İZMİR KÂTİP ÇELEBİ ÜNİVERSİTESİ

EXPERIMENT 8

A) EXPERIMENT NAME: Buckling Test

B) THE AIM OF THE EXPERIMENT:

Materials can fail under very high tension or compression. For tension, the way materials fail is simply breaking across section. However, for compression, materials can fail by breaking across section or buckling. And usually in building or bridges, buckling comes first before breaking occurs. In engineering practice, design for buckling is important, especially for slender columns.

The goal of this test is to determine critical buckling loads for columns with support and examination the Euler theory of buckling.

C) EXPERIMENTAL SETUP AND APPARATUS

The testing equipment is Shimadzu Autograph AG-IS 100 computerized servo hydraulic universal testing machine (UTM). The specimen is placed between the fixed heads of the UTM (Figure 1)

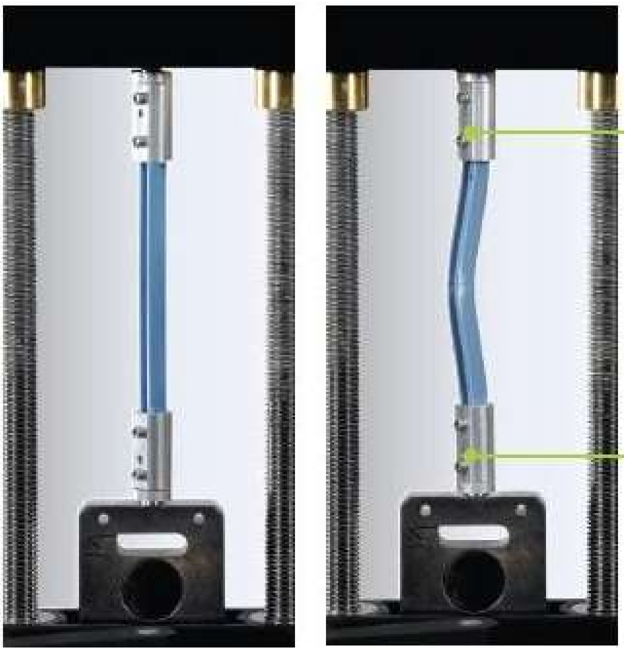

Figure 1: Fixed ends buckling

D) THEORY

Buckling is a failure type, which occurs under the verticial load on columns. Buckling occurs suddenly and without warning when a certain limit load is attained. It is therefore an extremely dangerous type of failure, which must be avoided by all means. As, soon as a rod begins to buckle, it will become deformed to the point of total destruction. This is typical unstable behavior. Buckling is a stability problem. The critical limit load P_{cr}, above which buckling can occur, is dependent on both the slenderness of the rod, i.e. influence of length and diameter, and the material used. The slenderness can be defined by the slenderness ratio (λ) in equation (1)

$$\lambda = \frac{LK}{i} \quad (1)$$

In this case LK is the characteristic length of the rod. It takes both the actual length of the rod and the mounting conditions into consideration. The influence of diameter in the slenderness ratio is expressed by the inertia radius i (Equation 2). It is calculated using the minimum geometrical moment of inertia I_y and the cross-sectional area A.

$$i = \sqrt{\frac{I_y}{A}} \quad (2)$$

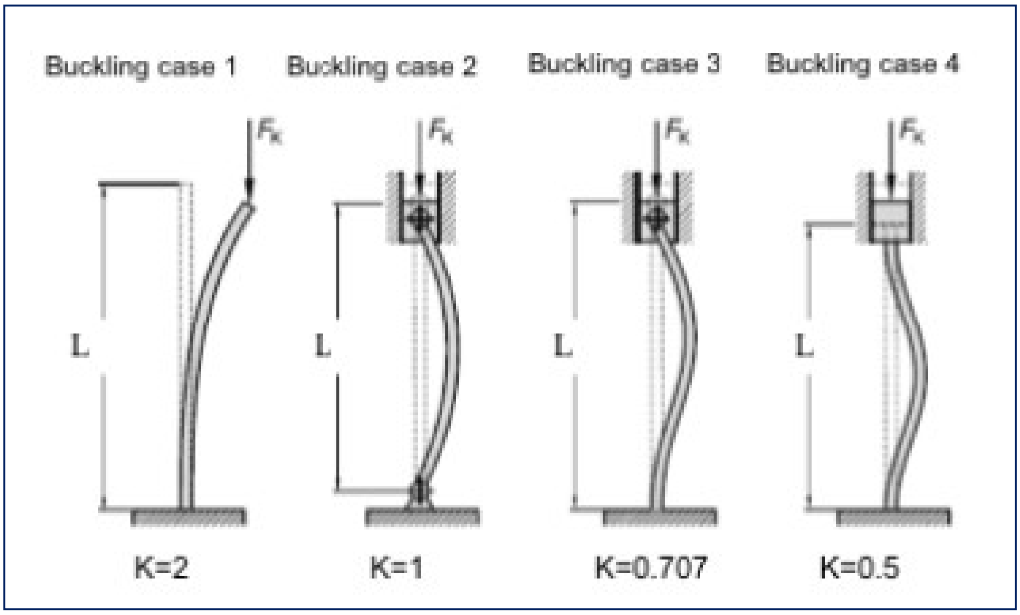

Figure 2: Buckling cases

The critical buckling load and stresses can be calculated by using equations 3 (Euler formula for critical load), equation 4 respectively.

$$P_{cr} = \frac{\pi^2 E\ I}{(KL)^2} \qquad (3)$$

$$\sigma = \frac{P_{cr}}{A} = \frac{\pi^2 EI}{(KL)^2\ A} \qquad (4)$$

P_{cr} : Maximum or critical load (vertical load on column)
E : Modulus of elasticity
I : Area moment of inertia
L : Unsupported length of column
K : Factor for various supports. (In this experiment fixed ends bending is used)

E) EXPERIMENTAL PROCEDURE:

1. Measure the dimensions of a specimen (*L, b, h*)

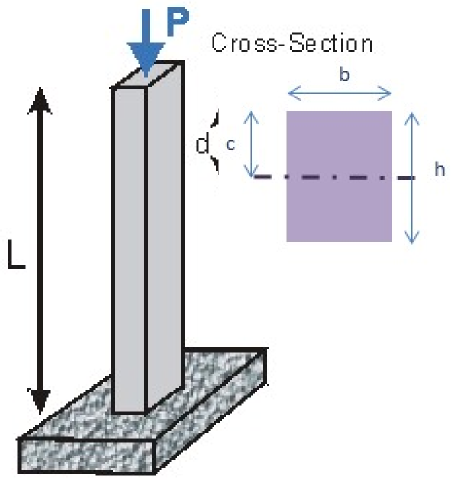

Figure 3: Dimensions of the specimen

2. Grip the specimen in the fixed heads of the UTM
3. Fix the extensometer within the gauge length marked on the specimen.
4. Adjust the dial of extensometer at zero.
5. Adjust the dial of the UTM to zero, to read load applied.
6. Keep speed of the UTM uniform.
7. Read the critical forces.

F) ASSIGNMENTS

1. Draw the force diagram and show critical load.
2. Calculate modulus of elasticity using critical load with Euler Formula.
3. Calculate the stress.
4. By using modulus of elasticity, find the critical load other support type.