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Investigation of stress in rotating cylinders with gray irons (Grade G4000) materials by mathematical programming

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Abstract
In this study, the elastic stresses occurring in a rotating cylinder made of Gray Irons (Grade G4000) material were investigated analytically. Elastic ranges were calculated analytically with reference to the Von Mises yield criterion. Obtained results are shared in graphics. It was determined that the rotating cylinder was inversely proportional to the increase in the rating parameter

Introduction

Cylinders are the reason for quite a lot of preference in the machine parts to be designed. Rotating cylinders of different sizes are used in integrated machine parts. It is important for engineering to know the stresses that occur in rotating parts exposed to high temperatures. Together with the literature search; In a study, stresses and deformations occurring in a rotating disk of different thickness were investigated. The results obtained were compared with each other [1]. In another study, the rotating ring disk stresses evaluated functionally were investigated. Different states of the disks mechanical cases displacement and recycling are indicated. The radial displacement and stresses of the proposed FGM disc are smaller than the conventionally homogeneous one disc .It it has been determined that the radial displacement and stresses of the proposed FGM disc are less than the traditionally homogeneous disc [2].In other similar studies, respectively; Thermomechanical properties of a rigid body-bodyless, functionally graded, uniform disc and stresses occurring in FGM cylinders were investigated, and the results obtained were shared with the literature in graphical form [3-4].Radial and tangential stresses formed in discs consisting of different materials have been investigated in different studies and compared with the literature [5-8].

Analytical Solution

The material of the cylinder to be analyzed is Gray Irons Grade G4000 selected from the appropriate material. Gray Irons Grade G4000the mechanical properties are given in Table 1.

Table 1. Mechanical properties of cylinder material [9]

Gray Irons Grade G4000	Modulus of elasticity	w	Density	Cylinder Inner half diameter	Cylinder Outer semi-diameter
	138 GPa	75 rad/sn	7150 kg/m3	30 mm	80 mm

Stress analysis in cylinders

Two-dimensional equilibrium equation in cylindrical coordinates [10];

$$\frac{d(\sigma_r)}{dr} - \frac{1}{r}\frac{(d\tau_{r\theta})}{d\theta} + \frac{(\sigma_r - \sigma_\theta)}{r} + R = 0 \tag{1}$$

For the stress analysis equation in rotating cylinders;

$$r^2\frac{d^2F}{dr^2} + r\left[1 - r\frac{E'(r)}{E(r)}\frac{dF}{dr}\right] + \left[v(r)\frac{E'(r)}{E(r)} - 1\right]F = \rho(r)\omega^2 r^3 [r\,\frac{E'(r)}{E(r)} - \frac{\rho'(r)}{\rho(r)} - 3 - -\frac{v}{1-v} \tag{2}$$

$$\sigma_r = C_1 r^{(n+k-2)/2} + C_2 r^{(n-k-2)/2} + Ar^{(2+\gamma)} \tag{3}$$

$$\sigma_\theta\,(MPa) = \frac{n+k}{2}C_1 r^{\frac{n+k-2}{2}} + \frac{n-k}{2}C_2 r^{\frac{n-k-2}{2}} + (3+\gamma)Ar^{(2+\gamma)} + \rho(r)\omega^2 r^2 \tag{4}$$

According to the formulas above; r=et transformation is performed, E_0, modulus of elasticity, ρ_0 density reference value, n and γ are optional constants.C1 and C2 are integral constants. For boundary conditions;

Findings

The radial stress, tangential stress and axial stresses that occur in a cylinder rotating at a speed of w=50 rad/sec with Gray Irons (Grade G4000) material are given in Figure 1-3.

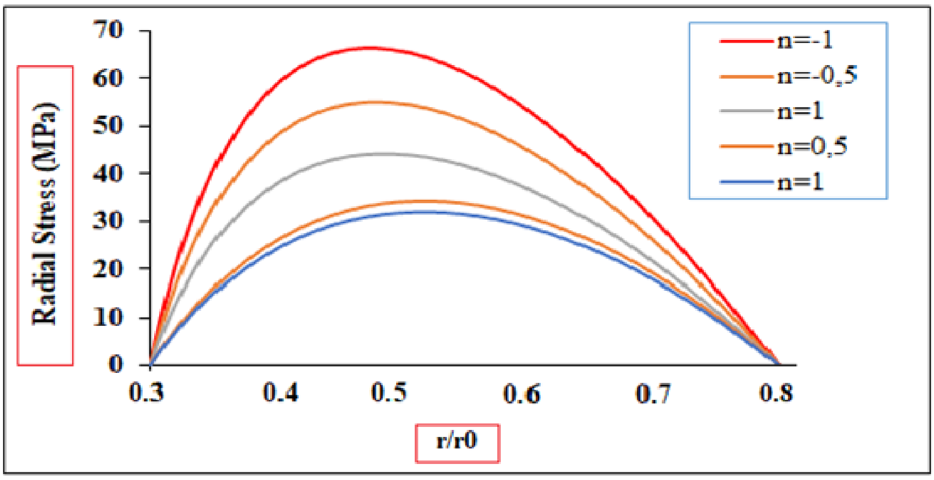

Figure 1. Radial stresses occurring in a cylinder rotating at a speed of w=50 rad/sec with Gray Irons (Grade G4000) material

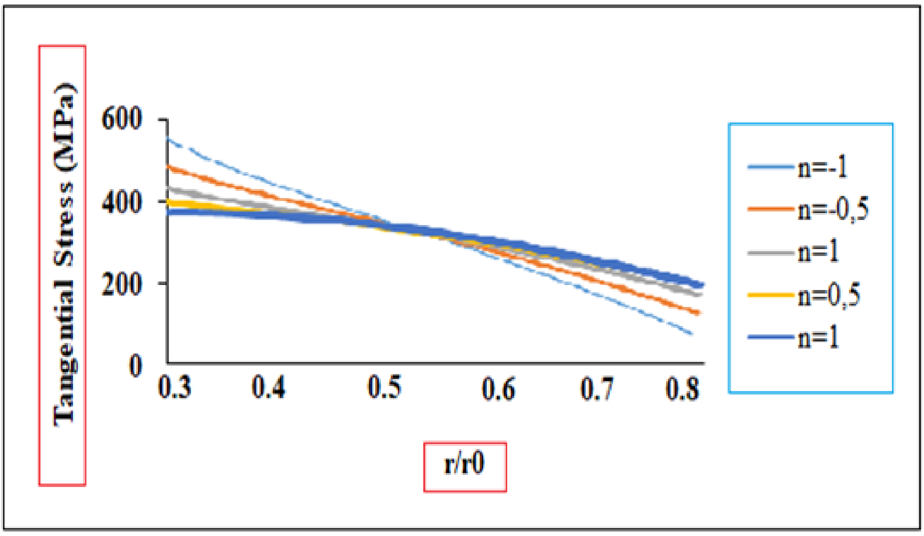

Figure 2. Tangential stresses occurring in a cylinder rotating at a speed of w=50 rad/sec with Gray Irons (Grade G4000) material

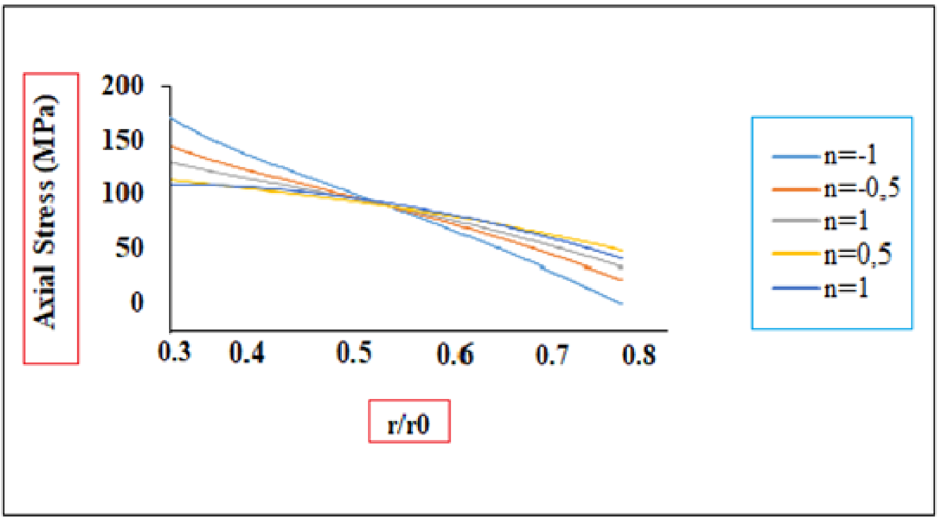

Figure 3. Axial stresses occurring in a cylinder rotating at a speed of w=50 rad/sec with Gray Irons (Grade G4000) material

Conclusion

In this study, the stresses occurring in a cylinder with Gray Irons (Grade G4000) material rotating at a hungry speed of w=50 rad/sec were numerically investigated. Gray Irons (Grade G4000) radial stresses on the innermost and outermost parts of the cylinder are zero. It was seen that the stresses were inversely proportional to the increase in the rating parameter in the cylinders. Gray Irons (Grade G4000) maximum radial stresses occurred in the central regions closer to the inner part of the cylinder. It has been observed that the tangential stress occurring in the cylinder is approximately 300% more than the axial stress.

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