TESTING AND CONFORMITY ASSESSMENT OF CONSTRUCTION AGGREGATES USING THE PM TECHMODEL SOFTWARE

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1. INTRODUCTION

The basic ideas of product development at Petromodel Ltd. (PM) are founded on materials science and can be described by the following hypothesis: *It is possible to predict the engineering properties of aggregates if their fundamental properties are known*[1]. This gives rise to a new approach for predicting and thus measuring or testing the engineering properties of construction aggregates. In this talk, *PM Techmodel,* new software specially prepared for this new test approach will be discussed. The use of Techmodel for research purposes is discussed in another talk[2]. Also, software for data collection and storage, PM Lithodata, a databank containing properties of Icelandic aggregates is introduced. Petromodel develops and markets software and high technical testing instruments for the aggregates industry, as well as providing consultancy.

2. GEOMATERIALS SCIENCE

Based on various authors[3], it is stated that the engineering properties, *P,* of unbound aggregates - mechanical, thermal and durability properties - are governed by fundamental properties (*FP*) of the particles and that of the surrounding pore fluid (*pf*). This context can be described as follows:

$$P = f(\text{FP, pf}) = f(\text{pc, s, sh, pf}) \tag{1}$$

The fundamental properties are taken as the petrographic composition (*pc*), size (*s*) and shape (*sh*). The link or function, *f*, can in rare cases be explained by a physical model, a causal connection. More often, the properties have to be related by statistically derived equations based on experimental data and this is one of the main roles of the PM Techmodel software. In practice, when deriving the predictive equations not only the fundamental properties are used as independent variables, but also engineering properties or other properties if they are known.

3. PM TECHMODEL

The new approach of measuring or testing the engineering properties of aggregates could be labelled "soft testing" or "virtual testing" and the traditional way, "mechanical testing" or "actual testing". Instead of using the mechanical testing for engineering properties at all times, one performs virtual testing in between. This approach creates benefits from the methodology of materials science by reducing the number of slow and expensive tests, by choosing mechanical tests much more purposefully and making more use of the measurements of fundamental properties.

PM Techmodel is a specialised prediction software program for statistical analysis of aggregate test results, including options for virtual testing of various technical properties, classification of aggregate sources and properties and pinpointing of redundant properties and test methods. PM Techmodel is easy to use; there is no need of knowledge of statistics beyond the very basics.

It will assist the industry to update product declarations more easily and allows for checking the conformity of the aggregate quality with the customer requirements and

that of law and standards. Besides, it should proof a good design and research tool. Version 1.0 of PM Techmodel was released in June 2002[4]. It is being developed in Austria by Dr. Jürgen Pilz, professor of statistics at Klagenfurt University, under the auspices of Petromodel.

In order to have the necessary data for preparing predictive models, Petromodel is developing software, PM Lithodata, for the users to collect data on their quarry or region. Petromodel has already collected such data in Iceland, from tens of quarries and established PM Lithodata-Iceland. Figure 1 shows results of prediction of engineering properties using Techmodel.
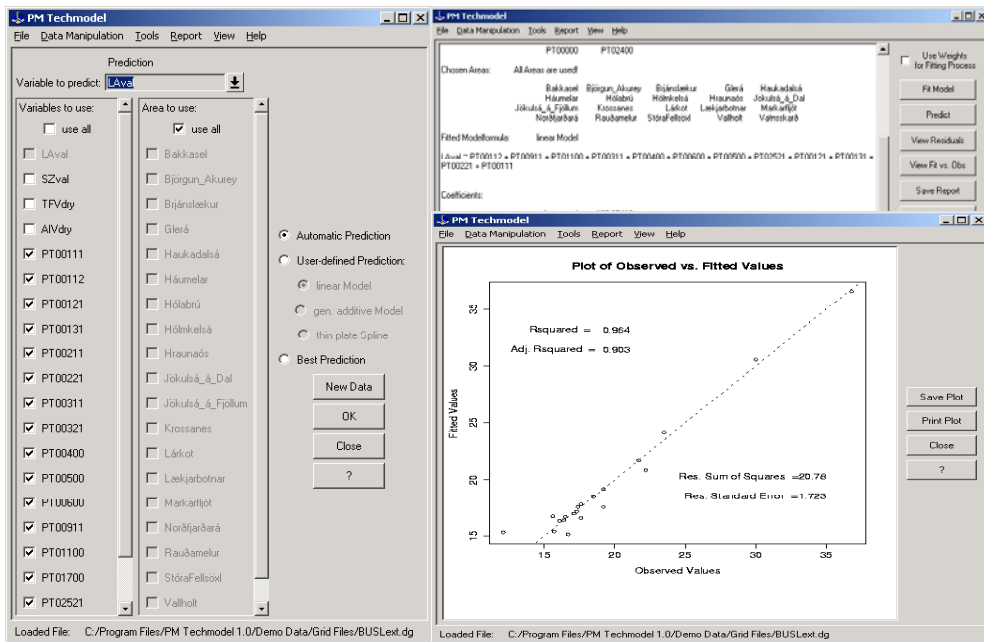

Figure 1: Virtual testing or predicting engineering properties, here LA value as expected from EN 1097-2, using PM Techmodel.

4. TESTING AND CONFORMITY ASSESSMENT – AN EXAMPLE

The whole of the European Economic Area has to fulfil the requirements of the EU Construction Product Directive, 89/106/EEC, giving rise to quality assurance, conformity assessment, factory production control, declaration of conformity and CE marking[5]. When addressing conformity, companies are dealing both with conformity with standards and compliance or conformity with the requirements of the customers and public regulations.

As an example of the use of PM Techmodel and PM Lithodata, some results from consulting work performed for ÍAV / IPC Ltd., based in Reykjavik, Iceland are presented. Data from a period of three years from a combined gravel pit and bedrock quarry, called Raudamelur/Stapafell quarry were studied. A databank was established with the test results and predictive equations were set up for the aggregates in the quarry, relating engineering properties, P and petrographic composition, pc. Conformity with requirement of different customers was checked, see Figure 2.

5. DISCUSSION

When preparing for turning the virtual testing, using PM Techmodel and PM Lithodata into formal test methods, it is necessary to check the requirements of measuring equipment, measurement process and test methods as put forth in EN and ISO standards[6]. Measuring equipment, per definition, is necessary to realize a measuring process, i.e. to realize a set of operations to determine the value of a quantity

(characteristic or property, such as polished stone value). The measuring equipment need not be a mechanical or electronic instrument, it can be software. The measurement process can be "published in standards", "non-standard" (recognized specifications) or "laboratory-developed". Any "laboratory-developed" test method need to be validated, e.g. by comparison of results achieved with other methods. Therefore, Petromodel as a supplier and a laboratory can use these standards[6] when the company chooses to specify PM Techmodel in combination with PM Lithodata as a measuring equipment and virtual testing as a test method.
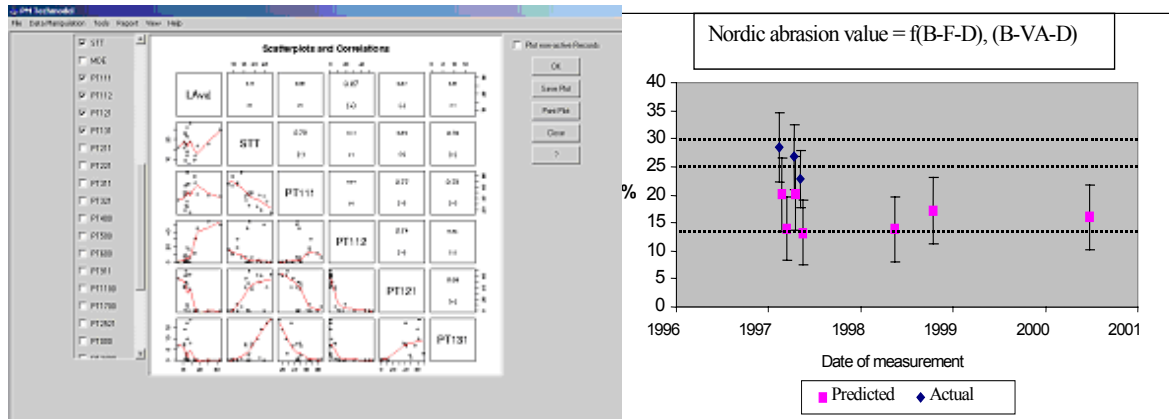

Figure 2: a) Observation and analysis of data. **b)** Conformity assessment; monitoring of data and checking for requirements of the Public Roads Administration for different road classes (horizontal lines) on the Nordic Abrasion Value (%) according to EN 1097-9. Values and 85% confidence limits are shown.

6. CONCLUSIONS

It is important for the aggregates industry in Europe to follow the EU and EFTA requirements of the "New Approach" to product regulation and the "Global Approach" to conformity assessment for products on the EEA market[5]. The "virtual testing" solution offered by PM Techmodel and PM Lithodata is one of many ways that can assist the industry in fulfilling the new demands.

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