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Web-based **MAT**erial Properties and Knowledge **DAT**abase

Support for Design of Efficient and Lightweight Products

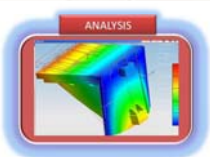


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INTRODUCTION

REQUIREMENTS IN PRODUCT DESIGN

- SHORTER DEVELOPMENT TIME
- CUTTING DOWN EXPENSES
- MORE EFFICIENT PRODUCTS
- LIGHTWEIGHT DESIGN
- ...



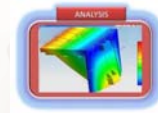
- Simulations of product behaviour
- Determination of load capacity / durability
- Evaluation of more design solutions
- Evaluation of more candidate materials

very early in design process

DETERMINATION OF LOAD CAPACITY / DURABILITY
EVALUATION OF MORE CANDIDATE MATERIALS

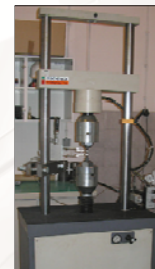
PREREQUISITES FOR ANALYSIS/SIMULATIONS:

- geometrical/numerical model of the product
- **mathematical model of material behaviour**
- boundary conditions (loading, etc.)
- **properties of materials**



Experiment-based acquisition of materials' properties (BASELINE)

- accuracy of acquired data
- properties obtained for required conditions



- price (expensive)
- test equipment availability
- complex and long-lasting (cyclic experiments)
- not applicable for many candidate materials

Alternatives?

Alternative #1 – LITERATURE

(handbooks, standards, reports,...)



- limited availability, modest contents
- no methods for inquiry and data comparison
- data appear in different forms and formats
- results published in scientific publications are for the most part unknown or inaccessible to the users from the industry

Alternative #2 – ESTIMATION METHODS

cyclic and fatigue parameters of the material can be estimated from monotonic properties such as hardness and ultimate strength

Strain-based approach

Strain-life expression (Basquin-Coffin-Manson law)

$$\frac{\Delta \varepsilon}{2} = \frac{\Delta \varepsilon_e}{2} + \frac{\Delta \varepsilon_p}{2} = \frac{\sigma'_f}{E} (2N_f)^b + \varepsilon'_f (2N_f)^c \quad \frac{\Delta \left(\frac{\gamma}{2} \right)}{2} = \frac{\tau'_f}{G} (2N_f)^{b_0} + \gamma'_f (2N_f)^{c_0}$$

Example of methods:

Original universal slopes method, Four-point correlation method, Uniform material law, Modified four-point correlation method, Hardness method,...

Alternative #2 – ESTIMATION METHODS

- + practicality, ease and speed of use
- + minimum prerequisites (basic material parameters such as ultimate strength R_m , Brinell hardness HB , Young's modulus E , etc. must be known)
- there is no universal, i.e. "the best for all materials" method
- difficulties in selection of method most suitable for given materials

Alternative #3 - DATABASES

COMMERCIAL

- + large number of materials
- + good search capabilities
- "closed" type – not user expandable
- advanced properties are available for limited number of materials




NON-COMMERCIAL

- + wide user community are allowed to search, use and expand data in the database
- from technical side they are usually less than professional
- modest number of materials available
- limited search options as well as reporting and displaying of results

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 Material Properties Database and Estimation Tools

WHAT IS IT?

- ✔ web-based information system
- ✔ interactive, expandable database of design relevant properties of (metallic) materials
- ✔ tools and expert system for use and evaluation of estimation methods for advanced (cyclic/fatigue) material properties



The screenshot shows the MATDAT.com website interface. At the top, there is a navigation menu with links for 'About MATDAT.COM', 'Features', 'Knowledge Base', 'PlumbOptions', 'Help', and 'Contact'. Below the menu, a banner asks 'Can't find material data you need? Register and search our complete database for free!' with buttons for 'Sign up for MATDAT FREE' and 'Sign up for MATDAT PRO'. The main content area includes a 'WHAT IS MATDAT.COM?' section, a 'Latest news' section, and a 'Database status update' section. There are also sections for 'Materials Database', 'Estimation Methods/Tools', 'Sharing Your Data', and 'PlumbOptions'. The 'MATDAT Partners / Sponsors' section features logos for '6' and 'CREATIVES'.

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 Material Properties Database and Estimation Tools

FOR WHOM?

- for industry professionals, engineers, scientists and students

WHY?

- **easier/faster** evaluation of **more** candidate materials
- optimal choice and **better** usage of material
- support for development of **light** and **efficient** products
- **shorter** development time and **lower** expenses
- **reduction** of number of candidate materials that need to be tested experimentally

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SECONDARY BENEFITS

- increasing level of utilization of experimental equipment,
- no need to repeat experiments performed elsewhere with the same materials,
- more possibilities of verification of own experimental results,
- enabling research requiring data on large number of materials
- increasing acceptance of advanced material models and crack initiation criteria by practicing engineers and experts from the industry.

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MATERIAL DATABASE

Materials currently in the database:

- unalloyed, low-alloy, high-alloy steels
- aluminium alloys
- titanium alloys
- cast & weld materials

Approximately 850 material datasets (another 600 sets are ready for upload into database)

Fully referenced content – dissertations, journal and conference papers, reports,...

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MATERIAL DATA AND PROPERTIES

Data sources and general material data

- literature/references
- general information
material designations, material group, chemical composition, heat treatment, microstructure,...

Testing conditions and parameters

- testing temperature, testing medium, loading control, loading type, specimen,...
- number of experiments, loading levels,...

MATERIAL DATA AND PROPERTIES (continued)

Material properties

- monotonic properties
- cyclic parameters
- fatigue parameters (stress-life, strain-life)


different loading types:

- monotonic, cyclic
- axial, torsional, bending, rotating bending loading

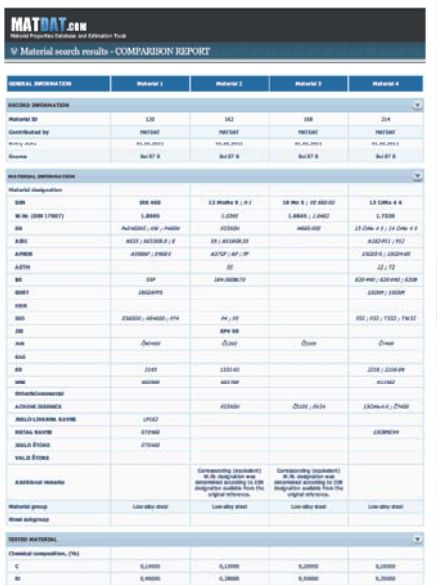
different loading ratios:

- $R=0$ (pulsating),
- $R=-1$ (fully reversed),...

Detailed report – single material



Comparison report – up to 5 materials



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Additional possibilities of working with the database:

- searching according to multiple criteria
- export of reports in pdf format
- *generation of stress-strain/strain-life/stress-life curves from corresponding parameters*
- contributing datasets available from literature or from own research

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Development directions and plans

- ✓ development of determination/estimation of cyclic/fatigue parameters from monotonic properties through the application of evolutionary methods (genetic algorithm, neural networks)
- ✓ topic of doctoral dissertation in the framework of the project
- ✓ integration with CAE software – material data export (Ansys, CATIA, Abaqus,...)
- ✓ connecting and networking with universities, industry and institutions possessing experimental equipment


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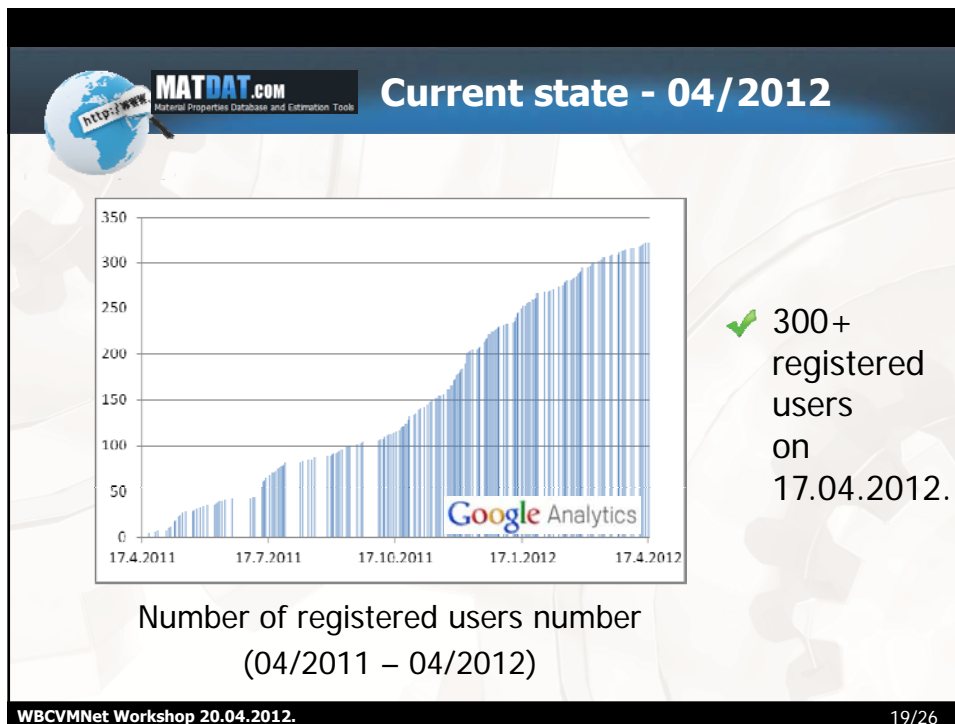
Current state - 04/2012

Google Analytics

- ✓ 850 (+600) materials in the database
- ✓ 4500 unique visitors - 90 countries (since 26.04.2011.)
- ✓ significant material data contributors
 Technical University Darmstadt - Germany,
 Technical University in Prague – Czech Republic,
 Montanuniversität Leoben – Austria ???





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 **PragTic Project**
(www.pragtic.com)


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Institut für Stahlbau und Werkstoffmechanik 

 **Faculty of Engineering**
University of Rijeka

Formula Student Team
Faculty of Engineering, Rijeka 

 **Montanuniversität Leoben**
Institute for Mechanics / AMB / Leoben
Materials Center,...



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How can you support MATDAT.com project?

Submit material data from literature
(check www.matdat.com for detailed instructions)





**Contribute
&
Share**


- ✓ over 1000 datasets
- ✓ fully referenced
- ✓ carefully verified
- ✓ advanced search
- ✓ detailed reporting
- ✓ comparison (up to 5)



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Promote MATDAT.COM (website links, inform students and your partners,...)

MATDAT EDU for scientists&students



Description	MATDAT EDU
Database access	<u>Full access to all materials</u>
New materials added to the database	Available immediately
Available search criteria	All criteria
Detailed reporting	<u>YES - all materials</u>
Multiple search criteria	YES

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Join in, share your data&knowledge and use what others have contributed!

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Thank you
for your
attention!



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