# SPECIAL DESIGN AND PRODUCTION OF FIXTURE TO MEASURE THE SYMMETRIC AND ANTI-SYMMETRIC TENSILE BUCKLING LOAD OF THE NOTCHED THIN PLATES

***M.Z. Kabir[1], A.E. Seif[1]***

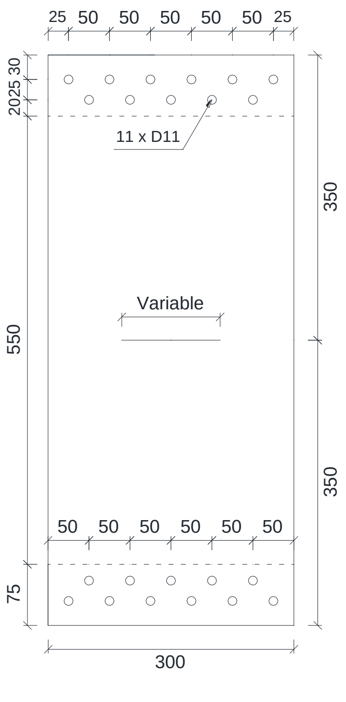
[1] *Department of Civil and Environmental Engineering, AmirKabir university of Technology Tehran, Iran*

## 1. General

The local buckling of the plate with a central notch under tensile loading has been studied by the authors [1], in which, two buckling modes of symmetric and anti-symmetric have been considered. In the current work, a special fixture was designed and produced to test the symmetric and for the first time the anti-symmetric buckling load. The main attention of the paper is to describe the fixture and test method. The specimens include the thin plates of C75 spring steel with a relatively high yield strength which allows user to perform successful local buckling tests without plastic failure. The buckling load was obtained from the tests and verified with both analytical and numerical results. The exiting experimental results of the other researchers were also been presented to show the accuracy of the current test method.

## 2. Fixture, specimens and test method

The main specimens with the total length of 700 mm were cut from the same coil with the width of 300 mm and thickness of 0.8 mm. The central notch with various lengths of 60, 90, 120 and 150 mm were formed by wire cut method using 0.25 mm wire. Fig. 1 gives the nominal dimensions of the samples and 3D view of the fixture.



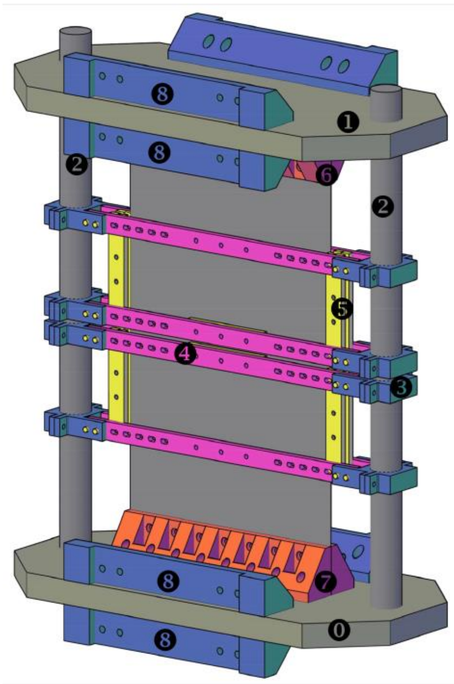




Fig. 1. Dimensions of the samples (mm) and 3D view of the fixture.

As can be seen in Fig. 1, the fixture is a complete mechanism made of different components which allow the operator to apply different boundary conditions on the notch edges as well as exterior edges of the specimen.

To obtain the buckling load, two strain gages were installed back to back on the one edge of the notch and the load-strains curves were recorded during the test. The load-deflection curves were also obtained from the LVDT mounted at the outer edge of the notch to use as additional data and to check the results of strain gages. The buckling load was then evaluated using the extended south well technique.

## 3. Main results

The buckling results of symmetric and anti-symmetric modes are presented in Table 1 for specimens with various crack lengths and they are compared with the numerical results of FEM and theoretical results from the previous work of the authors [1].

Symmetric mode

| | Experiment | FEM modelling | | Theoretical model [1] | |
|---|---|---|---|---|---|
| $a/W$ | $\sigma_b$ (kN) | $\sigma_b$ (kN) | Difference | $\sigma_b$ (kN) | Difference |
| 0.2 | 52.81 | 49.001 | 7.21% | 50.085 | 5.16% |
| 0.3 | 22.28 | 21.654 | 2.81% | 22.167 | 0.51% |
| 0.4 | 12.08 | 12.048 | 0.26% | 12.38 | 2.48% |
| 0.5 | 7.985 | 7.48 | 6.32% | 7.854 | 1.64% |

Antisymmetric mode

| | Experiment | FEM modelling | | Theoretical model [1] | |
|---|---|---|---|---|---|
| $a/W$ | $\sigma_b$ (kN) | $\sigma_b$ (kN) | Difference | $\sigma_b$ (kN) | Difference |
| 0.2 | 74.264 | 70.448 | 5.14% | 73.259 | 1.35% |
| 0.3 | 31.16 | 30.142 | 3.27% | 31.049 | 0.36% |
| 0.4 | 16.73 | 16.09 | 3.83% | 16.445 | 1.70% |
| 0.5 | 10.71 | 9.714 | 9.30% | 9.768 | 8.80% |

Table 1. Basic format specifications.

## 6. References


[1] A.E. Seif and M.Z. Kabir (2015). An efficient analytical model to evaluate the first two local buckling modes of finite cracked plate under tension, *Lat. Am. J. Solids Struct.*, **12**, 2078-2093.

[2] R.G. Forman (1965). Experimental program to determine effect of buckling and specimen dimensions on fracture toughness of thin sheet materials, *AFFDL*, TR-65-146.

[3] J.R. Dixon and J.S. Strannigan (1969). Stress distribution and buckling in thin sheets with central slits, *2nd Int. Conf. Fract.*, Brighton, UK, 105-118.

[4] G.F. Zielsdorff and R.L. Carlson (1972). On the buckling of thin tensioned sheets with cracks and slots, *Eng. Fract. Mech.*, **4**, 939-950.

[5] R. Brighenti (2009). Buckling sensitivity analysis of cracked thin plates under membrane tension or compression loading, *Nucl. Eng.Des.*, **239**, 965–980.

[6] M.Z. Dyshel (1999). Local buckling of extended plates containing cracks and cracklike defects, subject to the influence of geometrical parameters of the plates and the defects, *Int. Appl. Mech.*, **35**, 1272-1276.