

newsletter

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 Czech Academy
of Sciences

 ITAM ARCCHIP

INSTITUTE OF THEORETICAL
AND APPLIED MECHANICS

1 / 2022

TECHNOLOGICAL RESEARCH OF THE RUINS OF ŠTAMBERK CASTLE

In 2021, the first phase of the joint project Technological research of the ruins of Štamberk Castle in the broader context of the region was completed. The project was implemented by the ITAM CAS and the Telč Microregion, which was supported within the framework of the Cooperation of Regions with Institutes of the Czech Academy of Sciences, in this case specifically with the Vysočina Region. The project focused on research into the partial history of Štamberk Castle with an emphasis on selected technological aspects of its construction, structural changes and its demise. Within the project, a material analysis of the samples taken from the ruins was carried out in order to study the technology of construction of masonry structures and the provenance of raw materials used in the production of mortar. The latter is an important issue in terms of understanding the lime mortars used. Therefore, a surface geological survey of the sites identified on the basis of historical and contemporary maps, recommendations from local witnesses and the specialized Calcarius database was carried out. The presence of suitable raw material for lime production was

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EDITORIAL

Dear supporters of science,

After some time, we are now publishing another issue of the newsletter for the Institute of Theoretical and Applied Mechanics of the CAS which summarizes on these four pages the more significant events of the past half year. We have not been idle in this somewhat less busy period. After two years, the Engineering Mechanics Conference of Czech mechanics was finally held again in Vysočina with international participation, a continuation of the previous successful years.



Another event, which has also suffered from this two-year hiatus, was the ITAM staff's annual participation in the Science Fair and presentation of scientific exhibits to the wider public, especially the younger generation.

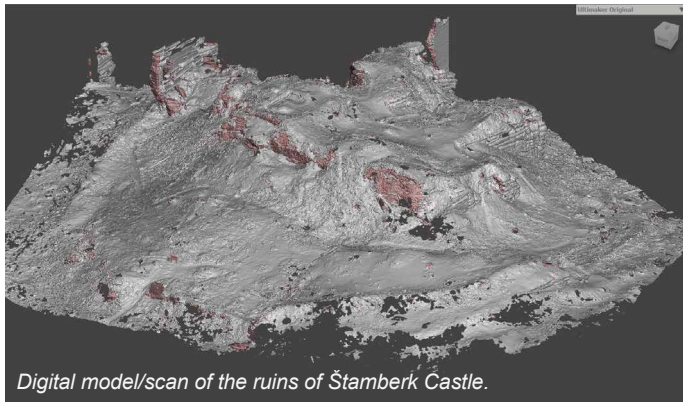
In this issue you also will find interesting information about X-ray tests from which it was possible to "extract" images of loaded foam with advanced morphology, and about the novelty of new patented TORATOM X-ray equipment in the form of a highly sensitive large-area scintillation detector. You will also learn about the continuation of the "Memory Tools" exhibition, which this time it is possible to visit at the Podřípské Museum until the end of summer. In the article on research conducted at the Štamberk ruins, you will find out how the Department of Heritage Science works, using numerous new technological tools and procedures developed by the staff from our Centre Telč and the Centre for Lime Technologies. The expertise of the ITAM researchers and the international reach of their research is further demonstrated in the article about a project that deals with building binders from the Late Bronze Age and Roman times in Cyprus.

We wish you an interesting and stimulating read!

Stanislav Pospíšil, ITAM director



Ruins of Štamberk Castle and 3D printed model of the castle. Photo: J. Novotný



Digital model/scan of the ruins of Štamberk Castle.

demonstrated at two sites. Another area of the project activities was the detailed mapping of geological points of interest in the broad surroundings of the ruins of Štamberk Castle. A total of 499 records were made, some of which have already been

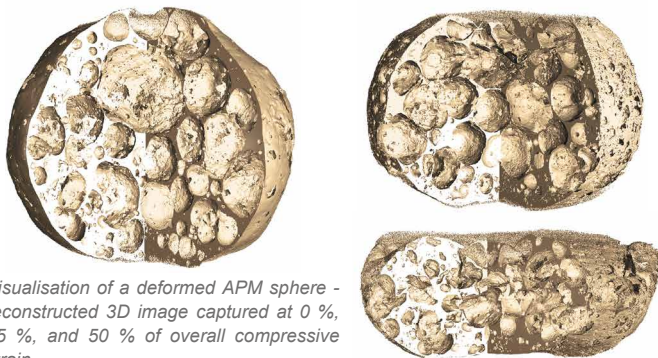


Sample of limestone taken during field survey. Photo: J. Novotný

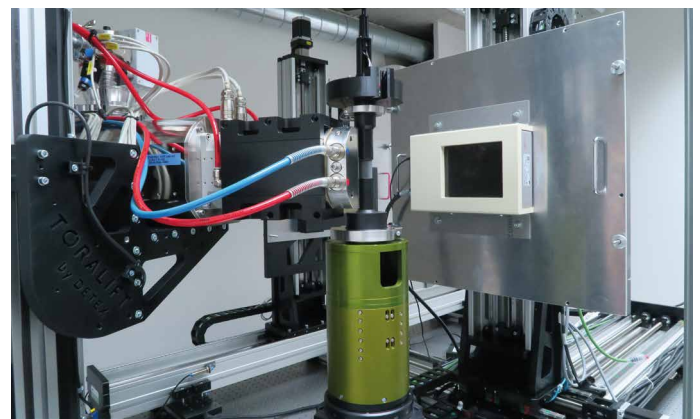
published in the Geopark Vysočina database. The last area of the project activities constituted the creation of a digital and subsequently physical 3D model of the ruins of Štamberk Castle.
J. Novotný

MICRO-CT AND IN-SITU COMPRESSIVE TESTING OF ADVANCED PORE MORPHOLOGY (APM) FOAM ELEMENTS

Demonstration of time-lapse X-ray tomography (4D XCT) for investigation of porous samples with complex microstructure designed for material engineering applications took place at the Department of Biomechanics. The ITAM designed and engineered tomography scanner together with micro-loading device was employed for experimental evaluation of the APM deformation behaviour. Advanced pore morphology (APM) foam elements are almost spherical foam elements with a solid outer shell and a porous internal structure mainly used in applications with compressive



Visualisation of a deformed APM sphere - reconstructed 3D image captured at 0 %, 25 %, and 50 % of overall compressive strain.



loading. To determine how the deformation of the internal structure and its changes during compression are related to its mechanical response, in-situ time-resolved X-ray microcomputed tomography experiments were performed. Simultaneously applying mechanical loading and radiographical imaging enabled new insights into the deformation behaviour of the APM foam samples when the mechanical response was correlated with the internal deformation of the samples. It was found that the highest stiffness of the APM elements is reached before the appearance of the first shear band, which was followed by stiffness decrease up to the point of self-contact at the beginning of the densification region.

D. Kytýř

CONFERENCE ENGINEERING MECHANICS 2022

After a two-year hiatus, the International Conference Engineering Mechanics 2022, the main event in the field in the Czech Republic, took place from 9 to 12 May 2022. This year's conference was organized by the Institute of Theoretical and Applied Mechanics of the CAS. Participants included researchers and PhD students from basic research as well as practicing engineers. Traditionally, all age categories are represented, especially young people. The aim of the organisers is to give young people the opportunity to gain experience and habits that can be useful at large conferences abroad, and to that aim the style of conducting the event is designed. Detailed information about this year's event together with photo documentation can be found at www.engmech.cz.



Photo: F. Šebek

C. Fischer, J. Náprstek

NEW ITN PROJECT ON ARCHAEOLOGICAL MORTARS



PlaCe-ITN

Pre-modern Plasters and Ceramics

The project titled *Characterization of binders used in pre-modern plasters in the ever-changing urban environment* is part of the Innovative Training Network and is funded by Europe's Horizon2020, the EU Research and Innovation funding program, as a Marie Skłodowska-Curie Action. The consortium includes eight Institutes across Europe, including Universities and Research Centers.

The aim of the project is to investigate Cypriot archaeological mortars in order to gain a broad overview on the development of the plaster industry in the Paphian region between the Late Bronze Age and the Early Roman Age. The subject of the study is plasters and mortars collected from five different archaeological sites across the modern district of Paphos. The key site is the settlement of Nea Paphos, which served as capital of the Paphian City Kingdom and later as administrative center for both the Ptolemaic and the Roman colony of Cyprus. Data gathered from Palaepaphos – the former Paphian capital, before the foundation of Nea Paphos – will also be collected in order to study the correlation between the two cities. Other relevant sites



Hellenistic theatre in Nea Paphos, one of the sampled sites. Photo: P. Pizzo



Sample YSC 18, a gypsum mortar laid on top of a sandstone. The sample was collected from Yeronisos Island and is supposed to be from the Hellenistic period. Photo: P. Pizzo

are the settlement of Maa-Palaiokastro, Kissonerga-Skalia and the complexes on the Island of Yeronisos, possibly built by the Ptolemaic army.

The first group of samples was collected in May 2022 from the sites of Palaepaphos-Hadjabdoulla, Yeronisos, and from the Hellenistic Theatre in Nea Paphos. The samples obtained were representative of their different functional uses at each site. Mainly masonry mortars, wall plasters, hydraulic plasters and scattered samples of floor mortars were selected.

After a preliminary macroscopic observation, relevant samples were selected for the production of thin sections, which will be used for optical microscopy, SEM analysis, and cathodoluminescence. Subsequently to the characterization using these techniques, further analytical strategies will be developed for each individual sample. XRD and TA are also being considered to compliment the microscopic analysis. Part of the study will involve the experimental approach to study of technologies and a reproduction of the samples, taking advantage of the facilities at Solvayovy lomy.

The first laboratory documentation and microscopic observations suggest that very interesting materials were sampled. The mortars are exceptionally hard and well preserved. Some preserve specific surface treatments and bear brush stroke marks or pigments. Besides a lime-based binder, these mortars also contain gypsum mixed with lime, crushed ceramic pieces added as puzzolans or specially polished gypsum stucco layers.

P. Pizzo, J. Válek

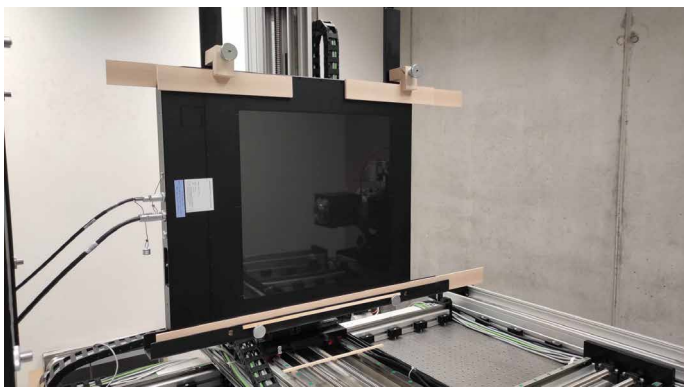
ITAM CAS AT THE SCIENCE FAIR 2022

After a three-year hiatus imposed by covid, the Czech Academy of Sciences together with its institutes organised Science Fair 2022, the largest event of its kind in Czechia. Interest exceeded expectations—according to the organizers' estimates, over 30 thousand people visited the fair. A total of 15 of our employees took turns at the ITAM stand, showing visitors a model of a climatic wind tunnel, skyscraper models demonstrating methods of damping vibrations of high-rise buildings, BIM models, a demonstrator of 4D XCT device and compact loading device for μ XCT scanners, and the traditionally popular oscillating bridge decks. A big thank you to all the colleagues from ITAM who participated in the preparation, installation and implementation of our stand at Science Fair 2022!



V. Rada from the Department of Biomechanics of the Institute of Theoretical and Applied Mechanics of the CAS explains the principle of the 4D microCT device on the demonstrator. Photo: B. Přečová
B. Přečová

NEW X-RAY DETECTOR IN CENTRE TELČ



New X-ray detector Varex XRD1611 in the TORATOM device. Photo. M. Vopálenký

During the spring of 2022, the top-class Varex XRD1611 X-ray scintillation detector, which was purchased last year, was successfully integrated into the TORATOM tomograph, operated at Centre Telč. This detector provides a matrix of 4096 x 4096 pixels with a size of 100 x 100 μm , i.e. its active area is almost 410 x 410 mm. Its face cover is made of carbon

composite, so it is sensitive from a photon energy of 20 keV. The detector fully replaces the older types XRD1622, which have a pixel size of 200 x 200 μm at the same active area and are sensitive to photons from about 40 keV. The new detector offers a number of significant improvements over these older detectors: it is able to detect photons with lower energy, so it can be used for imaging materials with lower attenuation (e.g. organic materials), it is able to work with an exposure time of 100 ms in full resolution, compared to 1000 ms in the case of XRD1622, which in many tasks means a significant reduction in tomographic scanning time. Above all, however, it offers four times the number of pixels on the same active area, which allows one to perform tomography with higher resolution (instead of one volume element in the 3D model, we obtain eight spatial elements with half the length of the edge). However, four times the number of pixels in each radiogram also results in significantly higher data volumes that need to be processed and a significant increase in processing time. The tomographic 3D model created from the entire detector in its full dynamic depth of 16 bits represents a data volume of 128 GB (!). Therefore, it is planned to expand the operating memory of the computer used in the tomographic laboratory of the Centre Telč for tomographic reconstructions from the current 256 GB to 512 GB.

M. Vopálenký

INVITATION TO THE RENEWED EXHIBITION "MEMORY TOOLS" AT THE PODŘÍPSKÉ MUSEUM IN ROUDNICE NAD LABEM

Thanks to the generous offer of the director of the Podřipské Museum, Dr. Trefný, it was possible to renew the exhibition "Tools of Memory" until 17 September 2022. Originally, this exhibition was prepared in the National Museum complex at the end of 2020, but due to COVID restrictions it was not actually open to the public. It can now be visited and viewed in Roudnice n. L. after a 45-minute train ride from Prague.

The exhibition deals with the history of cuneiform, the contribution of Professor Bedřich Hrozný to the decipherment of the Hittite script, and his archaeological excavations and digs in Kültepe (today's Turkey) from which he brought back objects that are the basis of the current collection of cuneiform tablets.

Last, but not least, the exhibition discusses the contribution of



Exhibition "Memory Tools " for the second time. The exhibition can be visited until 22 September 2022 in the Podřipské Museum. Both photos: J. Valach

modern scientific methods applied to the objects in the collection to expand knowledge of the material nature of the tablets and their physical properties. This new information contributes to the discovery of the provenance of the tablets as well as the ways in which the users of the tablets handled them. In addition to the "Memory Tools " exhibition, the Podřipské Museum also offers permanent exhibitions devoted to the nature, geology and archaeology of the Podřipsko region, a collection of ancient terracotta vessels and a pithy retro-futuristic model of the settlement of Mount Říp made from Merkur kit parts. The town of Roudnice n. Labem itself boasts historic buildings and picturesque nooks as well as interesting surrounding countryside and is therefore worth visiting.

Acknowledgement: The exhibition "Memory Tools" was created within the project "Analysis, description and archiving of information on the properties of cultural heritage objects and the use of this information in restoration, conservation and research practice" (NAKI DG 16P02M022, supported by the Ministry of Culture of the CR).

J. Valach



Preparation of the exhibition: 50-times enlarged cuneiform tablet made of glued-together layers of PU foam laser cut according to a digital 3D model.