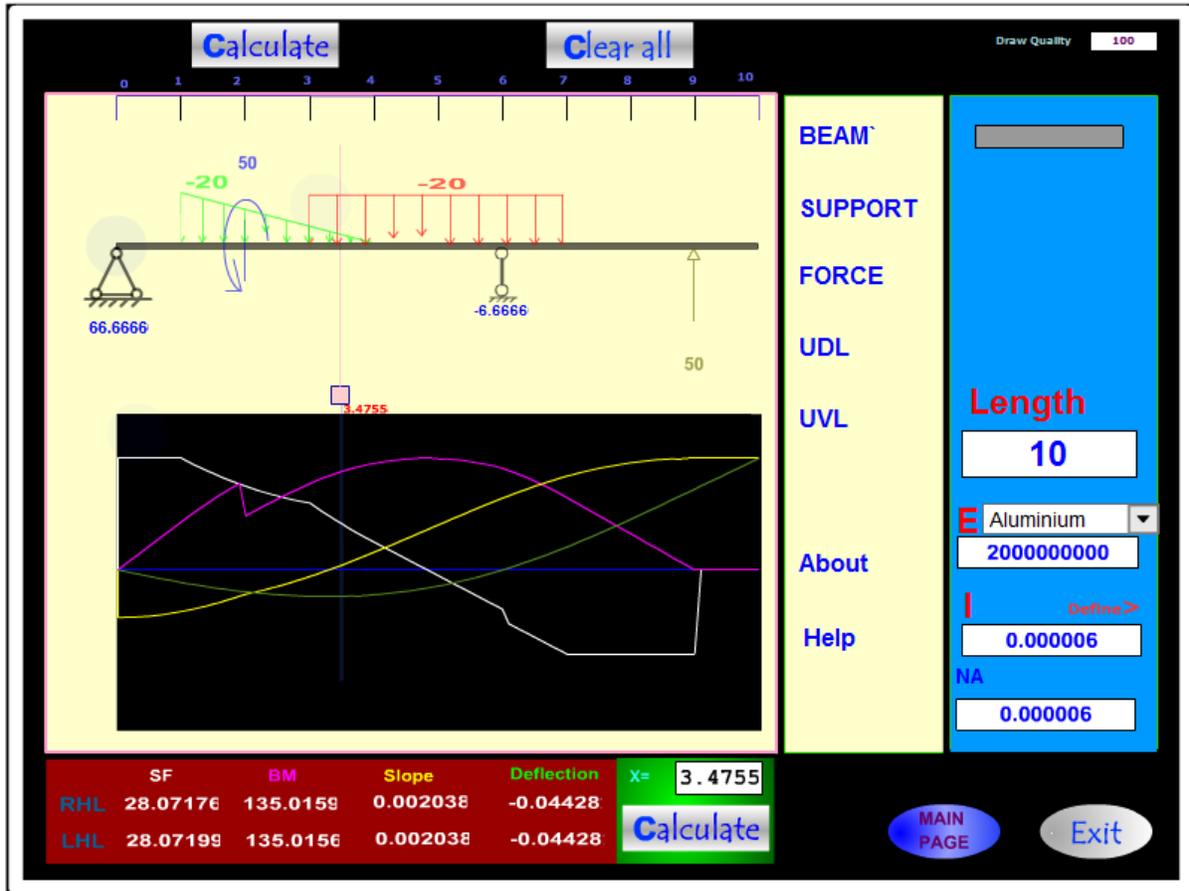


BEAMACULATOR

Software to analyze beam



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Preface

This software can analyze simply supported beam. This software has emerged to help students check their calculation. Since second sem in my college, I was thinking of such software. When I know about Macaulay's method in third sem, and the book of Beer and Johnston gave me the idea of developing such software.

When I found that the book has encouraged making program of moment function, I thought of developing software to analyze beam easily, quickly, and with enough graphics to easily understand it.

So, I teamed up with my brother, Rajendra Adhikari, to develop this software in flash.

I would like to thank all the teachers and friends who have helped me directly or indirectly in developing the software

Rabindra

Beamaculator

Beamaculator is software to calculate mainly shear force SF, bending moment BM, slope and deflection at any section of simply supported beam of given length with given loadings.

Beam section can be defined like I-section, rectangular-section, circular-section, etc with corresponding and its neutral axis and moment of inertia about centroid is automatically calculated.

The shear stress and bending stress at any height at specified section can also be calculated, which is important parameter.

It is flash based software, and therefore no installation is required. Just copying the single file will make the software ready to use. So, It is a handy software and its .swf version runs in web browser too.

This software uses Macaulay's method to calculate the SF, BM, slope and deflection at any section of beam. The beam is assumed of homogeneous material which is isotropic and has same value of Young's modulus both in tension and compression, and hook's law applies.

So, following formulas are used.

$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ $\text{Slope (dy/dx)} = \int \frac{M}{EI} dx$ $\text{Deflection(y)} = \int \left(\int \frac{M}{EI} dx \right) dx$ $\text{Shear stress } (\tau) = \frac{SF * A * \bar{y}}{I * b}$ $\text{Bending stress } (\sigma) = \frac{M * y}{I}$	$I_G = I_{1-1} - A * h^2$
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Program Data Flow Concept

1. Insert Beam (BEAM)

- a. Length : Length of the beam
 - i. Specify in text box
- b. Modulus of elasticity : E
 - i. Specify in textbox
 - ii. OR Material can be selected from drop down box
- c. Moment of inertia: I
 - i. Specify in textbox
 - ii. OR define the section with define button
 1. Specify dimensions of Rectangular or circular or I or ... section, to be considered.
- d. Clicking the beam icon will add the beam to the design area, with the above parameters set.

2. Specify Supports (SUPPORT)

- a. Distance : Distance from left end of beam
 - i. Specify in textbox.
- b. Clicking on desired support will add the support in design area at specified distance. Both supports are required!

3. Specify Forces (POINT LOAD, UDL, UVL)

- a. Distance : Distance from left end of beam
 - i. Specify in textbox
- b. Intensity : Magnitude of loading
 - i. Specify in textbox
- c. Width: Width of loading for UDL and UVL
 - i. Specify in textbox

4. CALCULATE support reactions and SF, BM, slope and Deflection Diagram

a. Click on CALCULATE at top to start.

b. For support reactions:

i. Taking moment of all forces about left end = m_1

ii. Taking moment of all forces about right end = m_2

iii. Hinge Reaction = $(b_1*m_2 - b_2*m_1)/(b_1*a_2 - a_1*b_2)$;

Roller Reaction = $(a_1*m_2 - a_2*m_1)/(a_1*b_2 - a_2*b_1)$

1. b_1 = distance of roller from left end

2. b_2 = distance of roller from right end (-ve)

3. a_1 = distance of Hinge from left end

4. a_2 = distance of Hinge from right end (-ve)

c. Constant of Integration Calculations

i. $dy/dx = \text{Integrate}(M(x)dx/EI) = x + C_1$; x = some function of x

ii. $y = \text{Integrate}(dy/dx) = xx + C_1x + C_2$; xx = some function of x

iii. y at roller and hinge supports = 0 gives two equations to solve C_1 and C_2

iv. $C_1 = (-xx \text{ about hinge support} - (-xx \text{ about roller support})) /$
(hinge distance – roller distance)

v. $C_2 = -xx \text{ about hinge support} - C_1 * \text{Hinge distance}$

d. Draw Graph

i. LOOP for $x = 0$ to beam length step (beam length / quality)
(Quality is input box, default = 100)

1. Use Macaulay's method to find SF, BM, slope and Deflection and plot it VS. x in observable scale.

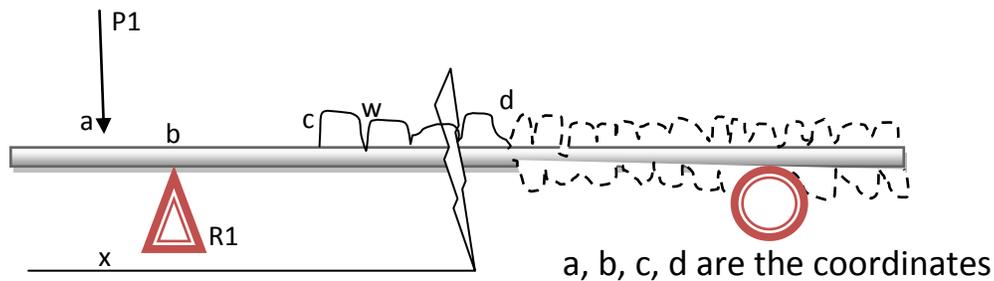
ii. Continue LOOP

5. CALCULATE the Numerical Value of SF, BM, Slope and Deflection at given x

i. Use Macaulay's method to find SF, BM, slope and Deflection

Macaulay's Method of Beam Analysis:

It uses step function to calculate the values.



For example, for loading as shown,

The moment function is

$$M(x) = -P1 * \langle x-a \rangle + R1 * \langle x-b \rangle - (w * \langle x-c \rangle^2) / 2 + (w * \langle x-d \rangle^2) / 2$$

Where $\langle \dots \rangle$ denotes that the value is zero if the value inside it is ≤ 0 , and this function continues for all loadings.

Hence it can be integrated twice to get deflection, the method to calculate constants of integration being discussed already.

Sample codes:

- To find m_1 :

This code lies inside loop:

```
if(_root[mclipudl].distance!=undefined){
    uddistance=_root[mclipudl].distance
    wide=_root[mclipudl].wide
    mag=_root[mclipudl].mag
    moment=moment+undef(mag*wide*(sdistance-uddistance-wide/2))
}
```

Here: `_root[mclipudl]` represents a UDL. All UDL are selected when loop continues.

`Undef(..)` is a function that returns zero if the value is not defined.

- To Find SF, BM, slope and Deflection

This code lies in loop:

```
//udl
if(_root[mclipudl].distance!=undefined){
    wide=Number(_root[mclipudl].wide)
    mag=Number(_root[mclipudl].mag)
    dis=Number(_root[mclipudl].distance)

    sf=sf+mag*sing((x-dis),1)
    sf=sf-(mag*sing((x-dis-wide),1))

    mf=mf+mag*sing((x-dis),2)/2
    mf=mf-mag*sing((x-dis-wide),2)/2

    dyvar=dyvar+mag*sing((x-dis),3)/6
    dyvar=dyvar-mag*sing((x-dis-wide),3)/6

    deflection=deflection + mag*sing((x-dis),4)/24
    deflection=deflection - 1*mag*sing((x-dis-wide),4)/24
}
```

This code is followed by:

```
dyvar=dyvar+Number(_root.constant1)
deflection=deflection+Number(_root.constant1*y)+Number(constant2)
ei = Number(_root.yme)*Number(_root.moi)
```

$dyvar = dyvar/Number(ei)$
 $deflection=deflection/Number(ei)$

Here $sf \rightarrow$ shear force, $mf \rightarrow$ bending moment, $dyvar \rightarrow$ slope and $deflection \rightarrow$ deflection at a section at distance "x" from left end by the end of loop and completing the second code.

- To find stress on circular section at section y from base:

case 2: //circle

```

        cd=Number(_root.circled)           //gives dia of circle
        aa=(y-Number(_root.na))           //na=height of neutral axis
        bb=(cd-Number(_root.na))
//stress
sigma= mf22 / moi*aa

/////for shearforce
A=(Math.acos(aa*2/cd)*cd*cd/4-aa*Math.pow((cd*cd/4-aa*aa),1/2))
ybar = -(2/3*Math.pow((cd*cd/4-bb*bb),3/2))/A + (2/3*Math.pow((cd*cd/4-aa*aa),3/2))/A

basewidth= 2*Math.pow((cd*cd/4-aa*aa),1/2)
tau =Number(_root.sf22)*A*ybar/basewidth/moi
tau=Number(tau)
_root.isection.varstress=Math.round(sigma*10000)/10000
_root.isection.varshear=Math.round(tau*10000)/10000

break;

```