Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014

Final Report on the Evaluation of the Institute

Name of the Institute: Institute of Theoretical and Applied Mechanics of the CAS, v. v. i.

Fields, in which the Institute registered its teams:

Materials engineering, materials science and nanotechnology ,Mechanical and civil engineering,Metrology and diagnostic methods

Observer representing the Academy Council of the CAS: Jiří Chýla
Observer representing the Institute: Zdeněk Fiala, substitute observer Jiří Minster

Commission No. 8: Engineering and technology
Chair: em Prof.DI.Dr.Dr.hc. Hans Peter Nachtnebel

Date(s) of the visit of the Institute: October 12 - October 21, 2015
Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:
No. 1 - Engineering mechanics;
No. 2 - Diagnostic methods and instrumentation;
No. 3 - Building materials, historical structures and conservation science

EVALUATION OF THE INSTITUTE OF THEORETICAL AND APPLIED MECHANICS

1. INTRODUCTION

1.1 Location of the institute and its dept., labs. & sub units.

Institute of Theoretical and Applied Mechanics of the CAS
Prosecká 809/76, Prague 9
Batelovská85-486, Telč

1.2 Brief history of the institute

In 1921, "The *Research and Testing Institute for Building Materials and Structures*" of Czech Technical University in Prague was founded. In 1953 this Institute was divided into two parts: "*Klokner Institute*" of Czech Technical University in Prague and "*Institute of Theoretical and Applied Mechanics"* of the CSAS. Since 2007, the *Institute* has become a public research institution.

1.3 Mission and research topics

Main research topics of the Institute are following:

- Non-linear dynamics – including interactions of solid bodies and flow.
- Stochastic mechanics – mostly related to building applications.
- Continuum mechanics – meso-mechanics, time dependent effects.
- Dynamics of building structures – towers, bridges, systems.
- Aero elasticity, aerodynamics, wind engineering – in complexity.
- Post-critical behaviour of thin-walled systems – incl. fatigue.
- Fracture mechanics – damage and failure mechanisms.
- Biomechanics – biological structures & tissues, metal foams.
- Experimental mechanics – including development of testing methods, devices and facilities.
- Soil mechanics – slope instability, passive & active pressure.
- Conservation science – interdisciplinary problems of cultural heritage safeguarding – historic structures, historic cities, global impacts.
- Material consolidation & protection – mainly wood, stone, mortars – incl. crystallization processes, degradation, replication of traditional materials, waste material conversion.
- Safety & security of citizens – preventive protection & resilience in relation to natural or anthropogenic threats and disasters.

1.4 Staff size and full time equivalents age distribution

The Institute has currently 117,11 employees in full time equivalent, 74,87 from which are researchers, 10,70 technicians, 19,1 administration etc., and 12,44 Ph.D. students. Continually increasing number of employees during the evaluation period is obvious from graph in Fig. 1.

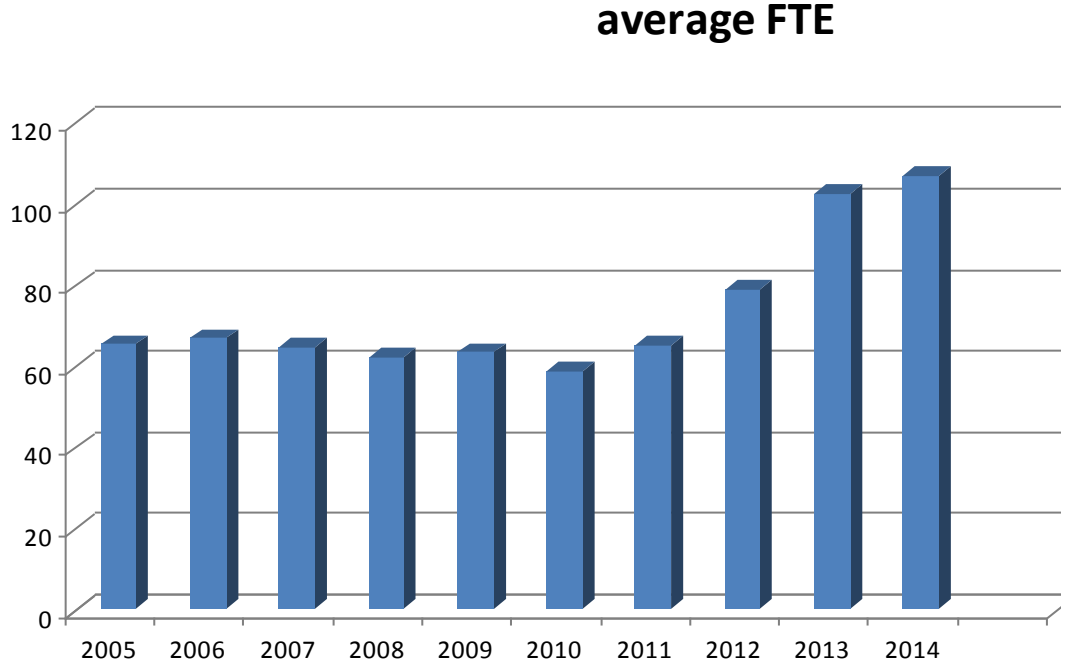

Figure 1: Numbers of Institute employees in full time equivalent during 2010-2014 period

Age structure of all Institute employees is presented in Fig. 2.

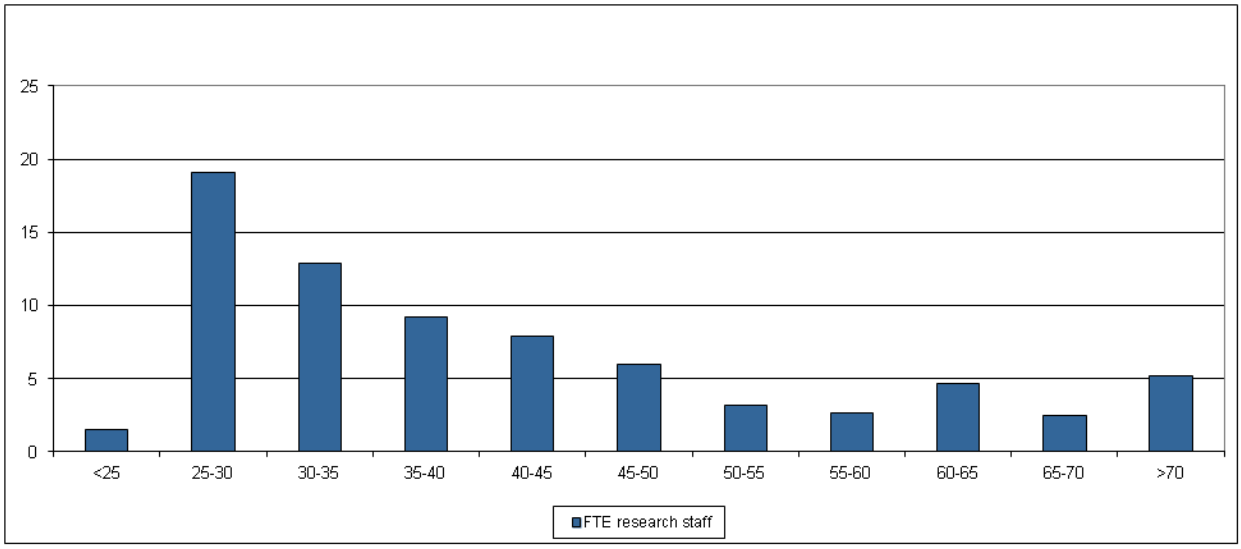

Figure 2: Age structure of Institute employees in full time equivalent during 2010-2014 period

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The research activities of the Institute are very diverse (see the paragraph 1.3), but collective characteristic of them is topicality, reasonability and benefit for various engineering and industrial sectors. They are focused on serious current problems.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

The Institute have proved the admirable ability to get some financial sources in addition to institutional money which represent only 32,5% overall budget. National and international grants and commercial contracts are for the Institute main source of budget.

2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Research topics of the individual research teams of the Institute are miscellaneous and thus the collaboration among them depends on the current needs and possibilities, e.g., utilization of the special instruments, joint participation on the projects etc. Cooperation of the Institute with other research subjects and universities both in the Czech Republic and around the world is very intensive and fruitful.

2.4 Position of the institute within the Czech scientific community and its international position

Position of the Institute especially within the Czech scientific community in the corresponding research areas is significant.

2.5 Reasonability of the structure of the institute and the departments

The Institute consists of 10 scientific departments and Centre of Excellence Telč. This structure is reasonable; it is based on the heterogeneity of the main individual research topics.

2.6 Comments on the age structure

High ratio of young employees (over 35 % under 35 years in full-time equivalent) is very beneficial and perspective. Young researchers and students have possibilities to be in close

contact with their older colleagues which are experienced and highly qualified experts of international stature.

2.7 Patents and role in contractual work

Number of patents or patent applications (9 in the evaluation period) is outstanding.

3. WEAKNESSES AND THREATS

3.1 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Possibility of the collaboration among individual teams of the Institute is rather complicated by distance between laboratories in Prague and Telč. Considerable instrumental potential of the Centre of excellence in Telč would have broad utilization but solution of this problem is partially restricted also by the lack of qualified personals.

3.2 The overall capacity of staff

Because of wide variety of research topics and demanding character of them, rather higher capacity of the staff (especially in some departments) would be desirable.

3.3 Comments on the age structure

The gap in the age structure of the Institute staff between 45 and 60 years would result in some trouble in the next years, but thanks to the high ratio of young researchers, perspective of the Institute from the personal point of view would be promising.

3.4 Frequency and quality of publications

Ratio of the total number of papers in journals with IF (133 in the evaluation period) to number of researchers and Ph.D. students (currently 74,87, and 12,44 respectively) is rather low, but this fact is related to the character of the research activities which are focused mainly on the applied research. Mentioned seeming deficiency is compensated by the remarkable number of patents and patent applications.

4. RECOMMENDATIONS

In the next years, main attention would be given to increasing of the personal capacity and to looking for adequate new financial sources.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

The research activities of the Institute are very diverse and they include both very exacting theoretical approaches and sophisticated experimental research. The topics under study, enumerated in the paragraph 1.3, are mostly very beneficial for various engineering and industrial sectors on some serious current problems of which the research activities of the Institute are focused.

Relevance in the national and international context

Research activities of the Institute have undoubtedly very import relevance not only in the national, but also in international context.

Overall quality of publications

Increasing number of publications in journals with IF during the last years is evident from graph in Fig. 3.

In 2010-2014 period, together 133 papers in journals with IF were published by the Institute staff members; 35 of which were classified as world-leading or internationally excellent. Quality of the research outputs is possible to support by 9 patents or patent applications in the evaluation period.

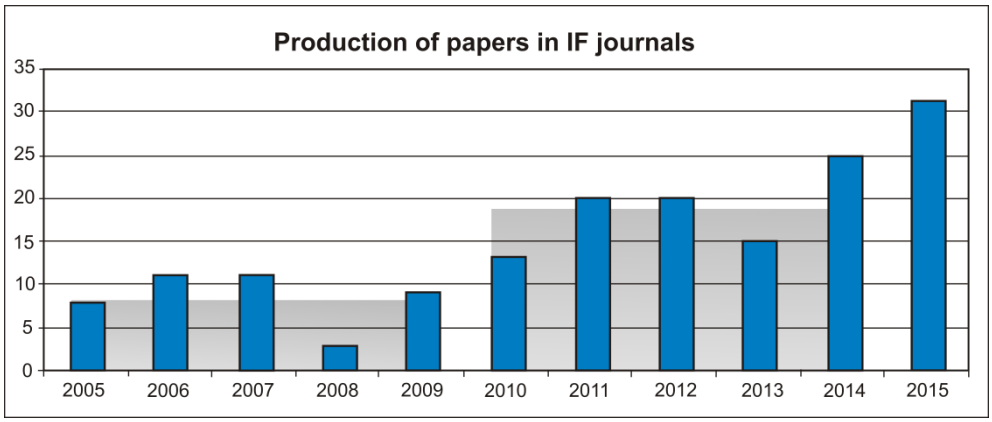

Figure 3: – Number of papers in journals with IF in previous and current evaluation period

Specification of the main achievements

There are 3 groups of research topics on which the Institute is focused on:

1) dynamics, stochastic mechanics and theory of structures,
2) mechanics of materials, experimental mechanics and biomechanics,
3) Interdisciplinary research of cultural heritage problems.

In all 3 groups the Institute reached important achievements in the evaluation period. Examples of some main of them are following:
Ad 1) Development of stochastic dynamics of linear and non-linear systems, study of dynamic stability, bi-furcation and post-critical effects, research of in the field of dynamics of non-conservative systems with moving inertial excitations, investigation of seismic processes and types of response, study of interactions of systems with the air flow, tasks of wind engineering and dynamics of structures, research of degradation processes in thin-walled vessels and pipes of gas lines and other media transportation lines under complex loads of internal stresses, temperature and aggressive environment, research of solid mechanics problems - mathematical tasks and mezomechanics.

Ad 2) Development of microstructural FEM models of trabecular bones for reliable assessment of their qualities by means of combination with microCT models and mechanical characteristics determined on the level of individula trabeculas, study of mechanical characteristics of composites subjected to time variable forces in environments accelerating degradation taking advantage of hybrid experimental and numerical methods, development of various special experimental devices which are designed for testing of materials, fracture mechanics investigations and building diagnostics.

Ad 3) Study of features of the current and atmospheric boundary layer; study of ice and frost formation on carrying cables of a suspended bridge; study of stability of U-beams; study of distribution of the heat transfer coefficient; development of flow visualisation methods; study of cumulative time-dependent processes in building materials and structures; development of high performance and compatible lime mortars for extreme applications; development of the methodology and instruments for protection and preservation of cultural heritage at risk from flooding; research and development of new materials and technologies for preservation; research and assessment of wooden carpentry joints of historical structures; research on application of colloidal nano-particles of lime; study of production of magnesium phosphate cement using toxic asbestos-cement waste, etc.

Specification of the contributions of the team to publications

Although some publications have co-authors from other research organizations, the contribution of the Institute members to the outputs was quite decisive.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

The Institute cooperates with many universities in the Czech Republic (Czech Technical University in Prague, Technical University in Ostrava, Technical University in Liberec, Technical University in Brno, University Pardubice, Mendel Agriculture and Forestry University in Brno). Numbers of BSc., MSc. and PhD theses under supervision of the Team members in the evaluation period is summarized in Tab. 1. Involvement of doctoral and undergraduate students in research is very extensive and significant. Students are able to do very useful scientific work and help their advisors in their research in the framework of various projects and they are often with co-authors of publications. This kind of collaboration with universities is very beneficial for the both contracting parties.

Table 1: Supervising students in 2010-2014 period

Type of study	No. of supervisors (theses, dissertations)	No. of consultants and co-supervisors	Theses defended in 2010-2014
Bachelor	10	4	5
Master	17	4	21
Doctoral	5	16	7

Particular contributions of students to research

Contribution of doctoral and undergraduate students to the research activities of the Institute is important and beneficial - students under supervision of experienced researchers are able to do very useful scientific work in the framework of various research projects which are solving at the Institute.

Number of defended PhD students in relation to students involved (success rate)

In 2010-2014, 5 Ph.D. students had their supervisors from the Institute; in the same period 7 Ph.D. theses were successfully defended.

Employment of former Phd students (career options)

Employment of former Ph.D. students would be very welcomed, but the budget of the Institute is restricted and financial possibilities depend especially on the success of project proposals.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

The Institute budget consists of 32,5% institutional and 67,5% grant and commercial source. From this fact is clear that success in grant application and acquisition of industrial contracts is entirely substantial for the Institute economy.

Impacts of the results and other activities on education

Cooperation of the Institute with many universities is very intensive not only in research, but also in education. Interesting scientific work, experience of researchers and many unique experimental instruments at the Institute offer very good opportunities for students. Joint work on the research activities of the Institute represents very beneficial part of their education. Aside from supervision of students' works, top researchers have some lectures at the universities.

Impacts of the results and other activities on culture

The research of some teams are very closely related to the culture because of their orientation on maintenance, preventive conservation and rehabilitation of cultural heritage assets and important historic sites, evaluation and monitoring of irreversible changes of unmovable cultural heritage due to repetitive human interventions and environmental effects, etc., thus impact of the relevant research results and other activities of the Institute on the culture is beneficial.

Popularisation and similar activities

Popularisation activities of the Institute are very wide and they have important impact. The Institute designed and carried out a special popularization project supported by the Ministry of Education, Youth and Sports. This project was aimed to develop a knowledge environment and supporting tools for long-term interactive popularization of research and development and its results in the sustainable management of cultural heritage and its use as a renewable resource in a broader social context. The project included a systematic work with students' involvement in the form of open research activities to solve specific types of project tasks. In order to promote the team´s field of research and to create easy to use education and popularization tools, there were produced 13 short movies in the preparing of which several researchers were involved.

The Institute workers were guests of various radio and TV programmes, e.g,:Public TV show "Hyde park civilizace" (one hour discussion about the Centre of Excellence Telč and its research projects and results), an interview in broadcast "Planetarium" of the Czech Radio (about traditional materials the experimental lime kiln), an interview in broadcast „Tandem z Vysočiny"of the Czech Radio (about Centre of Excellence Telč and its research programme).

Some other popularization items were presented in newspapers and journals.

The Institute also participated in various periodical public popularization events, e.g., „The Week of Science and Technology“, “Museum night”, “European Heritage Days” (lectures and excursions), etc.

Mentioned above and many other popularization activities are described in detail in the evaluation materials of the Institute.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams, Role and position in international collaboration, breadth/completeness of the research activities compared to world leading teams of comparable size

The Institute distinguishes by strong position both in national and international scientific community. The Institute is active in international research planning - represents Czech Republic in the JPI Cultural Heritage, coordination of research within the European Construction Technology Platform, Involvement in numerous joint RILEM, COST, ICOMOS activities, cooperation with hundreds of foreign scientists in EC research projects. Also cooperation of with numerous national and international universities in research and education joint activities is wide and important.

Quality of the Institute research work was among other things recognized byEU Prize, Europa Nostra Prize, award in SME research.

Ability to attract foreign researchers at different levels

The Institute employed and has been employing scientists and researchers from abroad. Especially the modern Centre of Excellence in Telč is very interesting and attractive and exhibits the strongest international representation. During the evaluation period researchers from many countries had been working at the Institute (e.g., from Austria, Croatia, France, The Netherlands, Russia, Slovenia, Slovakia, Belgium, Germany, Italy, Ireland, Mexico, Poland, Portugal, Spain, Ukraïna), many others were visitors etc.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience, Attraction of research programmes for young people,

Age structure of the Institute employees is given in Fig. 2. In this graph is visible a gap in the middle age sector but high ratio of young employees (over 35 % under 35 years in full-time

equivalent) is very beneficial and perspective. Young researchers and students are close contact with older, very experienced and highly qualified experts and scientists of international stature. The gender issue is treated; the ratio of men to women is different is rather varied in the individual teams but it is approximately 2:1. Female members of the Institute staff are in minority.

Funding (structure of the resources and its comparison with the outputs, grants and project activity, Effectiveness of research (based on comparing size of groups, funding and output)

The Institute budget consists of 32,5% institutional and 67,5% grant and commercial source. From this fact is clear that success in grant application and acquisition of industrial contracts is entirely substantial for the Institute economy.

Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

The Institute provides special financial incentives to research teams successful in solicitation research funding or contractual research.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans, Adequacy of available means and human resources to achieve these plans

This strategy and presented research plans are relevant. They are perspective and beneficial for the other progress in the Institute activities. The Institute has adequate both technical and human resources to achieve the out lined plans for next years.

EVALUATION OF THE INSTITUTE OF THEORETICAL AND APPLIED MECHANICS

Department of Engineering Mechanics

1. INTRODUCTION

1.1 Location of the institute and its dept., labs. & sub units.

Institute of Theoretical and Applied Mechanics of the CAS
Prosecká 809/76, Prague 9
Batelovská85-486, Telč

1.2 Brief history of the institute

In 1921, "The Research and Testing Institute for Building Materials and Structures" of Czech Technical University in Prague was founded. In 1953 this Institute was divided into two parts: "Klokner Institute" of Czech Technical University in Prague and "Institute of Theoretical and Applied Mechanics" of the CSAS. Since 2007, the Institute has become a public research institution.

1.3 Mission and research topics

Activities of the Team are focused predominantly on the basic research with the goal to solve relevant problems emerging in civil, mechanical, traffic and other types of engineering, physics and other domains.

1.4 Staff size and full time equivalents age distribution

Age category	< 25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	≥ 70
Number of members	0,5	1	2	2	3	1	0,5	1,2	2	1	3,35

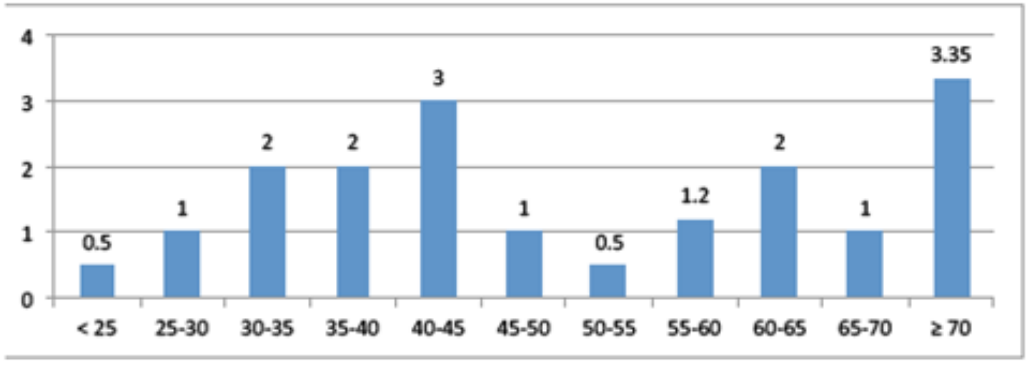

Figure 4: Age structure of all employees at the Department of Engineering Mechanics

The Team consists of 3 working groups; total number of scientists at the whole department is 13.25 in full/time equivalent. Age structure of all employees at the Department is presented in Fig. 4.

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

*T*he research topics on which the Department is focused on, are mostly front burner, serious, reasonable and beneficial for engineering and industrial sectors.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

Success in grant application and acquisition of industrial contracts is entirely substantial for the Department economy. In the comparison with number of staff members, number of national and international projects (23 in total) solved in the evaluation period is outstanding.

2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Intensity of collaboration among teams and among other research institutes and universities in the Czech Republic and abroad is very good.

2.4 Position of the department within the Czech scientific community and its international position

Position of the Department both in national and international scientific community is significant; the Department researchers are members of many relevant scientific societies, committees, boards, commissions, international associations etc.

2.5 Patents and role in contractual work

Contractual work represents very substantial and important part of the research activities of the Department.

3. WEAKNESSES AND THREATS

3.1 Budget: Ratio of institutional budget, grants and contractual resources, international funds

Institutional part of the Department budget is rather low. An increase of the institutional money would be undoubtedly helpful for the stability of the Department and for solution of its current personal problems.

3.2 The overall capacity of staff

Personal capacity of the Department staff is not fully adequate to the significance and extent of the problems under study.

3.3 Reasonability of the structure of the institute and the departments

The Department consists of 3 working groups which are rather small, but this dividing is based on the differences of the topics under study.

3.4 Comments on the age structure

Age structure of the Department staff is not very perspective: low ratio of the young researchers, noticeable gap between 45-60 years and relatively high ratio of the researchers over 70 years. This fact would result in some personal problems in the nearest future.

3.5 Frequency and quality of publications

Total number of the inputs in evaluation period is outstanding (251 in total), but most of them are contributions to conference proceedings, etc. Only 22 (i.e., just under 9 %) of which were published in journals with IF, but high ratio of these papers was classified as world-leading or internationally excellent in the Phase I of this evaluation.

4. RECOMMENDATIONS

Main activities of the Department would be focused on the solution of the unfavourable and not very perspective composition of the staff from age point of view. Some incentives for young researchers in cooperation with universities would be beneficial.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

Analytical, numerical and experimental investigation of dynamic stability, bifurcation, transition and post-critical processes in auto-parametric and self-excited systems with non-conservative and non-holonomic properties absorbing energy due to deterministic and stochastic interaction with moving medium. Study of the wave propagation in homogeneous and randomly non-homogeneous continuum.

Relevance in the national and international context

From relevant outputs, national and international grants, cooperation with many national and abroad universities, work on preparation and promotion of local and international standards compatible with EUROCODE and other activities is evident import relevance both in the national and international context.

Overall quality of publications

In 2010-2014 period, together 251 outputs were presented, only 22 of which were published in journals with IF. For phase I of this evaluation, 24 papers were selected, 14 of which were classified as world-leading or internationally excellent. Most of other outputs were contributions to conference proceedings, books and chapters in the books.

Specification of the main achievements

Main achievements of the research work in evaluation period were following:

- Analyse dynamic stability, transition and post-critical states of Hamiltonian/non-Hamiltonian systems with non-conservative constraints and ability of energy absorption due to interactions with other systems and moving medium.
- Study of the aspects of stability and non-stability and the character of limit cycles.
- Stability investigation was carried out on the basis of relevant Fokker-Planck equation. Perturbation of Probability Density Function (PDF) stability was analysed in the meaning of the mean value and variance using stochastic moments decomposition,
- The solution of non-linear mechanical systems subjected to the stochastic processes.

- The stability problems analysed on the case of a kinematically excited spherical pendulum.
- The unified linear variant of the general mathematical description of stability conditions.
- Experiments in aerodynamics, nonlinear aero-elasticity, and heat transfer phenomena.
- Research in dynamics effects on industrial structures, bridges, footbridges, masts, towers, and historical structural elements.
- Study of problems of soil-structure interaction.
- Development of approximate expressions for determining fracture parameters.
- Fatigue behaviour of pipeline steel.
- Study of the influence of cyclic stresses below the fatigue limit.
- Research of the effect of stress corrosion on the fracture toughness.
- The fatigue life estimation of orthotropic steel bridge.
- Investigation of thin-walled systems.
- Testing of model of lamella flanges.
- Geometrical setting of solid mechanics and its consequence for time-incremental analysis.

Specification of the contributions of the team to publications

The contribution of the Institute members to the papers and other research outputs was quite decisive.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

The Institute cooperates with some universities in the Czech Republic (Czech Technical University in Prague, Technical University in Ostrava, Technical University in Liberec, and Technical University in Brno). Numbers of BSc., MSc. and Ph.D. theses under supervision of the Team members in the evaluation period is summarized in Tab. 2.

Tab. 2 - Supervising students in 2010-2014 period

Type of study	No. of supervisors (theses, dissertations)	No. of consultants and co-supervisors	Theses defended in 2010-2014
Bachelor	0	0	0
Master	3	0	3
Doctoral	0	5	0

Particular contributions of students to research, Number of defended PhD students

It is evident that number of students involved in the research activities of the Department is low and thus their contribution is negligible. There are no defended PhD students.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

Because of relatively low ratio of institutional money in the budget, success in grant application and acquisition of industrial contracts is entirely substantial for the Department economy.

Popularisation and similar activities

The team Members are participating at Czech public fairs ABF, where they present the activities in the field of structural mechanics. Researchers of the Department take part in the educational project "Open Science II" focused on the popularization of Science for secondary school students and in lifelong learning courses for the secondary school teachers. Apart from the mentioned activities, the team envisages the popularization of research process and results in engineering practice by organizing workshops, public demonstrations, www presentations and TV appearances.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams, Role and position in international collaboration, Breadth/completeness of the research activities compared to world leading teams of comparable size

The Department holds important position both in national and international scientific community. Researchers of the Department are members of many relevant scientific societies, committees, boards, commissions, international associations etc.

Ability to attract foreign researchers at different levels

There are some scientists and researchers from abroad employed at the Department. Modern Centre of Excellence in Telč is very interesting and attractive and exhibits the strongest international representation.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience, Attraction of research programmes for young people

Staff has high qualification and international experience. Age structure of the Department staff is presented in Fig. 1. From this uneven distribution, two facts are visible: low ratio of young researchers (only 20 % under 35 years) and noticeable gap between 45-60 years. Both attributes would result in some personal problems in the nearest future, because there are almost 20 % researchers over 70 years. Staff has in total 17.55 internal and international members in full time equivalent and only one of them is female.

Funding (structure of the resources and its comparison with the outputs, grants and project activity), Effectiveness of research (based on comparing size of groups, funding and output)

Grant projects and industrial contracts represent substantial part of the Department budget. In the comparison with number of staff members, total number of national and international projects solved in the evaluation period is outstanding:

- 14 projects of the Czech Scientific Foundation,
- 2 projects of the Grant Agency of Academy of Sciences CR,
- 1 project of the Technological Agency of CR,
- 2 projects of the Ministry of Education, Youth and Sport CR (COST),
- 2 projects of the Ministry of Industry and Trade CR, and
- 2 projects realized in the frame of European programs BRIFAG and NIKER.

From this overview, very high efficiency of the research activities of the Department staff is evident.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

Main research topics for the next years are following:

- Numerical investigation of the Fokker – Planck equation using FEM.
- Stochastic Resonance implementation in mechanics.
- Rational Dynamics background development.
- Research of specific fracture mechanical problems at very low constraints.
- Experimental investigation of inertial moving loads.
- Experimental investigation of systems with non-holonomic constraints.
- Long-term collection and processing of experimental data sets using Bayesian updating.
- Continuation in studies of current topics.

Adequacy of available means and human resources to achieve these plans

These activities are relevant for the Department which is able to solve mentioned problems and to achieve these plans. The research teams of the Department have adequate human resources and technical equipment for these purposes.

EVALUATION OF THE INSTITUTE OF THEORETICAL AND APPLIED MECHANICS

Department of Diagnostic Methods and Instrumentation

1. INTRODUCTION

1.1 Location of the institute and its dept., labs. & sub units.

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1.3 Mission and research topics

Current research topics are following:

- Analysis of deformation characteristics of the aluminium foams' periodic unit cells.
- Investigation of deformation behaviour of metal foam under dynamic loading.
- Study of effective material characteristics of metal foams.
- Description of deformation behaviour of intact and defected rat vertebrae based on time-lapse tomography under loading.
- Quasi-static compressive deformation characteristics of a closed-cell metal foam.
- Indirect identification of the material model for trabecular bone based on micromechanical testing.
- Measurement of inner deformation of the trabecular bone structure using digital volume correlation technique.
- Measurement of the process zone evolution within aluminium alloy sample.
- Experimental evaluation of contour J integral and energy dissipated in the fracture process zone.

- Advanced non-destructive testing (NDT) method developed combines neutron and X-ray imaging.
- Analysis of mechanical properties of trabecular bone at the tissue level.
- Digitization of small objects by means of Photometric stereo technique.
- Study of implants for spinal surgery.

1.4 Staff size and full time equivalents age distribution

The Department has currently 15,42 employees in full time equivalent, 4,68 from which are researchers, 6,37 other workers, and 4,37 Ph.D. students.

Age structure of all Institute employees is presented in Fig. 5.

Age category	< 25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	≥ 70
Number of members		3,8	3,25	1,9	0,2	2					

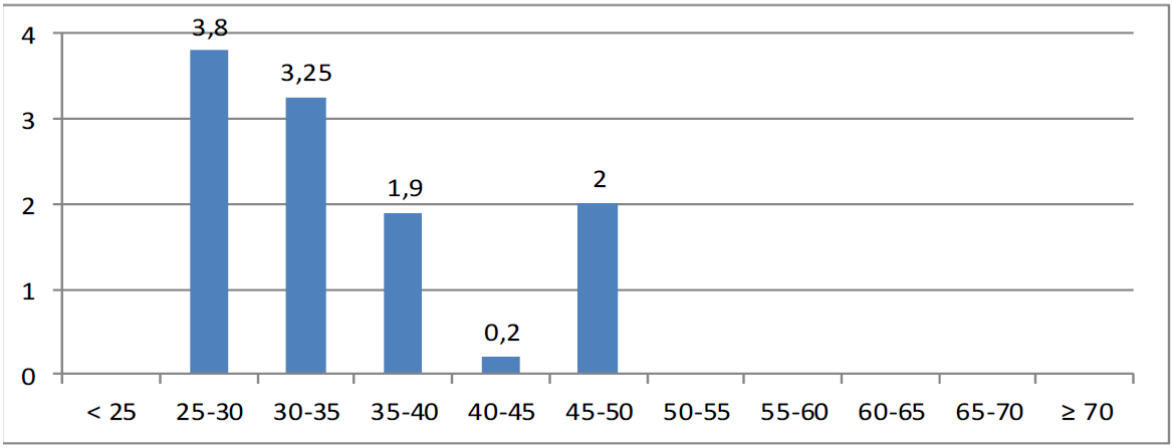

Figure 5: Age structure of Institute employees in full time equivalent during 2010-2014 period

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

Despite low number of the staff members, the research activities of the Department are very varied and extensive. The main outputs of the Department are beneficial for engineering and industrial sector.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

The Department staff is very successful in the application of grant projects and commercial contracts. This fact is very important and beneficial for the Department economy, because institutional part of its budget is minority.

2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Collaboration among teams and institutes is intensive. The Department have participated in joint research projects and cooperation with universities in Czech Republic and in many EU countries. The collaboration is dealing with both research and education.

2.4 Position of the institute within the Czech scientific community and its international position

Position of this small department in the national and international scientific community is significant and adequate to its possibilities.

2.5 Comments on the age structure

The Department staff is very young, about 63 % employees are under 35 years. The team can offer auspicious career for young peoples.

2.6 Frequency and quality of publications

Number of the Department outputs in 2010-2014 period is outstanding (174 in total), but most of them are articles in conference proceedings.

2.7 Patents and role in contractual work

Very important and beneficial output is the patent.

3. WEAKNESSES AND THREATS

3.1 Budget: Ratio of institutional budget, grants and contractual resources, international funds

Institutional part of the Department budget is rather low. An increase of the institutional money would be undoubtedly helpful for the stability of the Department and for solution of its current personal problems.

3.2 The overall capacity of staff

The Department staff is very small (11,25 persons in full time equivalent) and number of the researchers is almost critical (4,68 in full time equivalent), but extent of their outputs is considerable. Because of wide variety of research topics and demanding character of them, rather higher capacity of the staff would be desirable.

3.3 Frequency and quality of publications

In comparison with low number of staff members, number of the papers in journals with impact factor is appropriate (36 in total), but their quality is not quite convincing: 10 outputs were evaluated in the Phase I, none of them was classified as world-leading and only 3 were classified as internationally excellent.

4. RECOMMENDATIONS

4.1 Re-organisation of the internal structure of the institute and departments, laboratories, teams and groups considering the critical mass of each unit, the overlap of units

Thanks to the excellent technical equipment of the Department, its research possibilities and scientific capacity are very high and perspective. For the better utilization of this potential, rather higher number of the staff members, especially number of researchers, would be welcomed.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

Despite low number of the staff members, the research activities of the Department, presented in the paragraph 1.3, are very varied and extensive. The Department topics include both exacting theoretical approaches and sophisticated experiments. The outputs are beneficial for engineering and industrial sector.

Relevance in the national and international context

Research activities of the Department have import relevance both in the national and international context. The Department have participated in many joint research projects and cooperation with universities in Czech Republic, Germany, Slovenia, Austria, Poland and Greece. The collaboration is dealing with both research and education.

Overall quality of publications

In 2010-2014 period, togehter174 outputs were presented, 36 of which were papers in journals with IF. 10 outputs were evaluated in the Phase I, none of them was classified as world-leading and 3 were classified as internationally excellent. Very important and beneficial output is the patent.

Specification of the main achievements

Main achievements were getting at the areas of diagnostics methods and instrumentations (e.g., modular dual tube system for X-ray micro-radiography and micro-tomography, table loading devices for compression or bending test, portable device for indirect assessment of tensile strength of historical building materials, photometric stereo device etc.) and experimental research of materials (e.g., development of the FEM model utilizing dual-energy CT procedure, precise strain measurement in complex materials using digital volumetric correlation, investigation of mechanical behaviour of a single human trabecula, material porosity analysis, etc.).

Specification of the contributions of the team to publications

Although some outputs have co-authors from other research institutions, the contribution of the Department members to the publications was decisive and predominant.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

The Department cooperates with many universities in the Czech Republic. Numbers of BSc., MSc. and PhD theses under supervision of the Department members in the evaluation period is summarized in Tab. 3. From comparison of this table with the corresponding table for the whole Institute, it is evident, that this more likely small Department of Diagnostic Methods and Instrumentation has decisive ratio on the pedagogical activities of the whole Institute of Theoretical and Applied Mechanics. Involvement of doctoral and undergraduate students in research is very extensive and significant. Students are able to do very useful scientific work and help their advisors in the framework of various research projects. The collaboration of the Department with universities is very beneficial for the both contracting parties.

Table 3: Supervising students in 2010-2014 period

Type of study	No. of supervisors (theses, dissertations)	No. of consultants and co-supervisors	Theses defended in 2010-2014

Bachelor	10	3	5
Master	9	2	8
Doctoral	5	5	4

Particular contributions of students to research

Contribution of doctoral and undergraduate students to the research activities of the Department is very extensive and significant. Students are able to do very useful scientific work and help their advisors in the framework of various research projects. The collaboration of the Department with universities is very beneficial for the both contracting parties.

Number of defended PhD students in relation to students involved (success rate)

In 2010-2014, 5 Ph.D. students had their supervisors from the Department; in the same period 4 Ph.D. theses were successfully defended. This success rate (80 %) is very good.

Employment of former Ph.D. students (career options)

Employment of former Ph.D. students would be very welcomed, but the financial possibilities of the Department are restricted and they are mostly linked to the success in project application.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

Decisive ratio of the Department budget is created by money from grant projects and commercial sector, thus success in grant application and acquisition of industrial contracts is entirely substantial for the Institute economy.

Impacts of the results and other activities on education

Cooperation of the Department with Czech universities is very intensive both in research and education. Interesting scientific work, many top unique experimental instruments close relation to the practical application is very interesting and inviting for undergraduate and doctoral students. Joint work on the research activities of the Department represents very beneficial part of their education. Aside from supervision of students' theses, researchers have also some lectures at the universities.

Popularisation and similar activities

Researchers of the Department took part in some popularisation activities in TV and had some lectures for public.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams, Role and position in international collaboration, Breadth/completeness of the research activities compared to world leading teams of comparable size

The Department holds important position especially in national scientific community, but thanks to the cooperation with some universities and research institutes in the frame of joined research projects, position of the Department has also relevant position abroad. Modern Centre of Excellence in Telč is very good equipped; it exhibits the strongest international representation and offers very perspective possibilities of employment with promising potential.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience, Attraction of research programmes for young people

The Department staff is very small (11,25 persons in full time equivalent) and number of the researchers is almost critical (4,68 in full time equivalent), but age structure presented in Fig. 1 indicates very good outlook to the future – 63 % staff members are under 35 years. The team can offer auspicious career for young peoples.

There is no female between the Department researchers, only one woman is between other workers.

Funding (structure of the resources and its comparison with the outputs, grants and project activity, Effectiveness of research (based on comparing size of groups, funding and output)

Grant projects and industrial contracts represent substantial part of the Department budget. In the comparison with relatively low number of staff members, total number of the research outputs is outstanding. In comparison with low number of staff members, number of the papers in journals with impact factor is appropriate, but their quality is not quite convincing (this statement is based on the results of Evaluation Stage I).

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

Main new research activities for the future are following:

- One micrometer scale XCT – 3D X-ray microscopy for relatively large specimens;
- High resolution in-line XCT during loading – advanced FEM modeling of various materials
- High resolution 3D imaging of the surface layers utilizing back scattered X-ray photons – paintings, ceramics coatings etc.;
- Combined XCT and XRF imaging – wooden artifacts with polychome for instance;
- Advanced material decomposition utilizing DECT – reliable characterization of composites for inst.;
- Experimental measurement of cohesive law / DIC – nowadays fracture mechanics approaches don't have reliable experimental support;

There are some plans on cooperation in the frame of international research projects with the partners abroad (CT Research Group at the University of Applied Sciences Upper Austria, Institute of Polymer Product Engineering at the Johannes Kepler University Linz, Institute of Structural Mechanics at the Bauhaus University Weimar).
This strategy and presented research plans are relevant.

Adequacy of available means and human resources to achieve these plans

The Department has adequate means and human resources to achieve the out lined plans for next years.

EVALUATION OF THE INSTITUTE OF THEORETICAL AND APPLIED MECHANICS

Department of Building Materials, Historical Structures and Conservation Science

1. INTRODUCTION

1.1 Location of the institute and its dept., labs. & sub units.

Institute of Theoretical and Applied Mechanics of the CAS
Prosecká 809/76, Prague 9
Batelovská85-486, Telč

1.2 Brief history of the institute

In 1921, "The Research and Testing Institute for Building Materials and Structures" of Czech Technical University in Prague was founded. In 1953 this Institute was divided into two parts: "Klokner Institute" of Czech Technical University in Prague and "Institute of Theoretical and Applied Mechanics" of the CSAS. Since 2007, the Institute has become a public research institution.

1.3 Mission and research topics

Activities of the Department are focused on the following main research topics:

- conservation science (interdisciplinary problems of cultural heritage safeguarding – historic structures, historic cities, global impacts),
- materials research (mainly binders, mortars, stone and wood),
- diagnostics & testing methods, devices and facilities,
- safety & security of citizens (preventive protection & resilience in relation to natural or anthropogenic threats and disasters).

1.4 Staff size and full time equivalents age distribution

Total number of department staff members is 51,52 in full/time equivalent, 15,19 of which are researchers, 28,75 other workers and 7,58 Ph.D. students. Age structure of all employees at the Department is presented in Fig. 6**.**

Age category	< 25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	≥ 70
Number of members	1	14,3	7,67	5,35	4,7	3	2,65	1,5	2,7	1,5	1,8

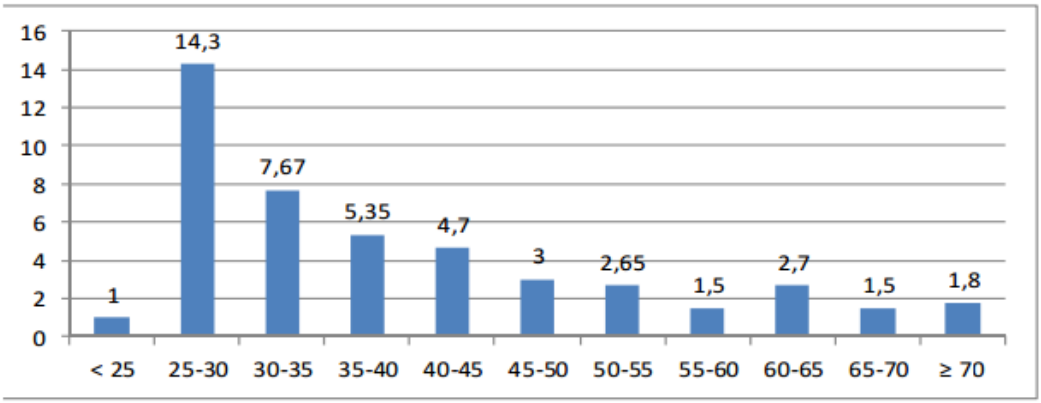

Figure 6: Age structure of all employees at the Building Materials, Historical Structure and Conservation Sciences

2. STRENGTHS AND OPPORTUNITIES

2.1 Timeliness of research topics

The research topics of the Department of Building Materials, Historical Structures and Conservation Science are very extensive. The main outputs of the team are beneficial not only for engineering, but also for culture and even for ecology.

2.2 Budget: Ratio of institutional budget, grants and contractual resources, international funds

Success in national and international research grant application and in acquisition of industrial contracts is entirely substantial and helpful for the Department economy, because of relatively low ratio of institutional part of the budget.

2.3 Intensity of collaboration among teams and among institutes, national collaboration and international involvement

Collaboration among teams and institutes is intensive. The Department have participated in joint research projects and cooperation with universities in Czech Republic and in many EU countries. The collaboration is dealing with both research and education.

2.4 Position of the institute within the Czech scientific community and its international position

Position of this Department in both national and international scientific community is significant. It has beneficial professional contacts with many research teams in the Czech Republic and abroad. Apart from join participations on some national and international research projects, the Department researchers are members of many significant international scientific or technical commissions, councils, and working groups. Cooperation in the area of research and education is important and seminal.

2.5 The overall capacity of staff

The overall capacity of the Department staff corresponds to the both quantity and quality of the research outputs.

2.6 Comments on the age structure

Age structure of the Department staff indicates promising potential for the next years: over 44 % employees are less than 35 years. For these young researchers is very beneficial the possibility to work at this Department and to be in close contact with respected and experienced scientists with international reputation.

2.7 Frequency and quality of publications

Total number of the outputs presented in the evaluation period) is outstanding together 277, including 41 papers in journals with IF, 4 professional books, 24 chapters in professional books, 2 patents, etc.

2.8 Patents and role in contractual work

Two patents in the evaluation period exhibit quality, usefulness and asset of the Department research activities in the application area.

3. WEAKNESSES AND THREATS

3.1 Frequency and quality of publications

Quality of outputs, based on the results of the Evaluation Phase I, is not entirely convincing, because from 23 selected papers, only 1 was classified as world-leading and 7 as internationally excellent. Also quality of outputs characterised by the number of citations is not obvious, but this fact is given by the special character of the Department research topics oriented often into the less exact areas like culture, protection of historical buildings and other artefacts, security of citizens, ecology, etc.

4. RECOMMENDATIONS

In the next years, main attention would be given to increasing of the personal capacity and to looking for adequate new financial sources.

5. DETAILED EVALUATION

5.1 Declaration on the quality of the results and share in their acquisition

Characterisation of the main research activities (experiments, theoretical areas)

Research activities of the Department are possible to split to the 8 following groups:
1 - Consolidation, strengthening and nano-materials:

- Evaluation of the consolidation effect of lime water and other consolidants on lime based porous substrates.
- Design of a new nanotechnology for strengthening of degraded mortars and stones.

2 - Earth pressures of incoherent rocks:

- Development of an experimental equipment and methodology for research of a lateral pressure of granular multiphase materials.
- Calibration Eurocode 7-1 (Geotechnical design).

3 - Degradation of wood:

- Determination of the degradation of wooden structural elements.
- Determination of the influence of chemical degradation caused by the reaction of certain chemical compounds contained in fire protection coatings on mechanical properties of wood.
- Changes in physical properties of wood (swelling and water absorption) caused by the action of pure cultures of wood-decaying fungi in laboratory conditions.
- Wood-damaging fungi in truss structures of Baroque churches.

4 - Diagnostics of historic materials and structures:

- Long-term monitoring of structural behaviour of important historical monuments.
- Non-standard testing of mechanical characteristics of historic mortars.
- Characterisation of historic materials.
- Development of devices for testing mechanical properties of wood (2 patents).
- Confirmation of correlation between the conventional strength derived from the newly designed devices and the mechanical properties of wood determined by experiments according to standards and numerical simulations.

- Innovation of the existing methods used for assessing performance of construction materials.
- Description of traditional lime technologies (hot mix) in order to support the use of

5 - Research and development of new materials:
- Compatible dilation limits of masonry joint mortars.
- Assessment of the effect of a small amount of linseed oil, a hydrophobic additive (added in 1.5 wt. % in respect to the weight of binder) on lime and lime with metakaolin mortar.
- Setting performance requirements for design of a repair mortar for historic masonry.
- Preparation of magnesium phosphate cement by recycling the product of thermal transformation of asbestos containing wastes.
- Comprehensive study on mechanical properties of lime-based pastes with additions of metakaolin and brick dust.

6 - Research and valorisation of traditional materials:
- Determination of optimal calcination temperatures for production of natural hydraulic binder known as Staroměstské lime.
- Design and development of a traditional lime kiln for a small scale production of lime.
- Development of a method for examination of historic technological traces and it application to determine criteria for selection of replacements stone for repair of historic ashlar masonry.

7 - Strategies for protection and conservation of cultural heritage:
- Selection a design of tools and methods for the European Cultural Heritage Identity Card.
- Comprehensive flood protection of monuments.
- Analysis of changes of properties and potential risks in the internal environment of buildings affected by flooding

8 - Interdisciplinary research:
- The structure and material composition of ossified aortic valves identified using a set of scientific methods

Relevance in the national and international context

From relevant outputs, national and international research projects, cooperation with many universities and research institutions in the Czech Republic and abroad, memberships in many scientific or technical commissions, comities, councils, working groups, editorial boards, extensive review and evaluation activities etc. is evident import relevance of the Department both in the national and international context.

Overall quality of publications

In 2010-2014 period, togehter277 outputs were presented: 41 papers in journals with IF, 30 papers in other journals, 4 professional books,24 chapters in professional books, 123 contributions in conference proceeding, 2 patents and 53 applied results. For phase I of this evaluation, 23 papers were selected, 8 of which were classified as world-leading or internationally excellent.

Specification of the main achievements

In the evaluation period, many interesting achievements were obtained. Some examples of them are following:

- Determination of optimal calcination temperatures for NHL production.
- Research on alternative and specific lime based binders and mortars: lime-metakaolin or lime-brick dust binder: microstructure, texture, nano-mechanical properties.
- Characterization of the water-repellent properties of the mortars and the effect on durability.
- Consolidation and strengthening of mortars (European cooperation: FP7 Stonecore, Nanolith).
- Nanolime based consolidation materials (European cooperation: FP7 Stonecore, Nanolith, EuroNanoForum 2013 - Award Finalist, Best Reaserach Project).
- New devices for in-situ testing of properties of wood – a mini-jack (Patent).
- New devices for in-situ testing of properties of wood – long pin pushing (Patent), etc.

Specification of the contributions of the team to publications

The contribution of the Institute members to the papers and other research outputs was quite decisive.

5.2 Declaration on the involvement of students in research

Involvement of students (doctoral, undergraduate) into research

The Institute cooperates with some universities in the Czech Republic (Charles University in Prague, Czech Technical University in Prague, Mendel University in Brno, Masaryk University in Brno, University Pardubice - Faculty for Restoration in Litomyšl, and Technical University in Ostrava). Numbers of BSc., MSc. and Ph.D. theses under supervision of the Team members in the evaluation period is summarized in Tab. 4.

Table 4: Supervising students in 2010-2014 period

Type of study	No. of supervisors (theses, dissertations)	No. of consultants and co-supervisors	Theses defended in 2010-2014
Bachelor	0	1	0

Master	5	2	10
Doctoral	0	9	3

Particular contributions of students to research

Cooperation with universities includes mainly research; therefore, the pedagogical activities are tightly connected with involvement of students in research work usually in combination with their diploma or Ph.D. theses.

Number of defended PhD students in relation to students involved (success rate)

There are 3 PhD students defended in the 2010-2014 period. In this period, no Ph.D. student had the Department staff member as main supervisor, but 9 Ph.D. students had consultants or co-supervisors of their thesis from the Department.

5.3 Declaration on societal relevance

Impacts of the results and other activities on economy

Because of relatively low ratio of institutional money in the budget, success in grant application and acquisition of industrial contracts is entirely substantial for the Department economy.

Impacts of the results and other activities on education

Cooperation of the Department especially with Czech universities is very intensive not only in in research, but also in education. Interesting scientific work at the Department and orientation on the historical and cultural subjects would be very inspiring for undergraduate and doctoral students. Joint work on the research activities of the Department represents very beneficial and interesting part of their education. Experienced members of the Department staff have many various lectures at the universities.

Impacts of the results and other activities on culture

The research topics of the Department are often very closely related to the culture because of their orientation on maintenance, preventive conservation and rehabilitation of cultural heritage assets and important historic sites, evaluation and monitoring of irreversible changes of unmovable cultural heritage due to repetitive human interventions and environmental effects, etc. It is clear, that impact of the Department research results and other activities on the culture is very beneficial.

Popularisation and similar activities

Researchers of the Department took part in many popularisation activities in TV, radio, journals etc.

5.4 Declaration on the position in the international and national context

Comparison of the position, recognition, outputs and impacts with leading and international teams, Breadth/completeness of the research activities compared to world leading teams of comparable size, Position of the team in the national context

The Department undoubtedly holds important position both in national and international scientific community. This is not fully supported by quality of outputs by number of citations, but this fact is given by the special character of topics under study. The Department is in beneficial professional contacts with many research teams in the Czech Republic and abroad.

Role and position in international collaboration, Ability to attract foreign researchers at different levels

The Department role and position in international collaboration is extensive and useful. Apart from join participations on some research projects, members of the Department staff are members of many significant international scientific or technical commissions, councils, and working groups. Also some international cooperation in the education area is important and seminal. Attractiveness of the Department research work for foreign researchers is proved by the fact that some of them are members of the staff.

5.5 Declaration on the vitality and sustainability

Composition of staff with respect to age and gender, qualification, international experience, Attraction of research programmes for young people, Organisational structure, recruitment methods, career system, incentives for females, young researchers, international researchers

From the point of view of age structure and qualification of the team, the Department has very promising potential for the next years. Over 44 % employees of the Department are under 35 years. For these young researchers is very beneficial the possibility to be in close professional contact with very experienced scientists with international reputation.

The research topics are very attractive bot for males and females. This fact is reflected in balanced gender composition of the Department staff.

Funding (structure of the resources and its comparison with the outputs, grants and project activity, Effectiveness of research (based on comparing size of groups, funding and output)

Grant projects and industrial contracts represent substantial part of the Department budget. The Department research activities are effective, number of research outputs is in accordance with the Department staff size and with it's funding.

5.6 Declaration on the strategy and plans for the future

Relevance of the out lined strategy and research plans

In the next years, the Department plans to continue in the research topics in which the staff has long-time experience and wide professional contacts, i.e., generally conservation science, materials research, diagnostics & testing methods, and safety & security of citizens. Examples of some individual particular topics on which the planned projects will be focused in, are:

Lime for conservation.
Diagnostics of historic bricks.
Historic timber structures: typology, diagnostics and traditional wood working.
Effect of gaseous compounds onto metallic collection objects.
Repair of damaged surfaces of porous stone sculptures and architectural objects.
Conservation of osteological material.
Preservation of the values of modern architecture of the 1960s and 1970s.
Telč and Jesuits – Order and its Patrons.
Origins and attributes of heritage values of historic towns of the Czech Republic.
Analysis of comprehensive data on characteristics of cultural heritage objects for restoration.

Adequacy of available means and human resources to achieve these plans

All mentioned topics are relevant and adequate to the Department both personal and experimental possibilities.

Date: February 28, 2016

Commission Chair: em Prof.DI.Dr.Dr.hc. Hans Peter Nachtnebel