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# Internet portal «Database of Steels and Alloys» as an efficient tool in engeneering

### *Introduction*

Design procedures in mechanical engineering are closely coupled with necessity of the analysis of large amount of experimental information about mechanical, physical and technological experimental data as well as about the chemical composition of modern structural materials. Traditional way of such data processing is connected with the hard work with paper handbooks, which often were published in small number of copies. Finding the right material, which meets all the requirements, is very difficult in such approach.

The present era of information technologies (IT) offers another way to analyze the parameters of structural materials. Storing experimental data in database allows one to use the powerful facilities of modern software, where the operations of storage, quick access and data processing are conveniently organized. The second step in database development naturally had to be associated with overall access to information, primarily via the Internet.

Worldwide distribution of Internet-technology allows one to design such a program as a website, where continual updates of information is immediately available to all users.

The first steps of IT use in metallurgy, similar to any other branch of industry, were directed to the development of advertising and informational websites. Each company had produced their own web-recourses, where the simple lists of goods and services were presented. Commercial message boards were added to such sites a little later. In such software the search for steel or alloy with desired properties is very laborious task.

Next stages of improving the data search are associated with satisfaction of requirements of maximum automation and user's convenience. User has to have quick access to the full information about steel and alloy properties which are offered for sale by different companies. Due to difficulties of implementation of very diverse information of steel and alloy grades and their properties as well as high labour intensity, the amount of software in which above mentioned facilities are realized is very small.

Very popular web-resource MATWEB [1], designed by Automation Creations, Inc. (ACI) of Blacksburg, Virginia, provides for any user a search of the chemical composition, physical and mechanical data of the basic grades of steels and alloys produced in USA. Information about the steel and alloy grades producing in other countries, especially in CIS (Russia, Ukraine and so on), is absent in MATWEB databases.

Another information system, based on the modern Internet technologies, is the web-portal "Database of Steels and Alloys" (Marochnik Stali i Splavov), designed at National Technical University "Kharkov Polytechnic Institute" (Ukraine) [2, 3]. The description of this Internet portal's possibilities, which can be used in metallurgy and engineering, is presented in the paper.

### *Description of the web-portal*

The Internet "Database of Steels and Alloys" **(www.splav.kharkov.com)** is designed by Faculty of Physical Engineering staff members and contains information on classification, chemical composition, critical points, Brinell hardness, physical, mechanical, and technological properties of more than 1,800 steels and alloys from CIS countries (Russia, Ukraine, etc.). It is possible to replenish the database values of the constants for the laws that describe the creep deformation and fracture of materials. The information in Database is constantly updated and supplemented.

The web-portal has both Russian and English versions. It contains broad information on CIS steel standards and grades and could be very useful for businessmen and engineers throughout the world.

The main feature of the "Database of Steels and Alloys" is high developed informational support including possibility to know any chemical and technological properties of any steel or alloy as well as other its engineering characteristics. Such possibility is unique in Russian–speaking Internet.

Computer program "Database of steels and alloys" [2, 3] is a website developed with use of specialized software PHP and MYSQL, which are available on network resources of Free Software Foundation. The programming language PHP was used for the implementation of this project's interface, the organizing and managing of databases were carried out by use of MYSQL.

### *How to work with the database?*

The typical user's session of the leader or commercial director of a company working in Metal Trading business, can include acquaintance with the news of metallurgical business, finding a list of the websites with any information in close areas, usage a metal trading advertisement and message board.

Wide range of "Database of steels and alloys" capabilities is provided to engineers of different specialties. For example, engineers in metal science can obtain information about chemical composition of any from more then 1,800

steels and alloys presented in Database. Fig. 1 contains the example of such information for high quality structural carbon steel 08kp (08кп), where its chemical composition is presented due to standard GOST 1050-74. In addition, any user can provide the advanced search of any steel or alloy, with a specified percentage of chemical components (Fig. 2). Here user can quickly find the necessary material by use of interactive on-line dialog boxes.

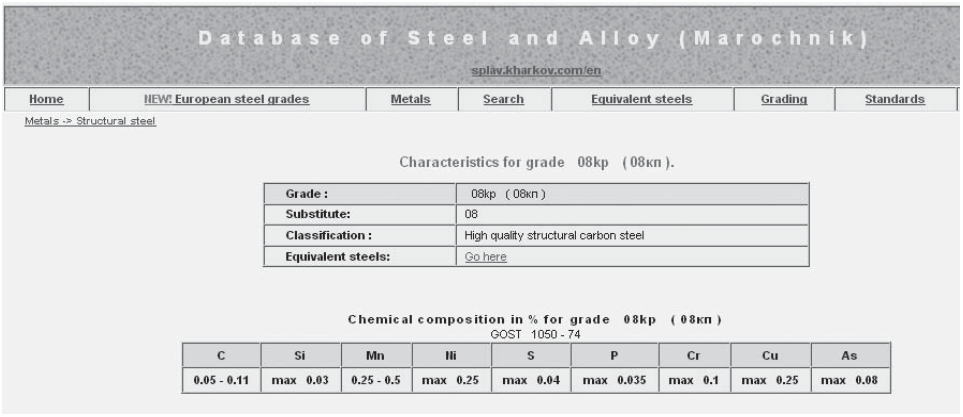


**Fig. 1. Example of information for high quality structural carbon steel 08kp**

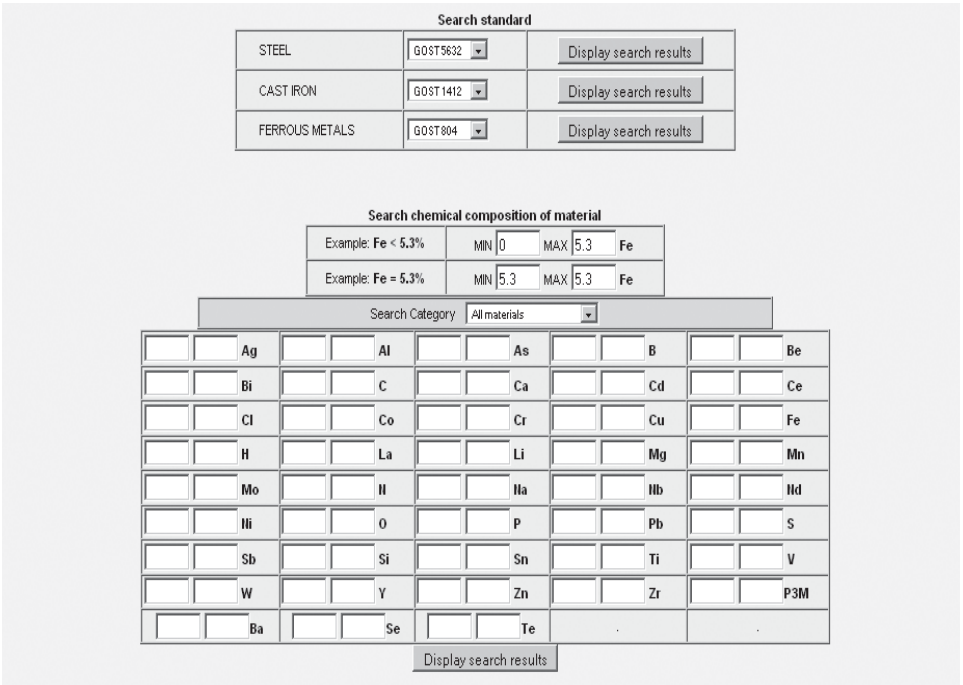


**Fig. 2. Advanced search of any steel or alloy, with a specified percentage of chemical components**

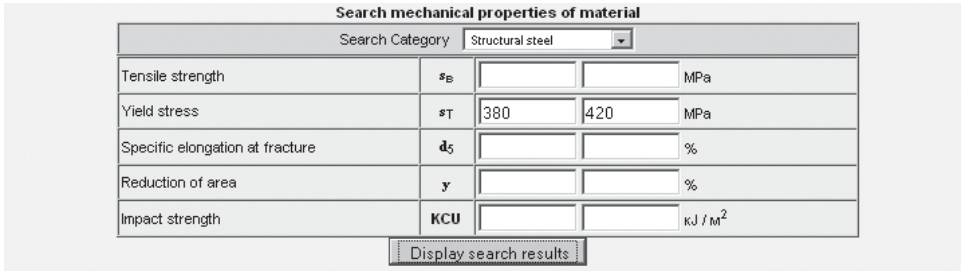


**Fig. 3. The window for selecting the required metal properties**

Engineers who are working in the field of mechanical or civil engineering can find various useful tools. It is possible to analyze the values of physical properties, such as Young modulus, coefficient of thermal (linear) expansion (in range from 20 °C to test temperature T), coefficient of thermal conductivity (heat), specific weight, specific heat (in the range from 20 °C to test temperature T); specific electrical resistance. Any engineer can obtain information about mechanical properties depending on heat treatment conditions, grades, sizes, direction of specimen's cutting etc, which include: tensile strength, yield strength, specific elongation at fracture, reduction of specimen's area, impact strength, Brinell hardness. In addition, the information of such technological properties, as weldability, flakes and temper brittleness is available.

The possible dialog between design mechanical engineer and "Database of Steels and Alloys" can include the following actions: search of necessary material by chemical composition, by any physical or mechanical property or their combination; comparison of materials by selected characteristics; use of calculator of weight, length and price for ferrous or non-ferrous metal products by data of more than 50 grades; finding of foreign steels analogs.

Let us briefly describe the typical steps of mechanical engineer in carrying out the design works. For example, under the terms of the job, a structural steel, which has yield strength in limits 480–420 MPa, has to be found. After downloading the Internet and "Database of Steels and Alloys" at www.splav.kharkov.com/en the user has to select main menu item "Search" or the option of Search type, which include searching on chemical composition, on physical and mechanical properties. In this case the search on mechanical properties has to be selected. The window for selecting the required properties is presented in Fig. 3.

After selection of the necessary search area, which in this case is "Structural Steel" and setting the search boundaries, the procedure can be executed.

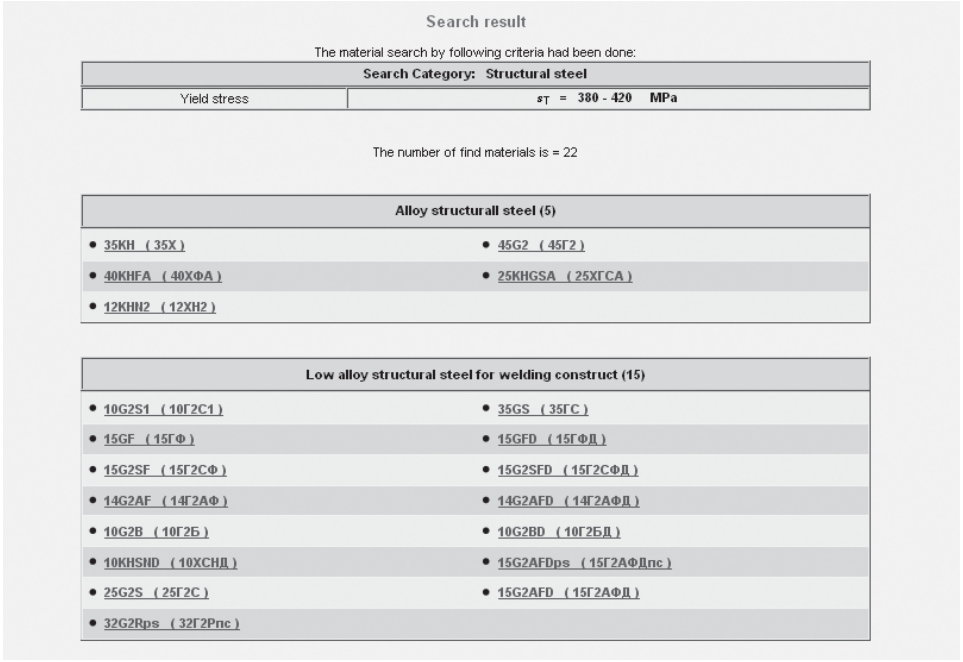


**Fig. 4. Search result**

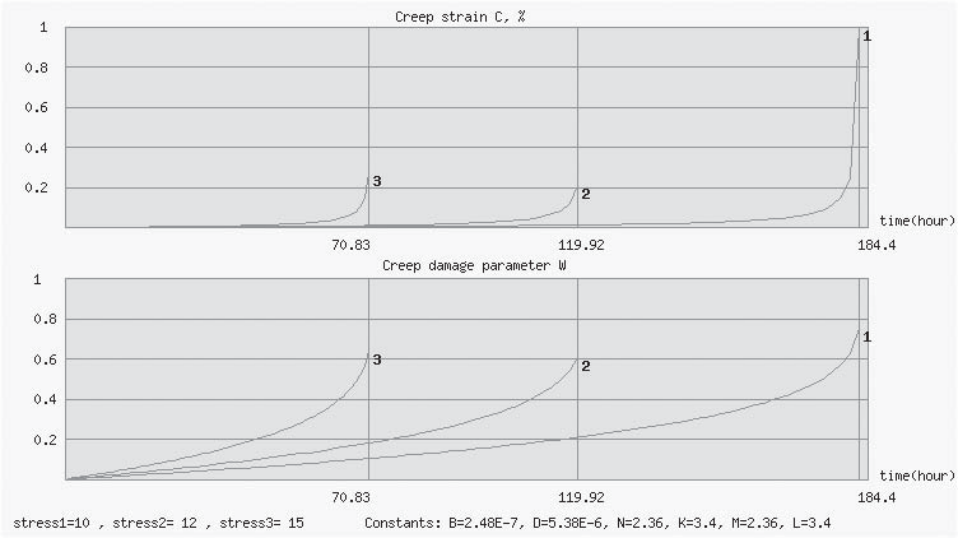


**Fig. 5. Creep and damage dependencies**

Some search results are presented in Fig. 4. Based on "Database" sample, it was determined that 22 steels have yield strength characteristics satisfying the above mentioned requirements. Then user can activate the link for the steel grade and carefully review all another properties, and repeat the search to specified requirements if necessary.

A separate service is provided for engineers who are developing the high-temperature structures, where creep deformation and damage accumulation have to be considered at the stage of future long-term strength evaluation.

One important factor that limits the possibilities of such analysis is the need of experimental studies of long-term properties of material. These experiments often are very long-time and expensive. The item "Creep" of the "Database of Steels and Alloys" allows one to carry calculations of time dependencies for creep strain and damage scalar parameter.

The numerical simulation is performed by use of well-known Bailey-Norton creep law and Rabotnov-Kachanov damage kinetic equation [4]:

$$c = B\frac{(\sigma)^n}{(1-\omega)^k},$$

$$\omega = D\frac{(\sigma)^m}{(1-\omega)^l};$$

$$\omega(0) = 0,$$

$$\omega(t_*) = 1, \quad (1)$$

where σ is the acting stress, c is the creep strain, ω is the damage parameter; *B*, *D*, *n*, *m*, *l*, *k* are the constants which are determined by creep and long term strength experimental data at specified temperature. Every constant is a field of the special "Creep" database, where they are stored due to specified test temperatures. Present database contains similar phenomenological description of several high-temperature steels and alloys, carbon steels and aluminum alloys. In addition the manual filling of the constants values is provided for the user to build graphs by obtained experimental data.

The program include the plotting of three dependences "creep strain vs time" and "damage parameter vs time" due to three values of acting stresses. User has to select material and the test temperature and choose the link "Plotting". The resulting graphs will be drawn in separate window. Fig. 5 contains the creep and damage dependences which are built for high-temperature nickel-based alloy KhN62MVKU (ХН62МВКЮ) at T=950 °C for stress values 100, 120 and 150 MPa respectively.

By fast creep-damage graphs building and subsequent analysis of process' characteristics, design engineer gets the possibility of the best choice of material with demanding creep resistance.

### *Software features*

One of the main advantages of the developed web-based application is that all information is not stored in read-only text files, but in a special database allowing one to select a particular characteristic exactly or in the given range. Interface is a stan-

dard for web-programming, all of actions are available from the site menu, located horizontally at the top of the page.

To install specialized Internet - portal «Database of Steels and Alloys» - the server Apache is necessary. Server-scripting language PHP-4 with built-in management system MySQL is used. In the case of previous PHP versions the additional module PHPLib has to be installed to support session. A version of MySQL optimized for processors of Pentium-type (mysql-opt) was used.

For user's session the personal computer with any Internet browser and Internet access is necessary.

Address of "Database of Steels and Alloys" is www.splav.kharkov.com

### *Conclusions*

The description of specialized Internet-portal "Database of Steels and Alloys" developed for storing, quick access and processing of the data of modern structural metallic materials properties is presented. The web-portal's possibilities for engineers, technologists and other specialists in Metallurgy and Mechanical Engineering are discussed.

### REFERENCES

1. http:www.matweb.com
2. http://www.splav.kharkov.com
3. *Breslavska O. O., Breslavsky D. V.* Computer program "Marochnik of steels and alloys". Certificate of registration of copyright № 7533 from 08.05.2003, State Department of Intellectual Property, Ministry of Education and Science of Ukraine (in Ukrainian).
4. *Yu. N. Rabotnov.* Creep Problems in Structural Members. - North-Holland Publishing. Amsterdam/London. 1969. 822 p.