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Pressure-impulse Diagrams Using Finite Element Analysis for Reinforced Concrete Columns Subjected to Blast Loading
Elastic Behavior of Reinforced Concrete Structural Elements Under Long Duration Impulsive Loads
Concrete Structures Under Impact and Impulsive Loading
Concrete Structures Under Impact and Impulsive Loading - Synthesis Report (PDF).
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## SAGE RHETT

Simplified Analytical Tools for Impact and Impulsive Loading Analysis of Reinforced Concrete Structures FIB - International Federation for Structural Concrete
An investigation was made to obtain, by means of tests, information which will contribute to a better understanding and more accurate prediction of the strength and behavior of reinforced concrete structhavior of simple-span reinforced concrete beams subjected to impulsive loading. To accomplish this, tests of beams and of reinforcing bar coupons were made and the resulting data analyzed. The practicability of an existing method of computing the resistance of dynamically loaded reinforced concrete beams was also checked. To this end, comparisons were made between the test results and the pres subjected to dynamic loading. The immediate objective was the determination of the resistance and behavior of simple-span reinforced concrete beams subjected to impulsive loading. To accomplish this, tests of beams and of reinforcing bar coupons were made and the resulting data analyzed. The practicability of an existing method of computing the resistance of dynamically loaded reinforced concrete beams was also checked. To this end, comparisons were made between the test results and the prediction of the method of analysis. (Author).
*Behavior of Structural Elements Under Impulsive Loads* Library and Archives Canada = Bibliothèque et Archives Canada
This report describes an investigation of the effect of a destructive impulse load upon fibre reinforced concrete beams. Concrete develops tension cracks as a result of minute flaws that are inherent in its nature. A method of arresting these cracks by placing short lengths of randomly spaced fine wire within the concrete mix is described. The results of the studies indicate that (1) the fibres increase the tensile strength of the concrete by as much as 100 percent for static loading, and (2) the material exhibits considerable post-cracking strength. These two effects increase the ability of the material to absorb energy.
**Assessment of Shear and Energy-absorption Capacity of Reinforced Concrete Elements Under Impulsive Loads** Taylor & Francis Group
Reinforced concrete slab systems are widely used in protective structures designed to resist blast events. Blast events subject structures to high pressure and impulse loads. The magnitude of blast load experienced by a structural element is directly related to the exposed area. Hence protection of reinforced concrete slabs and walls, which constitute the maximum exposed area of a structure when subjected to blast loads, is of great importance. The main purpose of the project is to study the non-linear response of reinforced concrete slabs when subjected to impact and blast loading. Blast loading comprises of impulsive, dynamic and quasi-static loading conditions. And the performance of reinforced concrete slabs subjected to these loads is highly dependent upon the reinforcing steel provided in the slab. Hence a comprehensive analysis is performed on a representative slab panel with varying reinforcement. Due to the nature of the blast loading analysis method used influences the slab response significantly. Hence the slab response was predicted and compared using finite element (FE) and single degree of freedom (SDOF) methods. An advanced finite element modeling tool, LSDYNA and a commonly used SDOF analysis tool, SBEDS are employed for the purpose of analysis. A parametric analysis is conducted to develop Pressure-Impulse (PI) curves for different damage levels. Curve fit analysis was performed to characterize the PI curves generated from FE method. Conclusions and future work recommendations are presented for design of reinforced concrete slabs for blast protection based upon the research are presented and discussed.abstract.
**Numerical Procedures for Extreme Impulsive Loading on High Strength Concrete Structures** CRC Press
Designing for hazardous and abnormal loads has become an important requirement in the design process of most major buildings and civil engineering structures, ranging from tall buildings to bridges, power plants to harbour and coastal installations. This state-of-the-art volume was compiled by the Institution of Structural Engineers' informal study group Model Analysis as a Design Tool and City University's Structures Research Centre. It contains a series of papers on the design and analysis of structures through full scale and numerical modelling including the crucial areas of hazard identification and risk assessment of structures. This book will be essential reading for civil and structural engineers, designers and researchers.
**Behavior of Structural Elements Under Impulsive Loads II**
Impact and impulsive loading on reinforced concrete structures have been a topic of investigation for many decades. The research program described in this report implemented strength-increase relationships from various researchers into a nonlinear finite element analysis (NLFEA) program that is currently in development. Modifications to this numerical tool and the overall performance of the numerical tool itself were verified with experimental data from published literature as well as data from the pilot study experiment of this research program. The pilot study program showed support loads were close to four times higher than the static capacity and the dynamic displacement differed from the static displacement during the initial stages of impact. In addition, it has been determined that strength-increase relationships are functioning properly within the finite element code and the inertial effects of reinforced concrete beams are captured properly.
*Concrete Structures Under Impact and Impulsive Loading*
The analysis of reinforced and prestressed concrete elements under blast and impact loading is drawing the interest of many researchers due to increasing number of natural or human-made hazards that require attention. The analysis methods used are mainly based on either simplified single degree-of-freedom methods or highly sophisticated and complex hydrocodes. Although single degree-of-freedom methods are commonly used by designers for practical reasons, they are incapable of providing detailed results such as deformed shapes and crack maps. Additionally, since they require simplification of the structure to a single degree-of-freedom system, they are difficult to apply to complex geometries. On the other hand, hydrocodes overcome the limitations associated

with the simplification of the structure. However, they require highly detailed models which require significantly increased modelling and computational time. Moreover, the accuracy of blast and impact analyses with hydrocodes heavily relies on the material input parameters which are not commonly known. Thus, there remains a need for accurate, simplified and reliable tools for analysis of reinforced and prestressed concrete subjected to blast and impact loading. The VecTor family of nonlinear finite element programs, using a macro-element smeared rotating crack approach, has been shown to be accurate in predicting the response of shear-critical structures under quasi-static conditions. In this study, two members of this suite, VecTor3 and VecTor6, were adapted for the blast and impact analyses of reinforced and prestressed concrete structures in 3D and axisymmetric conditions, respectively. The results obtained from the simulations were close to those experimentally observed. Additionally, a semi-analytical formula for the prediction of perforation velocity from missile impact was developed. The formula, which is based on the Modified Compression Field Theory, considers the influence of longitudinal and shear reinforcement in the target differently from other commonly used empirical formulae. The formula was validated with numerous missile impact data available in the literature, and good accuracy was found.

**Properties of Concrete Subjected to Explosively Generated Impact and Impulse Loading**

This paper is concerned with an analytical study of the effect of distributed impulsive loading on a range of concrete bridge types. The principal area of interest is collapse behaviour and the establishment of criteria for effective demolition by means of fuel-air explosives. The basis of a simplified analytical approach developed for this work is outlined. Analytical results relating the expected permanent midspan deflection to the total impulse delivered by the explosion are presented. Criteria for effective demolition are discussed and the calculated critical impulse loadings required to cause bridge collapse are shown to range from 18 kNsec/m square to 46 kNsec.m square. These results are compared with those of a previous investigation concerned only with steel bridges.

*Concrete Structures Under Impact and Impulsive Loading*

A finite element method is presented to analyze the effects of airblast-induced ground shock on shallow-buried, flat-roofed, reinforced concrete structures. A finite element based on Timoshenko beam theory is adopted. Material properties are defined in terms of nonlinear stress-strain relations in each of several layers through the thickness of the element. Elastic, ideally plastic constitutive properties for plain concrete are cast in terms of shear-stress/normal-stress variables. Elastic, strain-hardening constitutive properties are assumed for steel. Dynamic explicit and implicit and static solution algorithms are available. This analysis method is applied to simulation of static beam-column tests reported by ACI Committee 318-77. It is then applied to simulation of structural response of experimentally tested shallow-buried box structures subjected to airblast loads in which shear, flexure and combined shear-flexure damage was observed. (Author).

Behaviour of High Strength Concrete Subject to Impulsive Loading

Reinforced concrete is one of the prime building materials widely used to construct protective structures. One of the purposes of this project is to study the non-linear response of reinforced concrete structures when subjected to impact and blast loading. The study is conducted at two levels: material level and structural level. At the material level, the strength enhancement of three material models of LS-DYNA subjected to high strain rates is studied. The effects of strain rate and lateral inertial confinement on the strength enhancement are investigated. Recommendations are made to improve the accuracy of the results of future numerical simulations for reinforced concrete structures subjected to loads having high strain rates. At the structural level, Pressure-Impulse diagrams for reinforced concrete columns that have four configurations of transverse reinforcement are developed. Finite element modeling in LS-DYNA is used to analyze the structures and calculate the damage level for each blast event. The developed Pressure-Impulse diagrams are used to study the effect of confinement on the reduction of damage level at impulsive, dynamic, and quasi-static loading conditions.

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**Developments in Mechanics of Structures and Materials**

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