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Buckling of cracked plate reinforced

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Abstract

The objective of this paper is to numerically analyze the buckling of reinforced structures (stiffened plate) cracked under compressive stress by considering the evolution of cracks and its orientation. Numerical modeling and calculation by the finite element method, estimated the critical load for compression panel. The work presented in the article was inspired by several publications that related to this field. Brighenti (2005) have studied the behavior of elastic buckling of rectangular cracked thin plate for different boundaries conditions. Following these calculations, a calibration function was derived to estimate the load ratio ψ to the compression function of the crack length and its inclination. We found that the variation of the critical stress is proportional to the crack dimensions. In buckling, a transverse crack is more stable than a longitudinal crack.

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Keywords: Buckling; Plate; Crack; Stiffness;

1. Introduction

The stability of the plate increases with the increase of the thickness of the plate. An efficient solution is obtained by keeping the thickness of the plate as small as possible by introducing reinforcements. TIMOSHENKO and GERE (1961) clearly explained and applied the bar theory in linear buckling problems in several concrete cases.

R. Brighenti (2005) has studied the behavior elastic buckling of rectangular thin plates in different cracks for different boundary conditions. Numerical results proved that the effects of cracks under the compression buckling phenomenon dependent on boundary conditions of the plate. K. Ghavami and M.R. Khedmati (2006) worked on stiffened plates Submitted to axial compression load to failure.

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The finite element method has been used by these authors to simulate the elastoplastic behavior of stiffened plates. A.H.S. Nathera and al (2011) have studied the buckling problem by taking the influense of boundary conditions, the relative length and the orientation of the crack. These authors deducted that the cracks were very sensitive to the slope and if the cracks extended along the compression field, they can have significant effects. Seifi R. and al (2011) have studied the buckling carrying the influence of parameters processed by Nathera and al (2011) were taken by these authors. The thickness of the plate and the applied partial supports have been making the subject of a further study; drew the following conclusions, the plate (without cracks) on two simple supports and two free edges, loaded on both sides buckle in mode 1 (a half-wave in the load direction). If the free edges are clamped, the plate buckles in mode 2, 3 or 4, is not in mode 1 or higher than mode 4. This study shows the buckling problem that can note on plates or panels of a ship. As it behaves like a beam on elastic under bending stress, there may be instability in the compression buckling of reinforced plates or panels. For a geometric ratio of the fixed plate with two transverse reinforcements and a central crack, a passage functions were determined to evaluate the critical stress buckling in case of a cracked panel from the critical stress uncracked panel. These functions take into account the relative crack length and orientation.

2. Elastic buckling

Generally, the buckling intervenes for stress in the material much lower than the failure limits. For a plate under uniform compression stress, the analytical solution of critical loads (N_{cr}) for the four buckling modes can be represented as follows:

$$N_{\sigma} = \frac{k\pi^2 D}{b^2} \tag{1}$$

K is a coefficient which depends on the ratio b/a, and D is the flexural rigidity of the isotropic plate.

$$D = \frac{Et^3}{12\left(1-\upsilon^2\right)} \tag{2}$$

T is the thickness of the isotropic plate, E and ν are respectively the Young's modulus and Poisson's ratio of the material.

3. Elastic critical buckling load

It is obtained from the equation of linear buckling. It is given in the form:

k_{σ} is the dimensionless buckling ratio, under normal stresses σ .

$$\sigma_E = \frac{\pi^2 E}{12\left(1-\upsilon^2\right)}\left(\frac{t}{b}\right)^2 \tag{3}$$

Buckling coefficient k depends on α = a/b aspect ratio of the plate, the inflectional boundary conditions of the plate, plate stress, properties and location of the stiffening when the plate is stiffened.

4. Stiffeners

The stiffeners can suppress global buckling modes of the panel, and they provide a burden-sharing between the individual beams and thin plates as shown in a ship section (Figure 1).

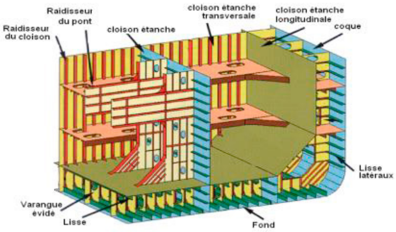

Fig 1. Chief section of a ship with various stiffened elements.