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SANDIA SHOCK COMPRESSION DATABASE

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ABSTRACT

An authoritative, updatable, and searchable bibliographic database whose topical area is shock compression is currently under development. The database is derived from published scientific articles and reports with current emphasis in the subareas of strength, phase transitions, spall, and stress-volume relations. The content of the cited work is described by keywords which are selected and reviewed by scientific advisors. Keywords are organized to provide major and minor descriptors which summarize the technical content in considerable detail. Details of theoretical and experimental approaches are described and major emphasis is identified. In addition to bibliographic information, abstracts, ~~figure captions, and table titles~~ are also included, and a field is provided for figure captions and table headings.

The desire to have a database in the discipline of shock physics arises from a number of considerations. It is apparent that in the scientific community today there exists a need for relatively rapid and organized procedures for locating and obtaining information applicable to a researcher's current experimental, analytical, computational, or modeling efforts. The problem is two-fold. First, there is the individual hunting for data/information who has problems because the collection or procurement of these data are periphery to his field of interest, or because he is a newcomer to the field. This requires a systematic procedure for scanning reports, many or most of which he may not be aware exist. Second, there is the veteran who has previewed, scanned and read countless documents of interest, but then no longer can remember where he actually saw the data. This individual also requires a systematic procedure for retrieving the authors, title, etc., of the source material. Both of these types of individuals will use a database if the descriptors/identifiers/keywords are pertinent and useful. Finally, there is concern

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that as researchers retire, information readily available from them would be difficult, and perhaps impossible, to obtain.

The utility and usefulness of a well-organized database is seldom questioned. A brief discussion of one of the largest technical databases, the National Technical Information Service (NTIS), maintained by the United States Department of Commerce, is illustrative of problems which can be encountered with searchable databases. As useful as this database is in performing a search of technical reports by the U. S. Government and its contractors, it has two drawbacks for specialists in a particular discipline. By its very nature, documents listed in the database are quite varied, ranging from such diverse topics as fires on railroad tank cars, terminal ballistics, and combustion studies, to airplane safety, risk assessments, and biological studies. Second, authors assign their own keywords. Keyword assignment varies considerably with individuals. Some authors jot down the first few keywords that come to mind; other authors list many keywords, some only remotely associated with their document. General descriptors are often employed to allow the widest dissemination of their work. A user of the database, then, is faced with two problems in searching the database. General descriptors become almost useless in searching for relevant documents because of the extremely large number of entries that are returned. Guessing appropriate keywords is often an art within itself, as is the proper selection of appropriate keyword combinations. The list of reports retrieved may be unacceptably long; this list requires further discrimination, typically performed using a logical AND, with two or more keywords (all keywords must appear or else the report is rejected). Thus, the reticent author's paper might not be found in a keyword search.

Other databases, either because they were limited in scope, not applicable, or too broad were found not suitable for the topical area of shock compression. Sandia National

Laboratories decided to establish a database in shock physics, hereafter referred to as the SSC Database (Sandia Shock Compression Database). A major objective in organizing this database is the assignment of identifiers or keywords, which are specific descriptors to identify the technical content of a paper, thereby making it a very useful, searchable technical database.

The SSC Database has provisions for storing an extensive amount of information extracted from papers, reports, symposium proceedings, and books dealing with the discipline of shock physics. The information is presented in a logical format for the database user. It is organized into four categories: paper identification, bibliographic citation, technical keywords, and supplemental information. Each of these will be discussed briefly.

IDENTIFICATION

There are two parameters associated with identification of a document. The first parameter is the Chronological Paper Number. This is an unique number assigned to each document as it is processed for entry into the database. This number is the identifier for retrieval operations inside the database software. The second parameter, the Paper ID, is similar to reference citations of some journals, and is a function of the year the document was published, and the primary author's last name. The Paper ID has six characters: the first two are the last two digits of the year in which the document was published; the third is the first letter of the primary author's last name; and the last three represent a sequential assignment (as chronologically processed) of papers that year with a similar letter (e.g., 73G003 represents the third document processed into the database from the year 1973 with a primary author whose last name begins with a "G").

BIBLIOGRAPHIC CITATION

There are seven data fields with information which can be directly or indirectly associated with bibliographic information. These fields consist of the following: Authors; Title; Source; Alternate Publication; Submission Date; Affiliation; and Acknowledgements. The Authors and Title fields are self-explanatory. The Source field denotes the publication information (including such things as report number and publishing organization, journal name, volume number, publication date, etc.); that is, the Source field gives the information required to obtain a hard copy of the document. The intent of the Alternate Publication field is to denote the original journal if the article is from a translated journal (a common occurrence for Russian articles); that a paper was presented at a symposium or conference, though the published proceedings appear at some later date; or a preprint or reprint when assigned a Laboratory report number. The Submission Date is used primarily for journal articles which often have considerable time between submission and publication; and the dates for symposia or conferences which can precede a published proceedings by as much as a year. The Affiliation field gives the organizational affiliations of the authors of the paper, while Acknowledgements give the names of ~~personnel~~ acknowledged by the authors.

people

TECHNICAL KEYWORDS

Key to the database is the selection of technical keywords for categorizing the technical content of a paper. The technical keywords have been divided into ten distinct topical areas:

Special Emphasis	**Experimental Method**
Material Response	**Experimental Results**
Phenomena	**Theory/Model**
Properties	**Computational Method**
Materials	**Applications**

The first five technical keyword categories, in general, describe the technical thrust of the paper, while the second set of five words describes the methodology or manner in which the phenomena were studied. The primary emphasis of each paper, such as theoretical, experimental, analytical, numerical, review, or symposium proceedings, is given in the Special Emphasis field. This field also is used to state that experimental data are presented in the paper and whether these data are original or referenced. The next field distinguishes the primary material response under consideration, such as mechanical, thermodynamic, electrical, optical, chemical, etc. The third technical keyword field gives the physical phenomena, the article is addressing. Phenomena of interest in shock compression physics currently in the database are:

Phenomena:	Strength	Porous
	Phase Transformation	Residual
	Spallation	Radiation
	Stress-Volume	Impact
	Equation of State	Stability

Obviously, some papers address more than one phenomenon, and more than one keyword can be used to describe an article (this is true of all the technical keyword fields). Measurements are made which characterize a phenomenon, and these physical attributes of a material are called properties:

Properties:	Strength	Residual
	Spallation	Porous
	Phase Transformation	Thermodynamic
	Stress-Volume	Elastic
	Equation of State	Rheologic

Note that while the keywords are similar, there is a distinction between studying a phenomenon and measured properties. Another method for subdividing articles in the database is by the material studied. After several iterations, the following material designators were defined:

Materials:	Metals	Organics
	Geophysical	Composites
	Polymers	Mixtures
	Ceramics	Liquids
	Inorganics	Explosives

Experimental work is divided into two distinct categories, methods and results. In the keyword field, Experimental Methods, the experimental methodology and instrumentation employed to collect the data are listed, e.g., the method for loading the material (flyer plate, etc.), the instrumentation used to monitor material response, and the geometry (plane strain, plane stress, expanding ring, etc.). Experimental Results are subdivided into active (or dynamic) measurements, such as particle velocity measurements; and residual measurements, such as post-shock metallurgical examination. Some papers develop, describe and/or use specific theories or models. These are entered in the Theory/Model field to further describe the technical content of a paper. If computational methods are used in the analysis, then the code name, the type of code (Eulerian, Lagrangian, etc.), the numerical method (finite-difference, method of characteristics, etc.), and special numerical techniques (e.g., rezoning, artificial viscosity, etc.) which are employed and discussed, are listed in this field. Finally, one last field, Applications, specifies particular applications of the research material, such as ballistic impact, explosive initiation, rubblization, etc.

In each of the technical keyword categories, these major and submajor descriptors are further qualified by minor descriptors. The intent is to describe, as best as possible with a finite set of keywords, the technical content of the paper. A dictionary of keywords has been prepared and lists the acceptable set of keywords. This dictionary, including the major and minor descriptors, is the result of several iterations with a test phase of approximately fifty reports covering a wide range of technical issues in the area of shock compression, including journal articles, articles from foreign journals, government reports, symposium presentations, and review papers. Besides a technical keyword dictionary, an author dictionary is being prepared which lists alphabetically all authors in the database. These dictionaries are not only of use to the user in the selection of descriptors, but since they are compiled from the database itself, misspellings are readily noted and corrected.

SUPPLEMENTAL INFORMATION

It has been found from experience that no matter how judicious the selection of keywords or identifiers, only so much information can be summarized by this method. While a judicious selection of keywords, and a combination of keywords can limit the number of articles to a manageable number, three supplemental information fields have been added to the database to supply further information on the technical content of a paper. An Abstract field contains an abstract of the paper content. Where possible, the original abstract of the paper is used. If no abstract was included by the original authors, a suitable abstract is written by the technical reviewer who assigns technical keywords. The Additional Information field is used by the technical reviewer to comment on the content of the paper with any information which might be relevant and informative to someone searching the database. Finally, a Data Summary field provides space for table headings and figure captions. At a later date, this field could be expanded to include experimental data.

SUMMARY

In principle, all fields in the database are searchable. Generally, though, searchable fields would be authors and acknowledgements, affiliations, and the technical keywords. The user will eventually have the opportunity to search the database via a "user friendly," menu-driven CRT display inquiry system, with an option to print the information on relevant reports retrieved by the database. An example of the information in a retrieved document is shown in Figure 1.

There are currently 2500 documents in the database after approximately thirteen months of effort, which has included several drafts of the Technical Keyword Dictionary, establishing the required tables in INGRES (the particular database manager being used), and entering the data. Work is just beginning on reviewing and entering the technical keywords--by next May, the goal is to have in excess of 3000 documents with bibliographic citations and abstracts, of which approximately 1900 of these articles will be complete with technical keywords and additional comments, primarily in the area of strength, phase transformation, and stress-volume.

Figure 1. Example of Database Information (continued)

Chrono Paper No.: 0017

Abstract:

Comparisons of calculated solutions with experimental solutions with experimental results for the impact of a 9.53-mm-diam nylon sphere on a 12.7-mm-thick steel plate at 5.182 km/sec are presented. Numerical solutions are difficult to obtain with existing Eulerian codes because of the need for accurate treatment of material strength and the definition of both the material interface and the free surfaces. The large distortion of the nylon sphere and the steel near the impact crater lip also make this a difficult problem for Lagrangian codes unless frequent rezoning is used. Newly developed Eulerian and Lagrangian rezoning codes are used. They give essentially the same solution. The computation results show that in order to obtain agreement with the experiment, it is necessary to account for the alpha (bcc)==epsilon (hcp) polymorphic phase change for iron. Calculations also indicate the need to obtain experimentally the correct spall strength for the steel and a description of this measurement is included. Treatment of elastic-plastic response, a good numerical model for fracture, and a high degree of numerical resolution are also shown to be necessary in order to predict accurately the back-surface spallation observed in the experiment.

Data Summary:

Fig. 1 - Hugoniot states for iron (pressure vs. density).
Fig. 2 - Comparison of code calculations (Eulerian & Lagrangian) with experiment.
Fig. 3 - Effect of polymorphic phase change of iron.
Fig. 4 - Free surface velocity history of planar impact of two steel plates.
Figs. 5-6 - Comparison of code calculations with experiment.
Table 1 - Material properties used for calculations.
Table 2 - Calculated spall strengths in steel for various calculational methods.

Figure 1. Example of Database Information

Chrono Paper No.:	0017
Paper ID:	75B001
Authors:	Bertholf, L. D., Buxton, L. D., Thorne, B. J., Byers, R. K., Stevens, A. L., and Tnompson, S. L.
Title:	Damage in Steel Plates from Hypervelocity Impact. II. Numerical Results and Spall Measurement
Source:	J. Appl. Phys. 46 (9), 3776-3783 (1975)
Original Publ.:	*
Submission Date:	Feb. 24, 1975
Affiliation:	Sandia Laboratories, Albuquerque, NM
Acknowledgements:	Bond, J. W., Shockey, D. A., Curran, D. R. and Herrmann, W.
Special Emphasis:	[numerical]
Mater. Response:	[mechanical]
Phenomena:	[phase transformation] mixed phase, polymorphic [impact] cratering, spall
Properties:	[spallation] spall strength
Materials:	[metals] steel [polymers] nylon
Exper. Method:	[loading] flyer plate [instrumentation] visar [geometry] plane strain
Exper. Result:	[active] free surface velocity [residual] cross-sectional photograph
Theory/Model:	[elastic-plastic] elastic-perfectly plastic
Comput. Method:	[code] toody, csq, toorez [type] lagrangian, eulerian [techniques] rezone
Applications	penetration, cratering
Additional Info.:	Limited spall strength measurement. Only one isolated hypervelocity impact experiment. Numerical prediction of spall depended upon mesh size