Development of a creep data base management system for engineering materials

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ABSTRACT

A fully menu driven creep data base management system has been developed for various high temperature materials using the client/server (C/S) architecture with Sybase system. 10 as backend and power builder 4.0 as an user interface. The relational data base constitutes of various classes of materials, their heat treatment, prior history and the related creep properties at different test conditions, in addition to the source, process route and chemical composition details. Top-down approach has been adopted in designing the entity-relationship (E-R) model. The creep data is organized into the third normal form, and the entire system is divided into manageable modules. Coding for the system is done using Transact-SQL for data definition, manipulation and control operations, and power script language for application development. This article briefly outlines the formulation of data base design, and the implemented E-R model, in addition·to the presentation of various screen formats used for data entry and retrieval modules.

INTRODUCTION

The volume of creep data being generated in the laboratory gets accumulated with time and it is not easily possible to locate any particular data with specified history for given test conditions. Also, querying on the creep properties is not possible with data being stored either on paper media or as a file on the electronic media. To overcome these problems, a centralized creep data base on a computer system has been created by different developers to achieve most effective and efficient administration of creep tests [1,2]. Computerized data base on physical, tensile and fatigue properties of various nickel base superalloys has also been reported [3]. Similarly, an information system on materials property has been developed for the NASA/Air Force Transportation Main Engine to support selection, design and reliability cri-

teria [4]. However, the data base design, structure diagrams and intricacies involved in the implementation of the system are not available.

DEVELOPMENT

Approach

Sybase system 10.0 has been chosen for the backend engine and Transact-SQL is used to perform data related operations and power builder 4.0 for application development, in the three tier client/server (C/S) architecture. The relational data base management system (RDBMS) runs on a Novell Netware 4.1 platform.

Data Base Design

To eliminate the potential inconsistency of data model, the following steps are performed to reduce the redundancy.

Determinancy diagram: Fig. 1 shows the determinancy diagram for the present system which is drawn to identify the determinants (entities), transitive determinants and non-identifying determinants.

E-R model : the entities like material_id (identification) alloy_id, source_id, heat treatment_id, history_id, test conditions_id are identified. The degree of relationships between the entities like one-one (1:1), one-many (1:N) and many-many (M:M) are identified, and all M:N relationships are decomposed in to 1:N. Top-down approach has been adopted in designing the E_R model as shown in Fig. 2. Possible connection traps (either fan or chasm) are eliminated. After setting up E_R model, all other attributes are assigned to the skeleton tables in such a way that the resulting set of tables are fully-normalized. In the following section, normalization and table generation techniques are described.

Data normalization : The foundations of data analysis and the building of the conceptual architecture of integrated system is the normalization of data [5]. In order to organize the data elements in an optimized fashion to produce as stable a data structure as possible, the data is transformed into third normal form, by eliminating the undesirable features from the initial un-normalized table. First normal form is obtained by eliminating repeating groups, and the second by eliminating non-identifier attributes which do not functionally depend on the identifier. The third normal form is obtained by eliminating functional dependency between non-identifier attributes. Af-
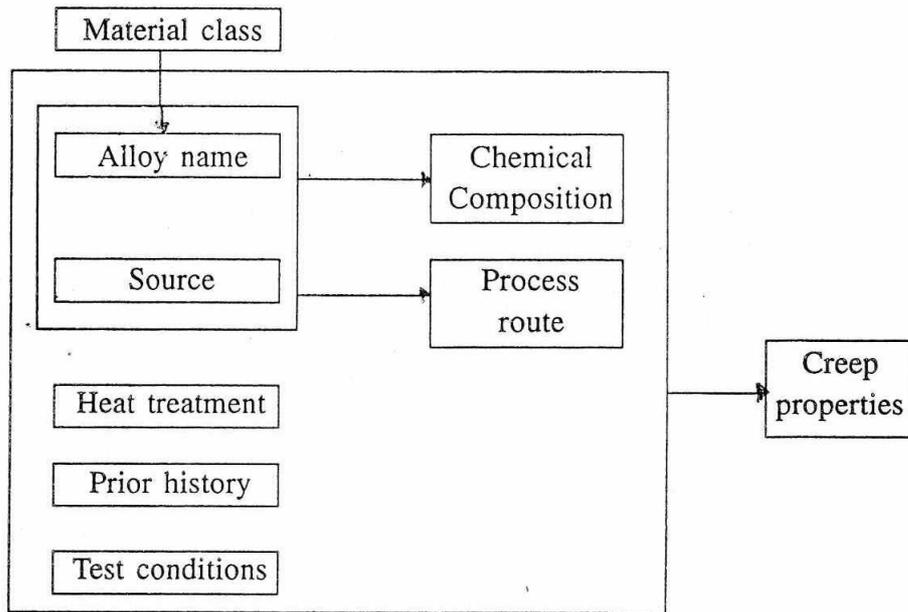
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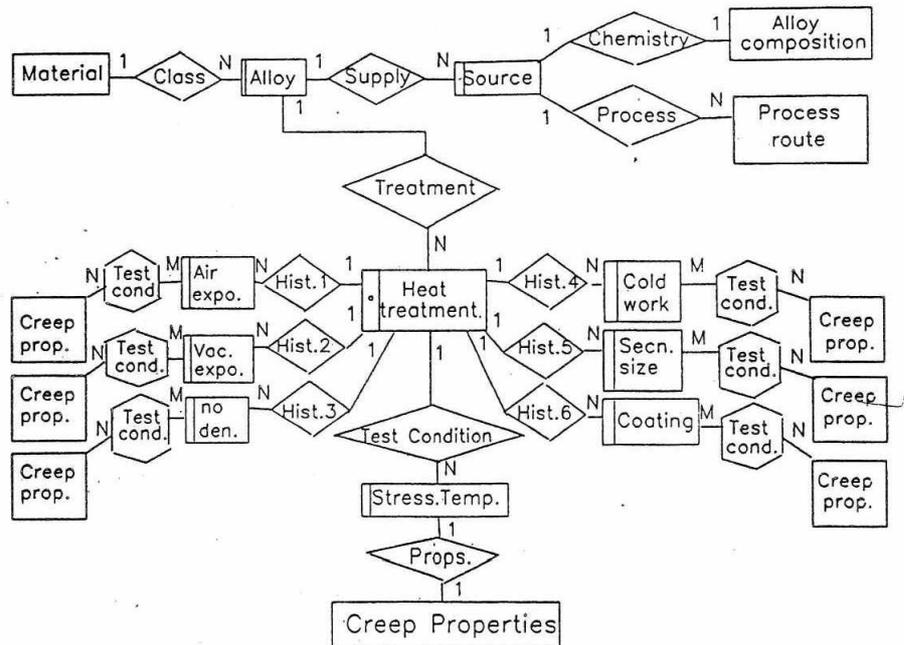
Fig. 1 : Determinancy diagram

Fig. 2 : E-R model for the creep data base

ter fully normalizing the data, each entity and the related attributes are translated to a table with each attribute being translated into a column of the table with a name and a precise format definition. All the mandatory attributes are defined as having "not null" values. The unique identifiers of the entity are defined as primary keys. The referential integrity between different tables (20 Nos.) is maintained by identifying suitable foreign keys. One of the typical data dictionary is shown in Table 1.

Table 1 : Data Dictionary

Name : Alloy_history_creep_properties :

Column name	NULL/NOT NULL	TYPE	KEY
Alloy_id	Not Null	Varcher (15)	Primary key
Heat treatment_id	Not Null	Integer	Primary key
History_id	Not Null	Integer	Primary key
Stress_ Temp_id	Not Null	Varcher (15)	Primary key
Creep life (h)	Not Null	real	
Creep ductility (%)	Null	real	
Minimum creep rate (h^{-1})	Null	double	
life at 0.1% strain	Null	real	
life at 0.2% strain	Null	real	
ductility (%) at 50h	Null	real	
ductility (%) at 100h	Null	real	

Coding : Coding for the system is done using T-SQL for data definition, manipulation and control operations. Power script language is used for developing graphical user interface (GUI) application. Coding is done for various events like clicked, row focus changed, item changed and lose focus events etc.

ABOUT THE SYSTEM

The application is a fully menu driven with facilities like multi document interchange (MDI) interface frames and response windows. Entire system is divided into manageable modules and is flexible

enough to perform any modifications or enhancements.

Main Menu

The execution of program will show the main screen menu with options for data information, query processing, report generation and data entry operation. This menu also contains the drop down and cascading menus.

The Data Information

This module gives general information like the materials source, process route and chemical composition. The creep properties can be obtained by selecting respective heat treatment, material history and test conditions. These details can be obtained by clicking on the respective fields [Fig. 3].

Data Entry

This module consists of entry, insert, modify and updating of the creep data base. Separate modules are made for data entry that include general information, heat treatment and history details. After selecting any one option the control passes to appropriate screen and corresponding data window appears for data entry. While entering the data into each field, the corresponding validation checks are performed and related error messages, if any, encountered are displayed in the dialogue box.

Reports

Report generation menu appears as soon as one selects the report option in the main menu. It contains options which can be selected by moving the arrow key/mouse. Two types of reports that can be generated are:

i) Any particular materials creep properties with all the pedigree information

ii) Lists for various materials general information like source, process route and chemical composition.

Query Processing

This menu contains options to perform different types of queries. Various types of queries are:
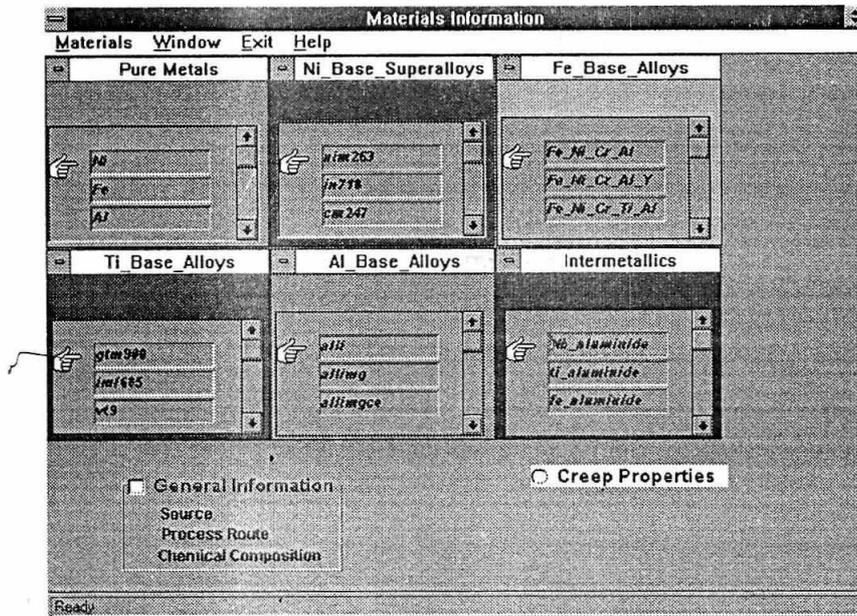
*Fig. 3 : Main window showing details to obtain
general information and creep properties.*

1. Comparison of different materials creep properties.

2. Details of materials with creep strain (%) at 100 hours or life of materials (in hours) at 0.01% or 0.02% elongation.

3. Creep properties of different materials with identical histories, or identical materials with different histories, at same test conditions.

CONCLUSIONS

1. A relational data model is developed and implemented to build a client/server application for storage and retrieval of the creep data of various material at different conditions.

2. A graphical user interface application program is developed to meet different user requirements on the creep data.

ACKNOWLEDGEMENTS

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