Discussion

Prediction of Creep-Deflection and Stress Distribution in Beams From Creep in Tension[1]

Joseph Marin.[2] The discrepancies between the creep-test results in bending and the prediction of creep bending by theory based on tension creep is subject to error since the samples used for the bending tests are taken from a different part of the sheet than those for the tension tests. Test data have shown that for the material tested, considerable variation in mechanical properties may occur, depending upon the location of the specimen in the sheet of plastic from which the specimen was cut.

The author assumes in the theory proposed that the tension and compression-creep behavior is the same. Tests of various plastics, including the laminated plastics considered by the author, indicate that considerable difference can occur between the creep in tension and compression. Theories are available in the literature that take into account these differences.

It also should be noted that the use of the hyperbolic sine relation for creep, which is of the same form as the activation energy, should not be interpreted to mean that the relationship used for creep is a fundamental one; that is, the hyperbolic creep-strain relation used still remains an empirical one in the same way as other relationships proposed.

Authors' Closure

We would like to thank Dr. Marin for his comments. The questions raised may be clarified as follows:

The possible sources of error in the test data and assumptions made were fully acknowledged in the paper. It will be observed that the consistency of creep data is excellent when the selection of samples and testing techniques are carefully controlled as in the tension creep tests performed in our own laboratory (see Fig. 2 of the paper). Whether the inconsistencies in data for bending creep obtained from another laboratory (see Fig. 3 of the paper) are due to the causes suggested by Dr. Marin is not known. The questions posed by differences between creep in tension and compression were considered by the authors in the present paper and form part of a subsequent report.[3] Usable creep data in compression, however, were not available, as described in the present paper. Theories available in the literature for creep in bending when the creep in tension and compression are not equal were cited and reviewed in the paper.

The hyperbolic sine-stress functions were based on the activation-energy theory—the time function was based on the observation of many creep curves. The authors have not claimed that the creep relation employed is fundamental. However, it does seem that a form of creep equation which closely describes test data of several materials, which contains a function derived from a broadly based concept such as activation energy, which has a minimum of constants, and which predicts known behavior at small values of the variables is a more significant relation than relations which do not have all of these attributes. There seems to be a tendency to try to avoid using empirical relations as though there were some stigma attached to them. If we did avoid them we would be completely at a loss to describe most physical phenomena. Surely the method of observing a physical behavior and seeking a mathematical relation to describe the behavior may be called empirical. However, if one continues to observe this behavior in all possible or available settings and finds the chosen relation to be applicable then the relation may be described as a law of the available universe. One relation so derived is Newton's second law of motion—an empirical relation. It is upon such basic empirical laws that many rational relations describing physical phenomena are derived, such as the whole of Newtonian mechanics.

[1] By W. N. Findley and J. J. Poczatek, published in the June, 1955, issue of the Journal of Applied Mechanics, Trans. ASME, vol. 77, pp. 165–171.

[2] Professor and Head, Department of Engineering Mechanics, The Pennsylvania State University, University Park, Pa. Mem. ASME.

[3] "Prediction of Creep in Bending From Tension Creep Data When Creep Coefficients Are Unequal," by W. N. Findley, J. J. Poczatek, and P. N. Mathur, Interim Report No. 3 to Picatinny Arsenal, Contract No. DA-11-022-ORD-401, February, 1954.

Frictional Vibrations[1]

J. J. Bikerman.[2] Erroneous statements on friction have been published so often in the last 30 years that it is a particular pleasure to welcome an investigation based on sound scientific principles.

In the writer's opinion all six conclusions of the author are correct and well substantiated by the experimental results reported in the paper. It is clear that the author knows his apparatus; when he observed (Fig. 13) an unexpected series of short oscillations, he did not attribute it to a fancy molecular mechanism but rather looked into its mechanical origin and thus traced it to vibration of the cast-iron base of the instrument.

However, the Bibliography can be improved upon. The first three conclusions were stated by Kaidanovskii and Khaikin[3] in 1933, and Equations [4] and [5] were derived by Bock[4] in 1936. That "time is required for the static friction to develop" was known to Coulomb.

After a step has been made in the right direction, the onlookers naturally wonder what the next step will be. Perhaps the writer will be allowed to make a few suggestions in this respect.

It would seem that elimination of brake squeal by making friction coefficient to increase with speed is not at all impossible. It is hoped that research in this direction will continue.

It also is hoped that time will be found to study the mechanism of friction between metal and brake surfaces. The author mentions only two possible mechanisms, namely, adhesion and lifting over surface asperities. These two phenomena do not exhaust all possibilities. Probably the elastic deformation of the brake is the main cause of the high resistance to its sliding over the metal surface. When rubber is used as rubber, i.e., as eraser of pencil marks, the main work of friction is spent not on overcoming surface roughness and, of course, not on the non-existing welding, but rather on elastically deforming the eraser.

[1] By David Sinclair, published in the June, 1955, issue of the Journal of Applied Mechanics, Trans. ASME, vol. 77, pp. 207–214.

[2] Woodside, Long Island, N. Y.

[3] "Mekhanicheskie relaksatsionnye kolebaniya" (Mechanical Relaxation Oscillations), by N. L. Kaidanovskii and S. E. Khaikin, *Journal of Technical Physics*, USSR, vol. 3, 1933, pp. 91–109.

[4] "Vibration bei Gleitreibung," by H. Bock, *Zeitschrift für Instrumentenkunde*, vol. 56, 1936, pp. 71–74.