◆ ABSTRACTS OF TECHNICAL PAPERS ◇

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Solid-Mechanics Strength of Materials

Study on the Interactioon of Fatigue Crack Propagation in Hybrid Bodies

Kazuaki SHIOZAWA, Kazyu MI-YAO* and Tsuneji KAZAMAKI** Interaction of crack growth in hybrid bodies subjected to cyclic loading is investigated using the coupled compact tension specimens model. Coupled CT specimens of 0.45% C steel, JIS S45C and aluminium alloy, A2017-T4, individually precracked to their initial lengths are loaded by common pins in the grip of a fatigue machine. The crack propagation behaviour of coupled specimens fatigued under a stress ratio of 0.05 is compared with that of a single specimen. It is found experimentally that crack growth rate of one of the coupled specimens is accelerated by the plasticity induced crack closure of another specimen. This behaviour is affected by the difference in residual plastic stretch on the crack wall in each specimen. An interaction curve for coupled hybrid specimens is theoreti-cally predicted, and the interaction law is discussed. It is concluded that multiple ended fatigue cracks may propagate with a mechanism such that the increment of total energy release rate in a hybrid body is distributed to each crack with the ratio of the strain constraint factor.

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A Fundamental Study on Parameters in the Expression of Fatigue Crack Growth Rath (In the Light of Crack Energy Density)

Katsuhiko WATANABE and Makoto ITO*** Previously, a general expression of fatigue crack growth rate was derived by one of the authors, based on the concept of crack energy density. In this paper, the meanings of that expression and the parameters of which that expression is composed are considered; and the meaning of conventional expression like the law of Paris is also made clear. Experiments of fatigue crack growth and finite element analyses corresponding to these experiments are carried out the influences of the differences of material, type of load and crack length or the like on the parameters and crack growth rate are discussed based on the results and it is verified that such influences can be evaluated by the general expression above. It is also pointed out that, if the constitive relation of the material is given, it may be possible to evaluate the growth rate as well as the influences of various differences.

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Dependence of Threshold Stress Intensity Factor Range ΔK_{th} on Crack Size and Geometry and Material Properties

Yukitaka MURAKAMI and Kenji MATSUDA** The dependence of ΔK_{th} on crack size and geometry, and Vickers hardness H_V under stress ratio $R=-1$ was studied. The effects of crack size and geometry are unified with a geometrical parameter $\sqrt{area}$ which is the square root of the area occupied by projecting defects or cracks onto the plane normal to the maximum tensile stress. The dependence of ΔK_{th} on $\sqrt{area}$ is expressed by $\Delta K_{th}\propto(\sqrt{area})^{1/3}$ and that of ΔK_{th} on H_V is expressed by $\Delta K_{th}\propto(H_V+C)$. For small cracks and defects with $\sqrt{area}\leqq 1\,000\ \mu m$, the following equation for predicting ΔK_{th} and the fatigue limit σ_w are available: $\Delta K_{th}=3.3\times10^{-3}(H_V+120)(\sqrt{area})^{1/3}$ $\sigma_w=1.43(H_V+120)/(\sqrt{area})^{1/6}$ where the units in these equations are ΔK_{th}: MPa·m$^{1/2}$, σ_w:MPa, $\sqrt{area}$: μm. For cracks and defects with $\sqrt{area}>1000$ μm, the dependence of ΔK_{th} on crack size gradually changes from $(\sqrt{area})^{1/3}$ to $(\sqrt{area})^0$ and this causes the difference in the exponent n in the equation of the type $\sigma_w^n l=C$ which was first obtained by N.E. Frost, and was conffrmed later by other researchers. Although the tendency of many data indicates that there may be a linear correlation between ΔK_{th} for a large crack and H_V, more systematic studies are necessary to establish the exact relationship between ΔK_{th} and H_V.

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Dynamic Interaction between Penny-Shaped Cracks in an Infinite Solid

*Sei UEDA** This paper deals with the dynamic interaction between penny-shaped cracks in an infinite solid. Laplace and Hankel transforms are used to reduce the mixed boundary value problems to a set of dual integral equations. The solution is expressed in terms of a Fredholm integral equation of the second kind having a kernel with fast rate convergence. A numerical Laplace inversion technique is used to recover the time dependece of the solution. The dynamic stress intensity factor is determdsed and its dependence on time and the geometry parameter is discussed.

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