Suggestion of Another Idea of Fracture

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Results of experimentation

On the behaviour of Al Column by homemade simple apparatus with drop hammer.

(1) Synchroscopic photograph of acceleration-time on impact compression test by $BaTiO_3$ acceleration pick-up are shown in Fig. 1~Fig. 6.

Explanation from Fig. 1 to Fig. 6.

No. of figures	1	2	3	4	5	6
Weight of drop hammer: W;kg	5.	5	5	5	5	5
Height of drops; h:mm	70	70	100	100	300	300
Sweeping time per a scale	10 MS	300 μS	10 MS	300 μS	10 MS	300 μS
Size of test piece: ϕ mm x ℓ mm.	20x30	20x30	20x30	25x50	20x50	20x50

MS: Milli-second, μS: Micro-second, ϕ:Diameter of test piece, ℓ : Length of test piece.

And at the same time, synchroscopic photograph of strain-time on impact compression test by strain gauge pick-up are shown in Fig. 7~Fig. 12.

Explanation from Fig. 7 to Fig. 12.

No. of figures.	7	8	9	10	11	12
Weight of drop hammer: W;kg	5	5	5	5	5	5
Height of drop: h: mm	70	70	100	100	300	300
Sweeping time per a scale	10 MS	300 μS	10 MS	300 μS	10 MS	300 μS
Size of test piece: ϕ mm x ℓ mm	20x30	20x30	20x30	25x50	20x50	20x50

Each Fig. 1~6 correspond with each Fig. 7~12.

Fig.11 and 12 show only perfect slip deformation without elastic deformation.

The same phenomena, i.e. that of only perfect slip deformation. appear not only in larger range of impact velocity u , but also in larger range of weight W of hammer and also in smaller range of size $\ell \times A$ of test piece (ℓ :length of test piece, A : sectional area of test piece).

(2) When arranging data with relation between σ and $W \cdot u^2/\ell \cdot A$, this diagram as in Fig. 13. shows the similar law between σ and $W \cdot u^2/\ell \cdot A$. (σ :Kg/mm^2:stress, W :Kg: weight of hammer, u :mm/s: impact velocity, ℓ :mm:length of test piece, A : mm^2:sectional area of test piece)

(3) When arranging data by stress measuring apparatus, i.e.strain gauge glued on steel column, these diagrams are as in Fig. 14,15,16. Fig. 14 is that in impact compression test, Fig. 15 is that in impact tensile test, and Fig. 16 is that in impact shear test. In Fig.15 and Fig. 16, about 3.5 x 10^4 kg/S^2.mm in value of $W \cdot u^2/\ell \cdot A$ is the bounds between range of no-rupture (black dots; ●)and rang of rupture (white dots; ○). This shows that fracture does not always require the notch, and in fact the concentrated stress can not be considered, because there disappears perfectly elastic deformation as in Fig. 11 and Fig. 12. In Fig. 14, the behaviour of rupture is not clear (● : black dots; data in variation of only size of test piece, ▲ : black delta dots; data in Variation of only impact velocity).

(4) Fig. 17 shows the relation between σ and $W \cdot u^2/\ell \cdot A$ by impact tensile notch test. (σ :Kg/mm^2 ;stress, W :Kg:weight of hammer, u :mm/s: impact velocity, R :mm: radius of curvature at bottom of notch, $2b$:mm: diameter of core at bottom of notch) and group of data: △ : ℓ : 10mm (ℓ :length of test piece),data: ○ : ℓ : 40mm, data: ● : ℓ : 70mm.

Explanation of phenomena

(1) Supposing that the equation of motion is $\rho \frac{\partial^2 v}{\partial t^2} = \frac{\partial \sigma}{\partial x}$, ρ : density, v : displacement, t; time, σ :stress, x : co-ordinate, and if Froud's No.$V^2/\ell \cdot \alpha$ (α :impact acceleration instead of g : acceleration of gravity) is constant, as ℓ : base length, V : base velocity, the system of this phenomena is dynamically similar.

On experimentation, because impact acceleration α is proportional to V^2/ℓ , this system is dynamically similar.

And by $f = m\alpha = A \cdot \sigma$, as f = impact force or resistence, m : mass of hammer, because σ is proportional to $W \cdot u^2/\ell \cdot A$ as in rising lines of Fig. 13, 14, 15, 16, there is formed the similar law between σ and $W \cdot u^2/\ell \cdot A$.

(2) This conclusion theoretically means that while σ is proportional to $W \cdot u^2/\ell \cdot A$, phenomena are not rupture, i.e. fracture does not occour by outer force ($W \cdot u^2$) less than permissible capacity of material in size ($\ell \times A$).

Also this is that theoretically the phase lag in behaviour of material happens to outer force, and further this is proved from idea of forced vibration, i.e. response (stress or strain) to force (outer force). This idea means that fracture occurs sensibly at unbalance in resistance of material to outer force.

Conclusion of the Idea.

(1) Fig. 17 shows that the larger the total size of test piece, the smaller the stress of fracture.

(2) Also fig. 17 shows that there is not only equivalency betweem sharpness of notch and velocity of deformation, but also betwen those and weight of drop hammer.

(3) Fig. 15 and 16 show that there occours fracture (or rupture) without notch.

(4) Fig. 15,16,17 show that problem of fracture with notch is included in the above mentioned idea.

(5) As in (2) of Explantion of phenomena, if fracture (or rupture) is unbalance in resistence to outer force at any moment , data of stress is to be scattering, i.e. strength of fracture of material is not constant.

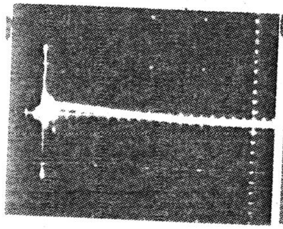

Fig. 1

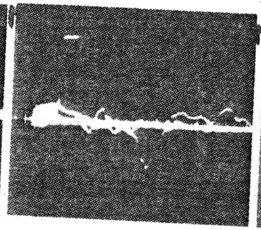

Fig. 2

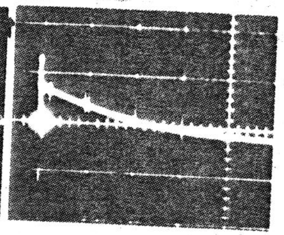

Fig. 3

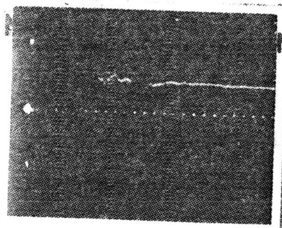

Fig. 4

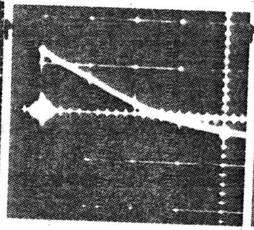

Fig. 5

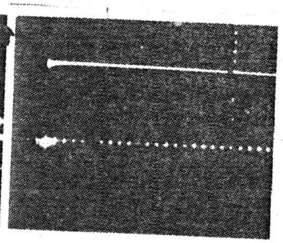

Fig. 6

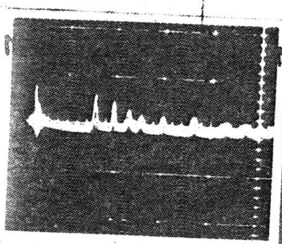

Fig. 7

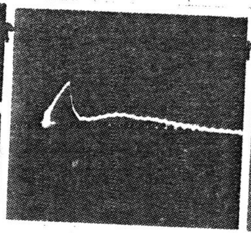

Fig. 8

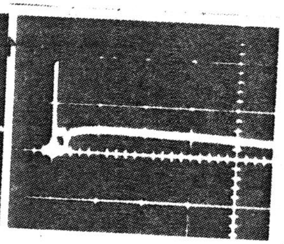

Fig. 9

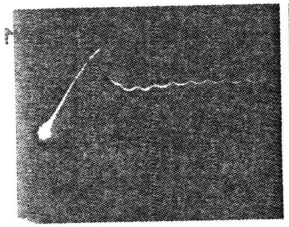

Fig. 10

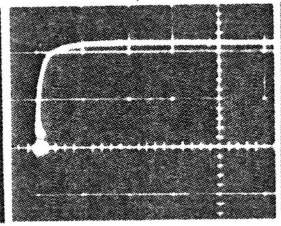

Fig. 11

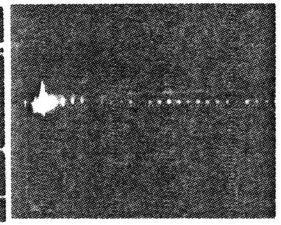

Fig. 12

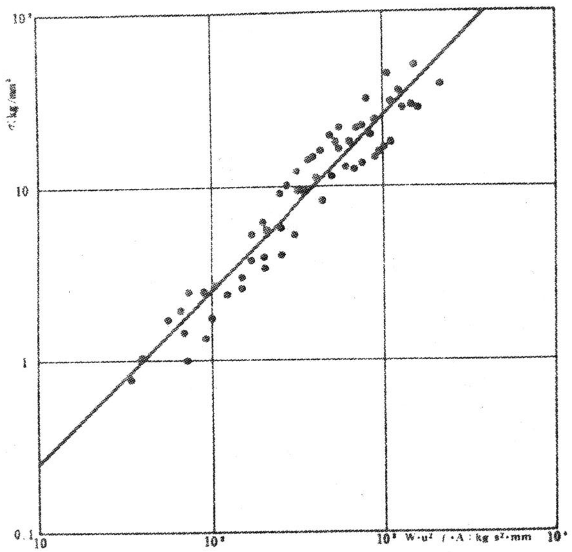

Fig. 13