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TRANSITION ANALYSIS IN SOLIDS

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Abstract

SETH'S transition theory and generalized strain measures play significant role to study the transition concept in the solids. According to classical theory, the behavior of transitions occuring in the solids are linear in nature and fails to tell about non-linearity behavior in the transitions. It was B.R Seth who successfully explained about the transition state in the solids known as "Intermediate State". The transition analysis in solids is very helpful for the engineers to understand the initial yielding and fully plastic state occurring in the solids due to elastic-plastic transition in the solids and provide guidelines to engineers to make safe and economical machinery products.

Keywords: Elastic, Plastic,Creep, Transition, stress, strain.

Introduction

The transition concept of deformation in the solid bodies has been developed by Seth in 1963.Transition is a physical phenomenon in which the fundamental structure of solid get disturbed . There is hardly any branch of engineering and technology in which body does not come across transition from one physical state to another state. In this paper, we will focus on the elastic-plastic and creep transitions. The concept of elastic-plastic & creep transition problems is related to the science of forces and motions. These transitions occurs with in the solid materials, especially when the stress is applied to the body. The transition occur in the body due to deformations. The term deformation plays a major role in the transitions. Deformation is a physical phenomenon causes change in shape, size or position of a body part as a result of compression, deflection or extension [2]. A deformation may be occurred due to body forces, internal pressure, external loads or temperature changes in the body. There are three type of Deformations occurring in the body due to stresses in the body. Deformations which are recovered after the removal of body forces are called elastic deformations. In this case, a body completely recovers its original configuration. On the other hand, if deformation remains even after body forces have been removed is called plastic deformation. It is one of type of irreversible deformations in which material bodies after stresses have attained a certain threshold value known as the elastic limit or yield stress A yield stress is the material property defined as the stress at which a material begins to deform plastically. Prior to the yield point the material will deform elastically and will return to its original shape when the applied stress is removed. Once the yield point is passed, some fraction of the deformation will be permanent and non-reversible. In materials science, creep transition is the tendency of a solid material to move slowly or deform permanently occur as a result of long-term exposure to high levels of stress. Creep is more severe in materials that are subjected to heat for long periods, and generally increases as they near their melting point. If the state of deformation in a body remains constant throughout the whole part of the material body is called homogeneous deformation .Thus, the deformation is responsible for change the behavior of body from elastic to plastic and plastic to fracture of the body.

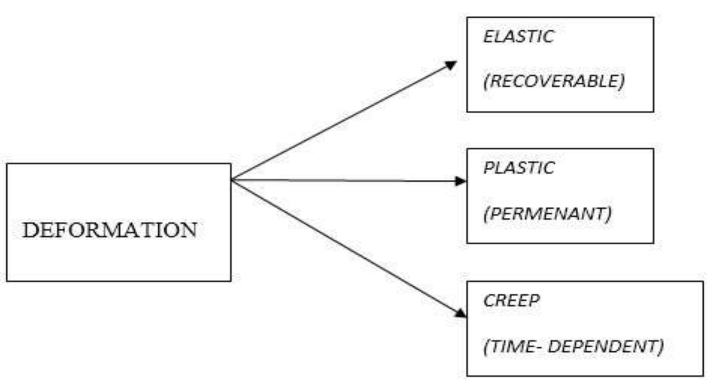

Figure: Deformation Behaviour Of Solid

Objective Of Study

To analyze the behavior of transition concept in the terms of the elastic-plastic and creep transitions developed by B.R. Seth.

Role Of Stress- Strain In Transitions

Stress and strain curves are very useful to show the behavior of elastic-plastic and creep transitions. The concept of stress- strain come into existence when a external forces like pressure, thermal effects are applied to the body, they produces new changes in the shape and size of the body. The term stress can be defined as internal forces generated per unit area in the solid body due to the external forces. The stress is also known as the tensile stress because every part of the solid body is subjected to tension[13].The term strain is associated with the stress, that is when a body is under the stress cause change in the shape and size of the body is known as strain in the body. The stress and strain in the body depends on the elastic properties of the body and different for the different materials. According to the HOOKE'S law , there is linear relationship between stress and strain. But this linearity holds only in case of elastic transitions up to certain limits known as yield point. After that the yielding starts in the body results in plastic behavior in the body. The change in the behavior from elastic to plastic transition occurs under non-linear curve as shown in the figure.

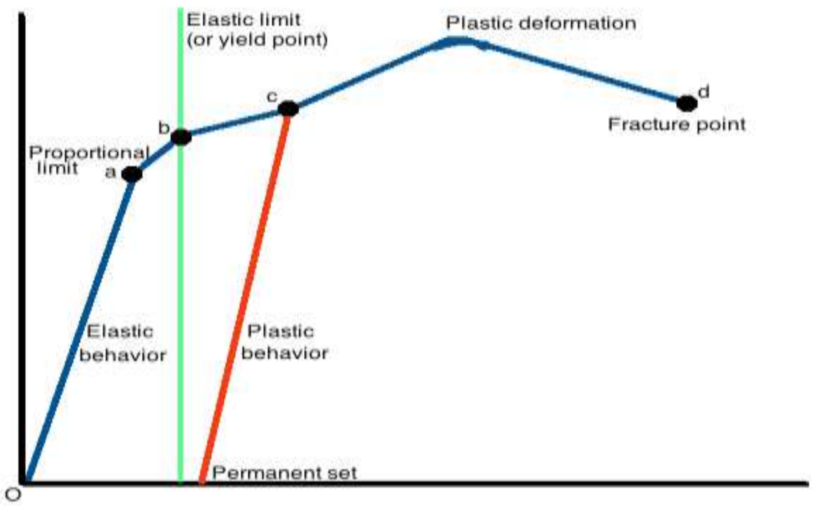

figure2: Stress-strain curve for elastic-plastic transition in solid

Seth's Transition Theory Of Solids

In 1868, Tresca considered that there exist a intermediate zone between elastic and plastic states of solid which is known as the "Transition Region". Many authors had tried to identify this intermediate state which is separate from elastic and plastic state. It was attempt of B.R. Seth who had explained successfully about this transitions occurring in the body due stress and strains. Seth has developed the concept of the generalized strain measures to study these transitions occuring in the solids. In order to study the transition behaviour of the solids, first of all the displacement components for the solid are taken then using the concept of generalized strain measures and gegenarlized hookes law, we can solve the transition criterian for the solids which is asymptotic in nature at critical points. By using these generalized strain components , the stress components can be obtained for the deformed body. The generalized components for strain are defined Seth as

$$e_{ii} = \int_0^{e_{ii}^A} [1 - 2e_{ii}^A]^{\frac{n-2}{2}} de_{ii}^A = \frac{1}{n}[1 - (1 - 2e_{ii}^A)^{\frac{n}{2}}, \text{ i=1, 2, 3.}$$

Also we have generalized hookes's law for isotropic material are given by Sokolnikoff
$T_{ij} = \lambda\delta_{ij}I_1 + 2\mu e_{ij}$, $(i, j = 1,2,3)$

where λ and μ are lame's constants and $I_1 = e_{kk}$ is called first strain invariant.
The finite strain components are given by Seth as

$e_{rr}^A = \frac{1}{2}[\,1-(r\,\beta' + \beta)^2]$, $e_{\theta\theta}^A = e_{\varphi\varphi}^A = \frac{1}{2}(1 - \beta^2)$

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$e^A_{r\theta} = e^A_{\theta\varphi} = e^A_{r\varphi} = 0$

where $\beta' = \frac{d\beta}{dr}$ and using the hookes law, we have generalized stress measures as

$T_{rr} = \frac{\lambda+2\mu}{n}[1-(r\,\beta'+\beta)^n] + \frac{2\lambda}{n}(1-\beta^n)$

$T_{\theta\theta} = T_{\varphi\varphi} = \frac{\lambda}{n}[1-(r\,\beta'+\beta)^n] + \frac{2\lambda+2\mu}{n}(1-\beta^n)$

$T_{r\theta} = T_{\theta\varphi} = T_{r\varphi} = 0$

This concept of generalized strain measaures and seth's transition theory is helpful to analysis the transition behaviour of solids in terms of elastic-plastic and creep transitions.

Conclusion

Therefore, it is observerd that transitions occuring in the solids have elastic-plastic and creep behaviour due to stresses. These elastic-plastic and creep transitions are non-linear in nature and their behaviour can be studied bu using the concept of generalized strain measures and Seth's transition theory.

References

1. Pankaj, T, "Deformation in a thin rotating Disc having variable thickness and Edge load with inclusion at the Elastic-Plastic transitional stresses", Vol.12, No 1, 2012.
2. Seth B.R., "Generalized Strain and Transition Concepts for Elastic-Plastic Deformation, Creep and Relaxation", Proc. XIth Int. Congress of Appl. Mech. Munich, pp. 383-389, 1964.
3. Purushothama, C. M.,"Elastic Plastic transition, ZAMM, 45(1965) Heft6, Seite 401-408. .
4. Seth B.R., "Transition Theory of Elastic-Plastic Deformation, Creep and Relaxation", NATURE, vol. 195, No. 4844, pp. 896-897, 1962.
5. Odqvist, F. K. G., Proc. IUTAM Symp. Second Order Effects in Elasticity, Plasticity and Fluid Dynamics (Haifa, 1962).
6. Seth, B. R. "Measure Concept in Mechanics", Int. J. Non-linear Mech., Vol.1, pp. 35-40, 1966.
7. Gupta, Sonia. & Verma, Gaurav. , "Elastic Plastic Transition in Shells Under Internal Pressure", IJETAE, Volume 4, Issue 8, August 2014.
8. Sokolnikoff I. S. "THE Mathematical Theory of Elasticity", MCGRAW Hill, 1946.
9. Beer, F, Johnston, R, Dewolf, J, & Mazurek, D. (2009). Mechanics of materials. New York: McGraw-Hill companies.