draw[RotBasic]($(#3)+(\Angle-90:.3)$)arc[EndRotB];}
212     }
213   }
214   {}
215 }
216
217 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
218 % Command 3: Hinge support
219 % \HingeSupport[1]{2}{3}
220 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
221 \NewDocumentCommand{\HingeSupport}{O{0} m G{1}}{
222 \begin{scope}[rotate around={#1:(#2)},shift={(#2)},scale=#3]
223 \draw[line width=.2mm](0,0)--+(-.25,-.4)--+ (.5,0)--cycle;
224 \draw[line width=.2mm,FIXED](-.4,-.4)--+ (.8,0);
225 \end{scope}
226 }
227 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
228 % Command 4: UDL
229 % \UDL[1]{2}{3}[4]{5}
230 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
231 \makeatletter
232 \NewDocumentCommand{\UDL}{O{N} m m O{ } G{1}}{
233 \IfEq{#1}{F}{\def\FAC{-1}}{\def\FAC{1}}
234 \coordinate(A)at(#2);
235 \coordinate(B)at(#3);
236 \pgfmanglebetweenpoints{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
237 \let\Angle\pgfmangle
238 \pgfpointdiff{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
239 \pgfmangleparse{\veclen(\pgf@x,\pgf@y)/28.45274}
240 \let\Length\pgfmangle
241 \draw[\fillColor,fill=\fillColor,fill opacity=.4](#2)--(#3)--($(#3)+(\Angle+\FAC*90:\Length/10*#5)
242 $)--($(#2)+(\Angle+\FAC*90:\Length/10*#5)$)--cycle;
243 \IfNoValueTF{#4}
244 {}
245 {\IfStrEq{\convention}{sign}

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235         {\node[NOFILL]at($(#2)!.5!(#3)+(\Angle+\FAC*90:\Length/5*#5$)[rotate=\Angle
236             ]{$#4$}};}
237         {\StrLeft{#4}{1}[\SS]\IfStrEq{\SS}{-}
238             {\node[NOFILL]at($(#2)!.5!(#3)+(\Angle+\FAC*90:\Length/5*#5$)[rotate=\
                Angle]{\StrDel{1}{#4}{-}}};}
239             {\node[NOFILL]at($(#2)!.5!(#3)+(\Angle+\FAC*90:\Length/5*#5$)[rotate=\
                Angle]{\StrDel{1}{#4}{-}}};}
240         }
241 \foreach\x in{0,.1,.2,...,1}{
242 \coordinate(C)at($(#2)!\x!(#3)$);
243 \IfNoValueTF{#4}
244     {\draw[<-](C)---+($(\Angle+\FAC*90:\Length/10*#5$));}
245     {\IfStrEq{\convention}{sign}
246         {\draw[<-](C)---+($(\Angle+\FAC*90:\Length/10*#5$));}
247         {\StrLeft{#4}{1}[\SS]\IfStrEq{\SS}{-}
248             {\draw[>](C)---+($(\Angle+\FAC*90:\Length/10*#5$));}
249             {\draw[<-](C)---+($(\Angle+\FAC*90:\Length/10*#5$));}
250         }
251     }
252 };
253 }
254 \makeatother
255 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
256 % Command 5: Fixed support
257 % \FixedSupport[1]{2}{3}
258 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
259 \NewDocumentCommand{\FixedSupport}{0{0} m G{1}}{
260 \begin{scope}[rotate around={#1:(#2)},shift={(#2)},scale=#3]
261 \draw[line width=.2mm,FIXED](-.4,0)---+ (.8,0);
262 \end{scope}
263 }
264 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
265 % Command 6: Roller support
266 % \RollerSupport[1]{2}{3}
267 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
268 \NewDocumentCommand{\RollerSupport}{0{0} m G{1}}{
269 \begin{scope}[rotate around={#1:(#2)},shift={(#2)},scale=#3]
270 \draw[line width=.2mm]
271     (0,0)---+(-.25,-.3)---+ (.5,0)--cycle
272     (-.15,-.35)circle(.05)
273     (+.15,-.35)circle(.05);
274 \draw[line width=.2mm,FIXED]
275     (-.4,-.4)---+ (.8,0);
276 \end{scope}
277 }
278 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
279 % Command 7: Slider support
280 % \SliderSupport[1]{2}{3}
281 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
282 \NewDocumentCommand{\SliderSupport}{0{0} m G{1}}{
283 \begin{scope}[rotate around={#1:(#2)},shift={(#2)},scale=#3]
284 \draw[line width=.2mm]
285     (-.25,-.1/#3)---+ (.5,0)
286     (-.15,-.14/#3)---+ (0,-.22)
287     (+.15,-.14/#3)---+ (0,-.22);
288 \draw[line width=.2mm,fill=white]
289     (-.15,-.14/#3)circle(.04)+(0,-.22)circle(.04)
290     (+.15,-.14/#3)circle(.04)+(0,-.22)circle(.04);
291 \draw[line width=.2mm,FIXED]
292     (-.4,-.14/#3-.26)---+ (.8,0);
293 \end{scope}
294 }
295 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
296 % Command 8: Sleeve support
297 % \SleeveSupport[1]{2}{3}
298 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
299 \NewDocumentCommand{\SleeveSupport}{0{0} m O{.4} G{1}}{
300 \begin{scope}[rotate around={#1:(#2)},shift={(#2)},scale=#4]
301 \draw[line width=.2mm,FIXED](#3/2,-.4)---+ (0,.8);
302 \draw[line width=.2mm,FIXED](#3/2,.4)---+ (0,-.8);
303 \end{scope}
304 }
305 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
306 % Command 9: Coordinate system frame
307 % \CoordOrigin[1]{2}{3}

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308 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
309 \NewDocumentCommand{\CoorOrigin}{0{0} m G{1}}{
310 \begin{scope}[rotate around={#1:(#2)},shift={(#2)},scale=#3]
311 \draw[line width=.2mm,->](-.2,0)---+(1,0);\node[fill=None,draw=None]at(1.1,0){\footnotesize$x$};
312 \draw[line width=.2mm,->](0,-.2)---+(0,1);\node[fill=None,draw=None]at(0,1.1){\footnotesize$y$};
313 \end{scope}
314 }
315 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
316 % Command 10: Rigid constraint
317 % \Rigid[1]{2}{3}
318 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
319 \NewDocumentCommand{\Rigid}{0{0} m G{1}}{
320 \begin{scope}[rotate around={#1:(#2)},shift={(#2)},scale=#3]
321 \draw[fill=black,rounded corners=.2mm](0,0)--(.25,.4)--(.4,.25)--cycle;
322 \end{scope}
323 }
324 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
325 % Command 11: Linear Internal Force
326 % \IForceA[1]{2}{3}{4}{5}{6}
327 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
328 \makeatletter
329 \NewDocumentCommand{\IForceA}{0{\fillColor} m m m m G{1}}{
330 \coordinate(A)at(#2);
331 \coordinate(B)at(#3);
332 \pgfmanglebetweenpoints{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
333 \let\Angle\pgfmathresult
334 \coordinate(C)at($(A)+(\Angle+90:#4*#6)$);
335 \coordinate(D)at($(B)+(\Angle-90:#5*#6)$);
336 \draw[#1,fill=#1,fill opacity=.3](A)--(C)--(D)--(B)--cycle;
337 \pgfpointdiff{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
338 \pgfmathparse{veclen(\pgf@x,\pgf@y)/28.45274}
339 \let\Length\pgfmathresult
340 \StrLeft{#4}{1}[\SA]
341 \IfStrEq{\SA}{-}{
342 {\node[NOFILL]at($(C)+(\Angle-90:\Length/8)$)[rotate=\Angle]}{##4$};}
343 {\node[NOFILL]at($(C)+(\Angle+90:\Length/8)$)[rotate=\Angle]}{##4$};}
344 \StrLeft{#5}{1}[\SB]
345 \IfStrEq{\SB}{-}{
346 {\node[NOFILL]at($(D)+(\Angle+90:\Length/8)$)[rotate=\Angle]}{##5$};}
347 {\node[NOFILL]at($(D)+(\Angle-90:\Length/8)$)[rotate=\Angle]}{##5$};}
348 }
349 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
350 % Command 12: Parabolic Internal Force
351 % \IForceB[1]{2}{3}{4}{5}{6}{7}
352 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
353 \NewDocumentCommand{\IForceB}{0{\fillColor} m m m m m G{1}}{
354 \coordinate(A)at(#2);
355 \coordinate(B)at(#3);
356 % original cord
357 \pgfmanglebetweenpoints{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
358 \let\Angle\pgfmathresult
359 \coordinate(C)at($(A)+(\Angle+90:#4*#7)$);
360 \coordinate(D)at($(B)+(\Angle-90:#5*#7)$);
361 % shape cord
362 \pgfmanglebetweenpoints{\pgfpointanchor{C}{center}}{\pgfpointanchor{D}{center}}
363 \let\AngleB\pgfmathresult
364 % original length
365 \pgfpointdiff{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
366 \pgfmathparse{veclen(\pgf@x,\pgf@y)/28.45274}
367 \let\Length\pgfmathresult
368 % inclined length
369 \pgfpointdiff{\pgfpointanchor{C}{center}}{\pgfpointanchor{D}{center}}
370 \pgfmathparse{veclen(\pgf@x,\pgf@y)/28.45274}
371 \let\LengthB\pgfmathresult
372 % center of inclined cord
373 \coordinate(G)at($(C)+(\AngleB:\LengthB/2)$);
374 \pgfmanglebetweenpoints{\pgfpointanchor{A}{center}}{\pgfpointanchor{G}{center}}
375 \let\AngleB\pgfmathresult
376 \draw[#1,fill=#1,fill opacity=.3](.5*\LengthB,0)parabola bend(0,\AngleB)(.5*\LengthB,0)---+(\AngleB-90:#5*#7)--($(-.5*\LengthB,0)+(\Angle-\AngleB-90:#4*#7)$)--cycle;
377 \end{scope}
378 }
379 \StrLeft{#4}{1}[\SA]
380 \IfStrEq{\SA}{-}{
381 {\node[NOFILL]at($(C)+(\Angle-90:\Length/8)$)[rotate=\Angle]}{##4$};}
382 {\node[NOFILL]at($(C)+(\Angle+90:\Length/8)$)[rotate=\Angle]}{##4$};}

```



```

383 \StrLeft{#5}{1}[\SB]
384 \IfStrEq{\SB}{-}
385     {\node[NOFILL]at($(D)+(\Angle+90:\Length/8)$)[rotate=\Angle]{#5$};}
386     {\node[NOFILL]at($(D)+(\Angle-90:\Length/8)$)[rotate=\Angle]{#5$};}
387 }
388 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
389 % Command 13: Beam Deformation (perpendicular)
390 % \BeamDeformP[1]{2}{3}{4}[5]{6}[7]{8}
391 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
392 \NewDocumentCommand{\BeamDeformP}{O{\fillColor} m m m O{0} m O{0} G{1}}{
393 \coordinate(A)at(#2);
394 \coordinate(B)at(#3);
395 % original cord
396 \pgfmathanglebetweenpoints{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
397 \let\Angle\pgfmathresult
398 \coordinate(C)at($(A)+(\Angle+90:#4*#8)$);
399 \coordinate(D)at($(B)+(\Angle-90:#6*#8)$);
400 \pgfmathanglebetweenpoints{\pgfpointanchor{C}{center}}{\pgfpointanchor{D}{center}}
401 \let\AngleB\pgfmathresult
402 \draw[#1,line width=.8mm](C)to[out=\AngleB+#5*#8,in=180+\AngleB+#7*#8](D);
403 }
404 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
405 % Command 13: Beam Deformation (Rotation Only)
406 % \BeamDeformR[1]{2}{3}[4][5]{6}
407 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
408 \NewDocumentCommand{\BeamDeformR}{O{\fillColor} m m O{0} O{0} G{1}}{
409 \coordinate(A)at(#2);
410 \coordinate(B)at(#3);
411 % original cord
412 \pgfmathanglebetweenpoints{\pgfpointanchor{A}{center}}{\pgfpointanchor{B}{center}}
413 \let\Angle\pgfmathresult
414 \draw[#1,line width=.8mm](A)to[out=\Angle+#4*#6,in=180+\Angle+#5*#6](B);
415 }
416 \makeatother

```