THE MASONRY DAMAGE DIAGNOSTIC SYSTEM


The MDDS (Masonry Damage Diagnostic System) is an Expert System for the evaluation of the deterioration of ancient brick masonry structures. A demo version was developed in the EC Environment Programme (EV5V-CT92-0108). The system is centered on damage related to the interaction between materials (brick masonry, brick, mortars, plasters/renderings) and environmental factors. Damage due to wrong planning, static or overloading problems, thermal stresses and living organisms is certainly taken into account, but the damaging processes responsible for it are less extensively developed. The system is meant for user groups like: local and national authorities in charge of the conservation of the cultural heritage, universities and restoration architects.

The knowledge of the system is organised within two interrelated sections, called damage type and damaging process: for each type of visible or immediately deducible damage, the damaging processes possibly leading to it are described: in the environmental circumstances under which damage (has) occurred are the necessary and sufficient conditions for selecting the responsible process(es) and make the correct diagnosis.

Decision tables were used to structure the knowledge furnished by experts. The structure of the system can be compared with a tree consisting of two main branches and lots of minor branches: new branches can be always generated, which guarantees the possibility of expanding and deepening the scientific knowledge. Being meant for an easy knowledge dissemination, the MDDS should be continuously updated. The structure of the system is based on the way of reasoning of an expert; consequently, while consulting the system, the user follows the same pattern an expert would follow: a visual inspection aiming at the definition of damage to the brick masonry structure is the first step; then the system helps the user in defining the circumstances under which damage (has) occurred; at this stage a hypothesis on the origin of damage is made; analyses/tests in the laboratory and/or other scientific data are requested to confirm or dismiss the hypothesis on a scientific basis; if the hypothesis is not confirmed a new one is made and checked.

The list of damage types in English, German, Italian, Dutch and French (Vocabulary) and the definition of all damages furnished with colour pictures (Help function and Pictures), make it possible for the user to start the consultation with a correct identification of the damage. A selection of tests and clues to interpret the results - taking into account the context in which damage (has) occurred - are meant to guide the user and to lay down a scientific basis for the investigations.

The posters presented at the congress show both the cooperation work performed to built the system and the way the demo-system operates.

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GOAL OF THE COOPERATION PROJECT
To develop an expert system for the diagnosis of the damage to ancient brick masonry structures, focusing attention on the role played by the environment.

CONSULTATION OF THE EXPERT SYSTEM
- identification of the visible damage;
- analysis of the environmental circumstances;
- hypothesis on the damaging processes;
- scientific control of hypothesis;
- diagnosis of causes of damage.

ADDED VALUE
- illustrated thesaurus of damage types (common terminology);
- stimulate cooperation among experts;
- use consultation outprint as a basis for a well structured report;
- set up archive of diagnosed cases;
- make up-to-date information (concerning materials, techniques..) available;
- use MDDS as a teaching tool.

FUTURE ACTIONS
- develop advice-support function;
- adapt MDDS to users’ specific needs;
- include natural stone monuments.
**EXPERT SYSTEM**

MDDS is an expert system for the diagnosis of damage to brick masonry monuments.

It is built up using decision tables. The knowledge contained in MDDS can be expanded and updated.

**WORKING AT DECISION TABLES MEANS**

- to translate the experts’ language into the language of the computer;
- to structure knowledge within tables according to specific criteria.

<table>
<thead>
<tr>
<th>Decision</th>
<th>C1: any degradation visible</th>
<th>C2: location of degradation in masonry</th>
<th>C3: layering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes</td>
<td>within material</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>between different materials</td>
<td>no</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Layering</th>
<th>C1: detachment of whole or part of surface layer of material</th>
<th>C2: more than one layer</th>
<th>C3: character of layer</th>
<th>C4: originally laminated structure</th>
<th>C5: type of layering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>unknown</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>no</td>
<td>unknown</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>no</td>
<td>thin (l&gt;3mm)</td>
<td>-</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>no</td>
<td>thin (l&lt;3mm)</td>
<td>-</td>
<td>no</td>
</tr>
</tbody>
</table>

- determination of the type of damage found;
- determination of the damaging process(es) leading to it.

**THE COOPERATION WORK AT THE MDDS**

**furnish information**

- instruments: forms and matrixes for gathering and structuring knowledge;
- aim: schematic presentation of selected knowledge to be implemented;
- approach: from all-comprehensive towards detailed knowledge;
- communication among scientists
- aim: improve MDDS;
- way: develop new tables, comments on existing tables, suggestions.

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