

COST Action TU1301

NORM for Building materials (NORM4BUILDING)

Proposal for a Short Term Scientific Mission

‘Investigation of the possibilities for application of NORM into polymer materials’

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Host Institution	Slovenian National Building and Civil Engineering Institute, Dimiceva 12, 1000 Ljubljana, Slovenia
STSM proposed start date	19/03/2016
End date	29/03/2016
STSM proposed duration	11 days

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1. Description of work

Aims and objectives

The main aim of the proposed STSM project is to perform:

- Comparison of fly ash characteristics (chemical composition, granulometry and density) from different origins: Slovenia and Macedonia.
- Characterization of the polymer materials: thermoset and thermoplastic.
- Estimate the possibilities for preparing of the composites based on fly ash as NORM material from different origins and polymers.

The analyses of the inorganic fillers and organic polymer matrices will be made in order:

- to find the most effective filler strengthening configuration,
- to quantify the thermomechanical characteristics of the thermoset and thermoplastic polymers,
- to better understand the interaction between fillers and matrix,
- to estimate the contribution of the fillers, matrix and designed composite systems for the thermomechanical properties,

The desired objectives of the STSM project will be achieved and guaranteed by the strong cooperation between Slovenian National Building and Civil Engineering Institute (ZAG) and Goce Delcev University in Stip, using the complementary competences of both research groups.

Background

There is growing trend towards the development of composites with low environmental impact and good commercial viability. Over the last few years different kinds of waste materials have been successfully utilized as filler in polymer composites with various applications. This not only reduces the production costs but also offers an opportunity for utilization of waste materials thereby reducing environmental pollution. Due to the environmental concerns and disposal difficulties, the utilization of fly ash (FA) as NORM material has become of great importance. Fly ash is promising for fabricating composites which can be widely used in various important fields especially for buildings. The granulometry of fly ash filler and filler blends are reported to be attractive as filler material in polymer composites. Such fly ash filled polymer composites possess attractive mechanical, thermal, electrical properties, better dimensional stability and are cost effective.

Fly ash, an industrial waste, can be used as a potential filler material in polymer matrix composites because it is a mixture of oxide ceramics. It improves the physical and mechanical properties of the composites. Reduction in filler size gives better enhancement in properties due to uniform distribution of particles in polymer matrix and increases degree of cross linking of matrix. A mechanical property such as tensile strength, impact strength and hardness of polymer matrix composites is enhanced with the addition of smaller size filler materials. In all particulate filled systems, the adhesion between the matrix and the filler plays a significant role in determining key properties such as strength and toughness. The size of the interface is generally dependent on the specific surface area of the filler. Modification of surface properties of the fillers can yield significant changes in strength. Fly ash mainly consists of alumina and silica, which are expected to improve the composite properties. Fly ash also consists to some extent, hollow spherical particles (termed cenospheres) which aid in maintenance lower density values for the composite, a feature of considerable significance in weight specific applications. Ceramic filled polymer composites have been the subject of

extensive research in the last two decades. The inclusion of inorganic fillers into polymers for commercial applications is primarily aimed at the cost reduction and stiffness improvement. Composites involving low cost fillers of fly ash, considered to be an industrial waste product and pollutant, are among the newer entrants to the family of particulate filled polymer composites. The use of fly ash as a reinforcement in polymer matrices gets strong support from a discipline such as building and civil engineering.

Summary of the work to be carried out by the applicant at the host institution

The main work that will be carried out by the applicant refers to the thermomechanical characterization of the thermosetting resin and of the thermoplastic polymers by DSC, TGA, DMA and DMTA methods and comparison of some characteristics (granulometry, chemical composition etc.) of the fly ash from Slovenia and Macedonia. Regarding the main characteristics of the constituents, the composites based on fly ash as received and fly ash mechanically activated and different polymers will be performed. It is the most important task of that project. The proposed project will allow the applicant to transfer the knowledge about designing of the polymer composites based on fly ash in accordance with the final application in construction. The whole analyses are very complex and difficult to define. It takes a lot of time and requires a lot of attempts in order to determine the composites in details. The all analyses of the fly ashes and of the polymer materials as well as preparing of the composites are planned to be carried out at the host institution (ZAG) and it will take 11 days.

A detailed plan of the STSM project and a diagrammatic work-plan are presented and further described in this proposal.

Foreseen results

The main aspect of the investigation which will be realized in this STSM is to define the possibility of the fly ash (as received and mechanically activated) to be used as a filler in different polymer matrices (thermosetting and thermoplastic).

The main foreseen result of this short term scientific mission is to improve the knowledge in the effective preparing of the polymer composites based on fly ash for their potential application in construction. The studies of the main constituents of the composites and the techniques for the preparing of the composites will be carried out within this investigation and will allow to estimate the possibilities of preparing the composites and to propose a reliable guideline.

The all analyses proposed in STSM will identify and describe the influence of the fly ash to be used as a filler, the influence of the fly ash as received and mechanical activated on the interfaces with polymers as well as interaction of the filler - matrix in the composites.

Dissemination of the results

Mechanical and thermal characterization of the polymers matrices and comparison of the characteristics of fly ashes from Macedonia and Slovenia as well as verification of the composite models to actual test results will be presented at several domestic and international conferences. After the continuous extend investigation in home and host institution the final results could be published in well-known international journals (e.g. Journal of Composite for Construction, Construction and Building Materials). The results of the proposed research will be disseminated among the Cost Action TU 1301 "NORM for

Building materials (NORM4BUILDING)” members as a STSM’s Report and among the worldwide fiber/filler reinforced plastic (FRP) community joined at the International Institute for FRP in Construction (IIFC).

The project results will be directly exploitable by researchers, fiber/filler reinforced polymer composite manufacturers, practicing engineers and architects. The long term benefits resulting from the development of recognized results of the proposed research will also address the needs of infrastructure and building owners and end users.

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2. Detailed Plan of Activities

Research program of the proposed STSM contains three main tasks. The first one refers to the thermomechanical characterization of the polymers and the comparison of the fly ashes; the second one to the possibilities of preparation and characterization of the composites and the last one contains preparation of STSM report. Each task is assigned by the partner institutions, which will be undertaken in joined cooperation of Slovenian National Building and Civil Engineering Institute (ZAG) and University Goce Delcevi in Shtip (UGD).

A diagrammatic work-plan for the full duration of STSM is shown in Table 1.

The STSM program covering 11 days approved by Dr. Vilma Ducman (ZAG) is planned to be carried out at ZAG from 19.03.2016 to 29.03.2016.

The report will be performed at home institution (UGD).

The research program contains:

- Task 1.** *Characterization of the polymers and comparison of the fly ash characteristics – performed at ZAG*
- Task 2.** *Estimate the possibilities for preparing of the composites – performed at ZAG.*
- Task 3.** *Preparation of Short Term Scientific Mission Report - performed at UGD.*

Table 1. A diagrammatic work-plan for the full duration of the STSM

Task	March, 2016												
	19	20	21	22	23	24	25	26	27	28	29	30	31
T.1 <i>Characterization of the polymers and comparison of fly ashes characteristics</i>													
T.2 <i>Preparing of the composites</i>													
T.3 <i>Preparation of Short Term Scientific Mission Report</i>													

LEGEND

- task performed at Slovenian National Building and Civil Engineering Institute (ZAG)
- task performed at University Goce Delcevi (UGD)

3. Benefits to COST Action TU1301

- The STSM research will contribute to the development and design of the new materials for construction based on the fly ash reinforced plastic. The predictive performance of this design guideline will be appraised by using the mechanical and thermal testing of the samples. It will improve the flow of data not only between the home and the host institution, but also between the research communities all over the world. Development and characterization of the PCMs based on fly ash have attracted world-wide research interest in the field of composites for construction.
- The success of the proposed STSM is based on the common work of collaborative institutions.
- The STSM will support cooperation and integration between home and host scientific institutions: University Goce Delcev in Stip (UGD) and Slovenian National Building and Civil Engineering Institute (ZAG).
- The STSM will also provide networking opportunity for early career investigators from two European countries, members of COST.

The results of the project will bring many crucial advantages. They will enable clarification of the design rules for choosing of the PCMs based on fly ash in accordance of their application in construction.

4. Benefits to the Applicant

- The project will bring benefits to the significant development of Applicant's skills in the field of PCMs based on fly ash for constructions.
- STSM project will provide networking opportunity for early stage researcher of University Goce Delcev in Stip (UGD) and will make an excellent beginning for international cooperation with Slovenian National Building and Civil Engineering Institute (ZAG).
- The international collaboration will allow Applicant to get new scientific contacts, to exchange experience and to expand databases of experimental data
- It will allow preparation of joint publications and will obtain scientific degrees by program participant.
- It will enable internships, study tours and direct cooperation, which will help in investigations of applying of the composite materials in construction. This will be the basis for further implementation activities.
- The participation in the Short Term Scientific Mission project will be an important scientific support of the Applicant's work and it will become a turning point in her international scientific career.