

Product requirement document (PRD)

Software title

buckling load calculator

Background

the overall context of this software contains GUI part and logic part.

In the GUI part, the user interface is designed through four types of widgets: entry, button, label and combobox. The radius and vertical height of the object are entered through entry, the connection method is selected through button, the material properties are selected through combobox and the calculation results are displayed through label.

In the logical part the input values are obtained by means of commands such as get, lambda etc. and the buckling load is calculated according to the formula principle, which will be described in this paper.

The screenshot shows a window titled "Buckling Load Calculator". Inside, the title "Buckling Load Calculator" is displayed above a subtitle "This is only for the object with cross-section area as circle." Below this, there are two input fields: "The radius of the cross-section area (r)" with a value of "1" and unit "m", and "The length of the object (L)" with a value of "1" and unit "m". Both input fields are annotated with the word "entry" in red. Underneath, a section titled "Type of connection:" contains five buttons: "Pinned ends", "Fixed ends", "Pinned and fixed ends", "Fixed and free ends", and "Fixed and guided ends". The "Fixed ends" button is highlighted, and it is annotated with the word "button" in red. Below the buttons, there is a "Property:" label followed by a dropdown menu showing "Wood", which is annotated with the word "combobox" in red. A "Calculate" button is located below the dropdown. At the bottom of the window, the result is displayed as "P = 11.085 N", with "11.085" annotated with the word "label" in red.

Motivation

In the lecture axial compression, we learnt about buckling load, buckling failure occurs because materials find ways to move 'out from under' the compression load. We also learnt that five types of connection determine the effective length when calculating the buckling load, so we wanted to design a buckling load calculator which could be used to calculate the buckling load of an object with a circular cross-section. We offered the two main construction material options of wood and brick and provided five alternative types of connection.

Fundamentals

Second Moment of Area (I)

The **Second Moment of Area** or **Area Moment of Inertia (I)** is a geometrical property of an area which reflects how its points are distributed with regard to an axis.

Cross-section shape	Moment of inertia of area	Cross-section shape	Moment of inertia of area
Rectangle 	$I = \frac{bh^3}{12}$	Circle 	$I = \frac{\pi d^4}{64} = \frac{\pi r^4}{4}$
Square 	$I = \frac{a^4}{12}$	Hollow circle 	$I = \frac{\pi(d^4 - d_1^4)}{64}$ This will $I \approx \frac{\pi}{8} t \cdot d_m^3$

Euler's Critical (Buckling) Load

Effective Length (K)

Effective length is the distance between the flexural points (zero moments) in a member. **Effective length is determined by the end-condition of members:** anything that prevents members hinging at ends will reduce the **effective length** and thereby increase the **buckling load**.

Buckling Loads					
Buckling Load	$\frac{\pi^2 EI}{L^2}$	$\frac{4\pi^2 EI}{L^2}$	$\frac{2.045\pi^2 EI}{L^2}$	$\frac{\pi^2 EI}{4L^2}$	$\frac{\pi^2 EI}{L^2}$
Effective Length	L	0.5L	0.699L	2L	L

Source: J.E.Gordon, Structures (1984) Da Capo Press

The diagram on the left shows the formula for The Second Moment of Area for an object with a cross section shape of circle, the diagram on the right shows the five types of connections for the object

Key functions of the software

The software can calculate buckling load (P) on an object with a circular cross-section, made of brick or wood.

Scientific methods

The Second Moment of Area for an object with a cross section shape of circle is:

$$I = \pi \frac{r^4}{4} \quad \text{Equ 1.}$$

where r is the radius and pi is the circumference of the circle

The Buckling load is calculated as:

$$p = \pi^2 \frac{EI}{L^2} \quad \text{Equ 2.}$$

Where I is Second Moment of Area, L is effective length, E is the Young's modulus of the object.

Similar products in the market

<https://calcresource.com/statics-buckling-load.html>

Units:

What is the the unknown?

End supports:

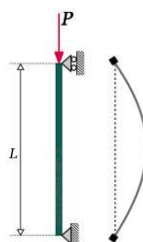
Input:

L =

E =

I =

Calculate the moment of inertia of various column cross-sections, using our [dedicated calculators](#).



Results:

$P_{cr} =$

$L_{eff} =$

$K =$