

beamz.sty

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Abstract

`beamz.sty` lets you draw beams with arbitrary loading and support conditions directly in your \LaTeX document in a parameterized fashion. Shear force and bending moment diagrams are also supported. `beamz.sty` uses PGF/Tikz to produce graphics and is ultimately only a set of `\newcommands`.

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1 Beam

The basic command is `\beam{<length>}{<height>}` which needs to be encapsulated within a `tikzpicture` environment.

Example :



```
\begin{tikzpicture}
\beam{5}{0.2}
\end{tikzpicture}
```

All other objects (eg supports and loads) need the beam as a reference so the command `\beam` should be provided before anything else is drawn.

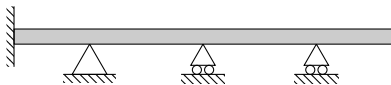
2 Supports

The following supports are implemented:

- Triangle supports: `\triangleSupport<rel.pos.>`
- Roller supports: `\rollerSupport<rel.pos.>`
- Clamped supports:
 - `\clampedLeft<height><thickness>`
 - `\clampedRight<height><thickness>`

The height of `\triangleSupport` and `\rollerSupport` are set by the command `\setSupportHeight{<height>}` which needs to be given before any support is drawn.

Example :



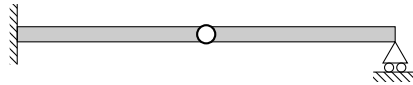
```
\begin{tikzpicture}
% beam
\beam{5}{0.2}

% supports
\setSupportHeight{0.4}
\triangleSupport{0.2}
\rollerSupport{0.5}
\rollerSupport{0.8}
\clampedLeft{0.4}{0.1}
\clampedRight{0.4}{0.1}
\end{tikzpicture}
```

3 Joint

A joint can be added to the beam using the command `\joint{<rel. pos.>}`.
The joint's size is proportional to the beam's thickness.

Example :



```
\begin{tikzpicture}
%beam
\beam{5}{0.2}

% joint
\joint{0.5}

%supports
\setSupportHeight{0.4}
\clampedLeft{0.4}{0.1}
\rollerSupport{1.0}
\end{tikzpicture}
```

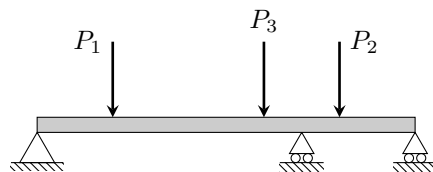
4 Loads

4.1 Point loads

The command `\pointLoad` takes 5 arguments:

`\pointLoad{<rel.pos.>}{<height>}{<annotation>}{<annotations pos.>}{<vertical offset>}`

Example :



```
\begin{tikzpicture}
% beam
\beam{5}{0.2}

% loads
```

```

\pointLoad{0.2}{1.0}{P_1}{left}{0}
\pointLoad{0.8}{1.0}{P_2}{right}{0}
\pointLoad{0.6}{1.0}{P_3}{above}{0}

% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{0.7}
\rollerSupport{1.0}
\end{tikzpicture}

```

4.2 Point moment

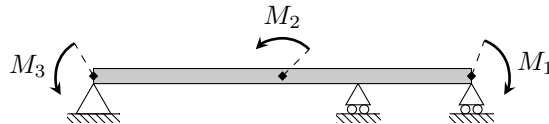
The commands `\momentClockwise` and `\momentCounterclockwise` both take the same 6 arguments:

```

\momentClockwise{<rel.pos.>}{<radius>}{<start angle>}{<delta angle>}{<annotation>}
{<annotation pos.>}

```

Example :



```

\begin{tikzpicture}
% beam
\beam{5}{0.2}

% loads
\momentClockwise{1.0}{0.5}{-30}{100}{M_1}{right}
\momentCounterclockwise{0.0}{0.5}{120}{90}{M_3}{left}
\momentCounterclockwise{0.5}{0.5}{45}{90}{M_2}{above}

% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{0.7}
\rollerSupport{1.0}
\end{tikzpicture}

```

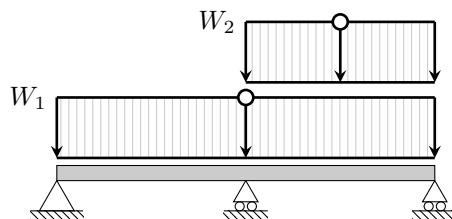
4.3 Distributed loads

4.3.1 Rectangle loads

The command `\distributedload` takes 6 arguments:

```
\distributedload{<start pos.>}{<end pos.>}{<annotation left>}{<annotation
right>}{<height>}{<vertical offset>}
```

Example :



```
\begin{tikzpicture}
% beam
\beam{5}{0.2}

% loads
\distributedLoad{0.0}{1.0}{ $W_1$ }{}{0.8}{0}
\distributedLoad{0.5}{1.0}{ $W_2$ }{}{0.8}{1}

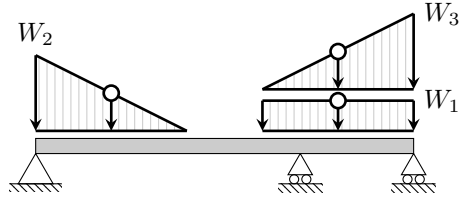
% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{0.5}
\rollerSupport{1.0}
\end{tikzpicture}
```

4.3.2 Triangle loads

The commands `\triangleloadLeft` and `\triangleloadRight` both take the same 6 arguments:

```
\triangleloadLeft{<start pos.>}{<end pos.>}{<annotation>}{<annotation
pos.>}{<height>}{<vertical offset>}
```

Example :



```
\begin{tikzpicture}
% beam
\beam{5}{0.2}

% loads
\distributedLoad{0.6}{1.0}{\${W_1}}{0.4}{0}
\triangleloadLeft{0.0}{0.4}{\${W_2}}{above}{1.0}{0}
\triangleloadRight{0.6}{1.0}{\${W_3}}{right}{1.0}{0.55}

% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{0.7}
\rollerSupport{1.0}
\end{tikzpicture}
```

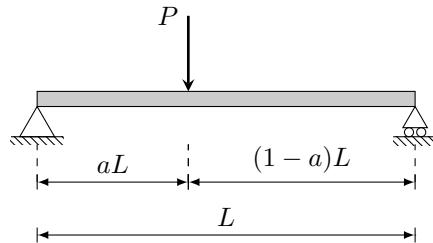
5 Annotation

5.1 Dimension annotations

```
\dimension{<start pos.>}{<end pos.>}{<vertical disp.>}{<annotation>}{<dashed
line extension>}
```

where <dashed line extension> is a fraction of <vertical disp.>.

Example :



```
\begin{tikzpicture}
% beam
\beam{5}{0.2}
```

```

% loads
\pointLoad{0.4}{1.0}{ $P$ }{left}{0}

% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{1.0}

% dimensions
\dimension{0.0}{0.4}{1.0}{ $aL$ }{0.5}
\dimension{0.4}{1.0}{1.0}{ $(1-a)L$ }{0.5}
\dimension{0.0}{1.0}{1.7}{ $L$ }{0.0}
\end{tikzpicture}

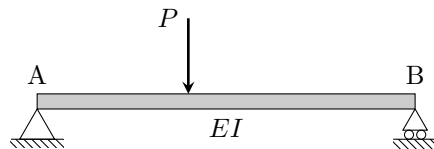
```

5.2 Beam annotation

Beam annotations can be added using the commands:

- `\beamAnnotationBelow{<rel.pos.>}{<annotation>}`
- `\beamAnnotationAbove{<rel.pos.>}{<annotation>}`

Example :



```

\begin{tikzpicture}
% beam
\beam{5}{0.2}

% loads
\pointLoad{0.4}{1.0}{ $P$ }{left}{0}

% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{1.0}

% annotation
\beamAnnotationAbove{0}{A}
\beamAnnotationAbove{1}{B}

```

```
\beamAnnotationBelow{0.5}{\mathit{EI}}
\end{tikzpicture}
```

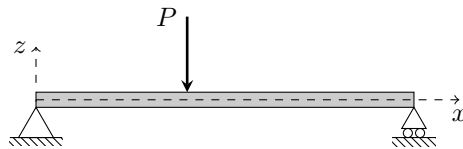
6 Coordinate axes

Coordinate axes for a beam can be drawn using the two commands:

- `\horizontalAxis` (draws x axis)
- `\verticalAxis` (draws z axis (positive direction upwards))

The coordinate axes' lengths are proportional to the beam's length and height, respectively.

Example :



```
\begin{tikzpicture}
% beam
\beam{5}{0.2}

% loads
\pointLoad{0.4}{1.0}{\mathit{P}}{left}{0}

% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{1.0}

% axes
\horizontalAxis
\verticalAxis
\end{tikzpicture}
```

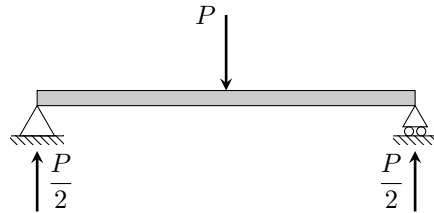
7 Reaction forces

Reaction forces can be drawn using the command `\reactionForce` which takes 3 arguments:

`\reactionForce{<position>}{<annotation>}{<annotation pos.>}` The arrow's offset distance from the support is proportional to the support's height so the supports need to be drawn before the reaction forces. The height of the

reaction force is set by the command
`\setReactionForceHeight{<height>}`

Example :



```
\begin{tikzpicture}
% beam
\beam{5}{0.2}

% loads
\pointLoad{0.5}{1.0}{\mathstrut}{left}{0}

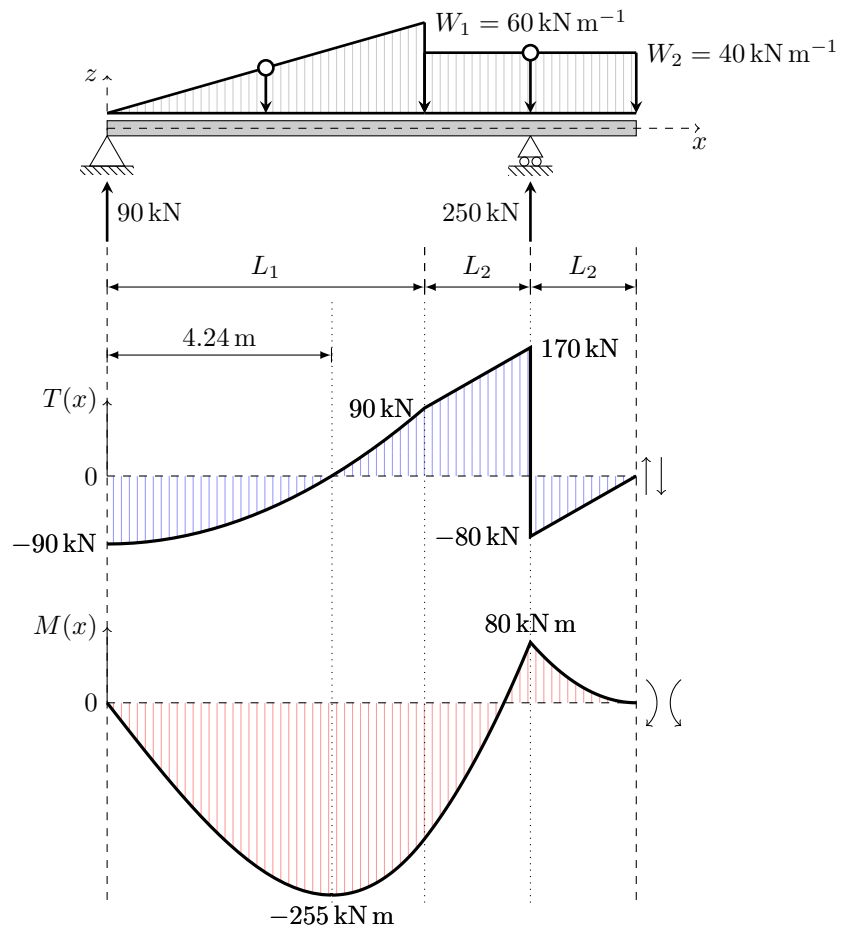
% supports
\setSupportHeight{0.4}
\triangleSupport{0.0}
\rollerSupport{1.0}

% reaction forces
\setReactionForceheight{0.8}
\reactionForce{0.0}{\mathstrut}{right}
\reactionForce{1.0}{\mathstrut}{left}
\end{tikzpicture}
```

8 Cross-sectional force diagrams

The commands `\Tofx` and `\Mofx` both take the same 3 arguments:
`\Tofx{<T(x)>}{<vertical shift>}{<scale factor>}` where `{<T(x)>}` is $T(x)$ (or $M(x)$) given as a path of either coordinates or analytical functions, or a combination of both (see example below). When analytical expressions are given in `{<T(x)>}`, the true length of the beam needs to be declared for correct scaling of the graph, which is done using the command `\setTrueBeamLength{<beam length>}`.

Example In the example below $L_1 = 6$ m and $L_2 = 2$ m. The example needs `\usepackage{siunitx}` in the preamble.



```

\begin{tikzpicture}

% Beam
\beam{7}{0.2}

% Force
\triangleloadRight{0}{0.6}{\$W_1 = \SI{60}{\kilo\newton\per\meter}\$}{right}{1.2}{0}
\distributedLoad{6/10}{1}{}{\$W_2 = \SI{40}{\kilo\newton\per\meter}\$}{0.8}{0}

% Supports
\setSupportHeight{0.4}
\triangleSupport{0}
\rollerSupport{8/10}

% Dimension

```

```

\dimension{0}{6/10}{2}{\L_1$}{0.3}
\dimension{6/10}{8/10}{2}{\L_2$}{0.3}
\dimension{8/10}{1.0}{2}{\L_2$}{0.3}
\dimension{0}{4.24/10}{2.9}{\SI{4.24}{\meter}$}{0}
\horizontalAxis
\verticalAxis

% Support reactions
\setReactionForceheight{0.8}
\reactionForce{0}{\SI{90}{\kilo\newton}$}{right}
\reactionForce{8/10}{\SI{250}{\kilo\newton}$}{left}

\setTrueBeamLength{10}
% T(x)
\Tofx{
(0,-90) node[left] {\SI{-90}{\kilo\newton}$}
--
plot[domain=0:6] (\x, {5*\x^2-90})
--
(6,90) node[left] {\SI{90}{\kilo\newton}$}
--
plot[domain=6:8] (\x, {40*(\x-6)+90})
--
(8,170) node[right] {\SI{170}{\kilo\newton}$}
--
(8,-80) node[left] {\SI{-80}{\kilo\newton}$}
--
plot[domain=8:10] (\x, {40*(\x-6)-160})
}{4.5}{0.01}

% M(x)
\Mofx{
(0,0)
--
plot[domain=0:4.24] (\x, {-90*\x+5/3*\x^3})
--
(4.24,-255) node[below] {\SI{-255}{\kilo\newton\meter}$}
--
plot[domain=4.24:6] (\x, {-90*\x+5/3*\x^3})
--
plot[domain=6:8] (\x, {20*(\x-6)^2+90*\x-720})
--
(8,80) node[above] {\SI{80}{\kilo\newton\meter}$}
--

```

```

plot[domain=8:10] (\x, {20*(\x-6)^2-160*\x+1280})
}{7.5}{0.01}

% dimenstions
\setVerticalLineOffset{2.2}
\verticalLine{0}{8}{dashed}
\verticalLine{4.25/10}{8}{dotted}
\verticalLine{6/10}{8}{dotted}
\verticalLine{8/10}{8}{dotted}
\verticalLine{1}{8}{dashed}
\end{tikzpicture}

```