**NOTRE DAME UNIVERSITY**

**FACULTY OF ENGINEERING**

**CEN 204**

**SECTION "D"**

**EXPERIMENT #7**

**EFFECTS OF SUPPORTS ON BUCKLING**

**Abstract**

After the contribution of the buckling of an elastic simply supported strut the question that came up to the mind is:" what is the effect of supports on buckling?" in that experiment this experiment this question will be in question so this report will study the effect of supports on buckling, the values for both theoretical and experimental of the critical forces will be calculated discussed and tabulated also respective graphs for these values will be formed with appropriate conclusions.

**Introduction:**

In this experiment the effect of supports on buckling will be discussed where the experimental and theoretical forces applied on the steel supported beam will be calculated also the calculations will involve the determination of the K factor to determine the effective length of the beam in addition to the support degree values will be compared in addition to the percentage error that will be determined.

**Apparatus and list of equipments used:**

* Lever arm
* Steel strut(20\*2.5)mm
* V- groove
* 2 supports (upper and lower)
* Stopper
* Movable slider
* Weight hanger
* Weight of 30 N
* Restraining bar(10\*2)mm

**Sample calculations:**

First the support degree will be calculated by the following:

ф (angle)=EIsupp/EIstrut\*(Lstrut/Lsupp)^3

for a support length of 500mm the angle is: ф=(210000\*6.67/210000\*26.04)\*(550^3/500^3)

ф=0.340928187

where: E: is the modulus of elasticity of the steel

 I supp: is the moment of inertia of the support beam I=1/12\*10\*2^3=6.67mm^4

 Istrut: is the least moment of inertia of the buckled beam I=1/12\*20\*2.5^3=26.04mm^4

 L strut: is the effective length of the buckled beam 550mm

 L supp: is the length of the support beam 500mm

Now the factor "G2" will be calculated by the following;

G2=(I strut/L strut)/(I supp/L supp)=(26.04/550)/(6.67/500)=3.549134524

The determination of the k factor is graphically from appendix "A" where G1 is taken to be always 10 and G2 is calculated 3.549 by joining the 2 values on the scales the intersection with the K scale will give us the value of K which is in this case 0.93125

In order to determine the theoretical value for the force the value of the effective length should be calculated by the following:

Lk =L strut\*k=550\*0.93125=512.1875mm

Now the theoretical force will be calculated by the following:

 F theo=Π2 EI / (Lk) 2

Where

 E: is the modulus of elasticity

 I: is the least moment of inertia

 Lk: is the calculated effective length

Then F= (3.14^2\*210000\*26.04)/(512.1875^2)=205.7321049N

Now the equation involved in the calculation of the experimental force is the following: F=(a min+ a max)/100\*(w/2)+Fv

Where:

 A max: is the reading on the lever arm when the first time it touches the stopper it is read in mm

 A min: is the reading on the lever arm when it is about to leave the stopper

 W: is the weight applied

 Fv: is a constant equal to 59N

Hence F=(687+638.5)/100\*(30/2)+59=257.825N

**Discussion of the work done:**

For the whole experiment the average error was about 29% it is a high percentage this high value was due to. First the strut deflection was occurring in an opposite sense to the desired one this was leading to the displacement of the strut from the groove support second the support strut was in a bad condition where cracks start appearing on the sides of the fixing wholes in addition the support strut get deformed after the first few measurements that shows that this beam is no more in its elastic range and became plastic. As for the difference between this experiment and the experiment of the bending at cantilever beams is that in experiment 4 case 1 the experiment enable us to determine the bending of a small beam on a very strong support but in this experiment it is impossible to calculate the deflection of the lever arm so it was possible to see the effect of the weight on the lever arm on the support of the lever this could be simulated to a balcony of a house the balcony is suspended and fixed from one end when loaded it is impossible that the balcony bends but the supports of the balcony could buckle if they are week."K" has a range between 0.8 and 0.95. From appendix "A" if g increases the value for k will increase hence the value of the force will decrease and that what is shown in the data sheet table. The support length and the support degree are disproportional as the first increase the second decrease and vice versa since in the formula for the support degree the length is in the denominator and it is cubed. From the graphs the support degree and the critical force seems to be linear with a positive slope.

**Procedure followed:**

The strut has been placed between the two supports and connected to the support beam fixed at the second end and topped by the lever arm the movable slider placed on the lever and the weight hanged on the slider the slider is moved until the lever touches the stopper then it is moved back ward until the lever leaves the stopper in the 2 cases the values on the lever arm is recorded in order to find the experimental applied force.

**Conclusion**

This test can serve as prototype for the determination of the strength of any structure in most engineering applications

**Tables and graphs**

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| **Experiment 7** | **F=30N** |  |  |  |  |  |  |
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| Supporting bar length LE (mm) : | **500** | **450** | **400** | **375** | **250** | **200** | **125** | **100** |
| **φ=(EIsup/EIstrut)x(Lstrut/Lsup)3** | 0.340 | 0.467 | 0.665 | 0.807 | 2.723 | 5.319 | 21.787 | 42.552 |
| **G=(Istut÷Lstrut)/(Isup÷Lsup)** | 3.549 | 3.194 | 2.839 | 2.662 | 1.775 | 1.420 | 0.887 | 0.710 |
| **K** | 0.93 | 0.925 | 0.92 | 0.915 | 0.895 | 0.88 | 0.85 | 0.84 |
| **Theoretical: Fcrit=π2EI/Lk2** | 206.286 | 208.522 | 210.794 | 213.104 | 222.735 | 230.393 | 246.943 | 252.858 |
| **a1 (mm)** | 687 | 686 | 887 | 838 | 954 | 870.5 | 723 | 704 |
| **a2 (mm)** | 638.5 | 659 | 816.5 | 793 | 861 | 778.5 | 630.5 | 643 |
| **Experimental: Fcrit=((amin+amax)/100)\*W/2+Fv** | 257.83 | 260.75 | 314.525 | 303.65 | 331.25 | 306.35 | 262.025 | 261.05 |
| **% error** | 24.985 | 25.047 | 49.209 | 42.489 | 48.719 | 32.968 | 6.107 | 3.240 |
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