Generalized Hooke's Law

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Abstract

In this paper the generalized Hooke's law has been presented.
Keyword : Generalized Hooke's law.

1 INTRODUCTION

Hooke's law is valid for small deformation of a solid body.

2 GENERALIZED HOOKE'S LAW

Let $E_i = E_i(x, y, z)$; $G_{ij} = G_{ij}(x, y, z)$; $\nu_{ij} = \nu_{ij}(x, y, z)$; $\nu_{ij} = \nu_{ji}$; i, j [$i \neq j$] = x, y, z

$$\varepsilon_{xx} = \frac{\sigma_{xx}}{E_x} - \nu_{xy}\frac{\sigma_{yy}}{E_y} - \nu_{xz}\frac{\sigma_{zz}}{E_z}$$

$$\varepsilon_{yy} = \frac{\sigma_{yy}}{E_y} - \nu_{yx}\frac{\sigma_{xx}}{E_x} - \nu_{yz}\frac{\sigma_{zz}}{E_z}$$

$$\varepsilon_{zz} = \frac{\sigma_{zz}}{E_z} - \nu_{zx}\frac{\sigma_{xx}}{E_x} - \nu_{zy}\frac{\sigma_{yy}}{E_y}$$

$$\gamma_{xy} = \frac{\tau_{xy}}{G_{xy}}$$

$$\gamma_{yz} = \frac{\tau_{yz}}{G_{yz}}$$

$$\gamma_{zx} = \frac{\tau_{zx}}{G_{zx}}$$

where $\gamma_{ij} = \gamma_{ji}$; $\tau_{ij} = \tau_{ji}$; $G_{ij} = G_{ji}$
Thus there are nine body parameters for a given body and at a given location within the body.

3 HOOKE'S LAW FOR A HOMOGENEOUS BODY

Case (i): For a homogeneous body having cuboidal symmetry in arrangement of unit cells. For this case the corresponding moduli of elasticity and Poisson's ratios will be same for all locations within the body, i.e.,
$E_i(x, y, z) = A_i$, $G_{ij}(x, y, z) = B_{ij}$, $\nu_{ij}(x, y, z) = C_{ij}$
where i, j [$i \neq j$] = x, y, z and A_i , B_{ij} , C_{ij} are material dependent constants.

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Case (ii): For a homogeneous body having axial symmetry in arrangement of unit cells. For this case the corresponding moduli of elasticity and Poisson’s ratios will be same for all locations within the body, i.e.,
$E_i(r, \theta, z) = A_i$, $G_{ij}(r, \theta, z) = B_{ij}$, $\nu_{ij}(r, \theta, z) = C_{ij}$
where i, j [$i \neq j$] = r, θ, z and A_i , B_{ij} , C_{ij} are material dependent constants.

Case (iii): For a homogeneous body having spherical symmetry in arrangement of unit cells. For this case the corresponding moduli of elasticity and Poisson’s ratios will be same for all locations within the body, i.e.,
$E_i(r, \theta, \varphi) = A_i$, $G_{ij}(r, \theta, \varphi) = B_{ij}$, $\nu_{ij}(r, \theta, \varphi) = C_{ij}$
where i, j [$i \neq j$] = r, θ, φ and A_i , B_{ij} , C_{ij} are material dependent constants.

4 CONCLUSION

Thus this theory provides us with an easy and effective method for stress analysis.

References

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