

**A THESIS ON**  
**HIGH SPEED TENSILE IMPACT ON SHORT SPECIMENS**

By

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CERTIFICATE

This is to certify that the thesis entitled 'HIGH SPEED TENSILE IMPACT ON SHORT SPECIMENS' by Prem Chander Dumir has been prepared under my supervision in conformity to the rules and regulations of the Indian Institute of Technology, Delhi. I further certify that the thesis has attained a standard required for a Ph.D. degree of the Institute. The research report and results presented in the thesis have not been submitted for any degree in any University.



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## PREFACE

The impact of tensile specimens treated in this thesis forms a part of that class of dynamic loading of structures where the load is applied 'suddenly', viz., in a very small fraction of a second. This domain is sandwiched between that of static loading and the region of hypervelocity impact when perhaps a quasi-fluid behaviour predominates requiring a completely different treatment. The rate of loading and the sizes of bodies considered in the present class of problems are such that the deformation process is considered to occur by means of wave propagation phenomenon while the stresses and strains are highly nonhomogeneously distributed in the bodies. Such impact studies find applications to automobile accidents, impinging of tidal waves or air blast on structures, high speed machining, explosive and impact metal forming, shock attenuation of structures, etc. However, theoretical analysis of such practical problems is extremely complicated requiring a thorough understanding of elastic-plastic stress wave propagation and interaction phenomenology. Naturally methods of analysis have to be evolved by studying simpler and more straightforward cases where experimental verifications are possible on laboratory scale. The subject has been

of extensive research in recent years and a number of books<sup>8,18,25,38,44,60\*</sup>, research monographs<sup>36,39,42,48,51,65</sup> and review papers<sup>1,16,17,20,26,32,33,45,57,58</sup> have appeared covering various aspects of the phenomenon.

The problem of longitudinal elastic-plastic waves in bars, the problem chosen for study in the present thesis, has been the earliest problem to be considered in dynamic plasticity because it is the simplest. By the term 'bar' we generally mean that the length is at least one order of magnitude greater than any cross-sectional dimension. The problem is of intrinsic interest because a bar or a rod represents the simplest of all engineering structures. Although the structure itself is simple, the total problem becomes complicated enough because of dispersion and interactions of stress waves reflecting repeatedly from free boundaries. The problem becomes further complicated due to presence of unloading waves and considerable non-uniformity in the geometry of the bar in the later stages of its deformation.

This thesis presents an alternate method of mathematical tractability for the prediction of high tensile impact deformations in short specimens using lumped parameter techniques and substituting the vibration equations of a large number of discrete masses in place of wave equation of a continuum.

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\*Superscripts designate the serial number of the references listed alphabetically at the end of the thesis.

For the investigation of the practicability of this method, an experimental rig was also devised to subject tensile specimens to large permanent deformations with or without necking, and also fracture with single or double necks, by varying the testing conditions so that sufficient information could be available for checking the theoretical predictions.

The thesis confirms that the procedure of analysis suggested in the text provides a good mathematically tractable way of studying tensile impact problems as verified from the experimental results.

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