

## Year 4: Executive summary

The TEAM project consortium, representing 9 EU countries, comprises 16 partners such as stone producers and trade associations, testing laboratories, standardisation and certification bodies, consultants, building owners and care-takers and producers of fixing and repair systems.

The main objectives of the project are to find the mechanisms of the expansion and loss of strength and the connected bowing of marble and limestone façade claddings. In addition, site investigation and monitoring systems have been developed and various solutions to the problem are being tried. Drafts of laboratory test methods will be presented to the European Standardisation of Natural Stone: CEN TC 246. A handbook containing instructions and methods for selection and testing of natural stone directed to professionals is also planned.

A state-of-the-art report has been updated and is now based on an extensive compilation of papers on marble and limestone deterioration dating from late 1800s to 2004. Despite the knowledge gathered from the literature and practical experience, the understanding of the complex and synergetic mechanisms is still not complete. Temperature variations, moisture and type of microstructure seem to be determining factors, but cannot explain all the observations in practice.

The inspections and evaluations of selected buildings have confirmed that the phenomenon of bowing of marble in some cases is a significant problem and is not restricted to one marble type or only European marble. Several new objects have been identified in the last year. These new objects show that bowing occurs in most climates, ranging from very dry and hot in the south to wet and cold in Northern Europe. The task to search for more buildings will continue throughout the entire project on a low activity level. Buildings with no bowing are also of importance for the validation of bowing theories and for promoting a continued use of natural stones as a suitable façade material.

Six buildings have been chosen for a detailed investigation and sampling. These buildings are situated in Copenhagen, Denmark; Nyköping, Sweden; Lünen, Germany; Göttingen (2), Germany and Magenta, Italy. The inspections have been finalised for these buildings. A first evaluation of the results from these inspections shows different patterns and reasons for observed bowing. The microclimate seems to be a very important parameter. Sampling, strength and screening tests have been started on these buildings.

The Danish National Bank, Copenhagen, Denmark; University Library, Göttingen, Germany and Nyköping City Hall, Nyköping, Sweden have been chosen for long-term continuous monitoring of deformation, internal and external surface temperature and environmental climatic conditions. Furthermore the amount of bow and ultra sonic velocity are measured. Monitoring equipment has been installed at these buildings. This has involved development of a system, which is suitable for measurement on existing buildings. The Nyköping City Hall, a climatic chamber in Trondheim and field test sites at SP are used for assessment of the influence of impregnation and surface coating.

The first draft of a prediction model for risk analysis has been prepared. This task will be co-ordinated with other tasks focussing on anchoring systems, long term monitoring, impregnation and surface coating as protection and also installation of a field test site.

An instruction for stone sampling and description has been developed. The sampling of blocks (>1 m<sup>3</sup>) from quarries has been completed. Different marble types from Italy, Switzerland, Sweden, Norway, Portugal, Poland and Slovenia have been chosen. The selection of these stone types has been based on the inspection of buildings in WP2 and on the screening test in WP5. Thirty-seven marble and two limestone types have already been tested in accordance with the newly laboratory draft test method for moisture and temperature-induced bowing. Also samples from 12 buildings have been tested. The samples tested show major variability in the behaviour from no bowing to severe bowing. A very important finding from the first evaluation of these tests, are that all marbles are likely to loose strength over time, when exposed to RH/T variations also without showing any bowing behaviour.

Rock stress measurements have been carried out in three quarries in the Carrara area. Blocks have been sampled from these quarries for comparison of laboratory tests, field exposure and rock stress measurements.

A web site where the project is presented is established ([www.sp.se/building/team](http://www.sp.se/building/team)). A database to compile information from building inspections and stone analyses has been developed and linked to the website. A poster and a project-brochure have been produced and a pdf version of the brochure has been placed on the TEAM homepage. The TEAM project has been presented at international fairs and meetings. The aims and results of the laboratory tests have been introduced to an audience of Italian stone producers during an internal workshop in Carrara, Italy and for a wider audience of producers, consultants and architects in Stockholm, Sweden, in Copenhagen, Denmark and in Istanbul, Turkey.