

On the Velocity of Formation of Lüders Bands

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1. Introduction. In the following article¹ it is assumed that the Lüders band is initiated by the formation of an indefinitely small plastic region within the elastic material at its yield point. This plastic region then grows or is propagated with great rapidity into the elastic material resulting in the appearance of the band as observed, for example, in tensile tests on flat plates.

In Fig. 1 the region BFGC represents the portion of the plastic band already formed in a thin rectangular bar while AEFB and CGHD are the associated elastic regions which will pass into the plastic state as a result of the propagation. The angle θ in Fig. 1, which determines the direction of the final band relative to the applied load, is considered to have its theoretical value $35^{\circ}16'$. This idealized concept of the formation of a Lüders band in a thin rectangular bar, with ABCD and EFGH in Fig. 1 representing planes perpendicular to the flat sides of the bar, will furnish the basis of the following investigation.

We shall be concerned with (1) the determination of the portion CG (or BF), hereafter denoted by Σ for brevity, of the surface of separation of the plastic material of the band and the elastic medium, and (2) the normal velocity G of propagation of Σ . On the basis of the continuity assumption in §2 we have shown in §4 that Σ must be a plane normal to the flat sides of the bar and either parallel or perpendicular to the direction of the applied load. Moreover, the normal velocity G of Σ will be equal to the velocity of propagation of an equivoluminal disturbance in the elastic medium (§4). From these results we immediately deduce the *velocity of formation* V of the Lüders band, defined as the velocity of propagation of Σ in the direction of the lateral sides ABCD and EFGH of the band. Formulæ for V are given in §5.

The Prandtl-Reuss stress-strain relations for plastic flow are used in this investigation and we have availed ourselves of the results on Lüders bands, valid under these relations, in our previous paper² in THIS JOURNAL.

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² *The Lüders band problem*, Jour. of Math. and Mech. 7 (1958), pp. 17-27.