NOTE: THIS IS AN AUTOMATIC TRANSLATION BY GOOGLE TRANSLATOR. THE ORIGINAL PORTUGUESE VERSION IN http://www.eracareers.pt/opportunities/index.aspx?task=global&jobId=124352&lang=pt IS THE ONLY BINDING TEXT

Call Opening Notice for

Awarding of PhD Research Grants

1. APPLICATION PRESENTATION

The competition is open from 08 of June of 2020 and 23 h 59 (Lisbon time) of 15 of August 2020.

Applications and supporting documents for the application provided for in this Call for Proposals must be submitted by email sent to gestao.isise@civil.uminho.pt .

Each candidate may submit only one application, under penalty of cancellation of all applications submitted.

The provision of false statements or the performance of plagiarism by the candidates is grounds for canceling the application without prejudice to the adoption of other measures of a sanctioning nature.

2. TYPE AND DURATION OF SCHOLARSHIPS

Research grants for doctorates are intended to finance the performance, by the fellow, of research activities leading to obtaining the academic degree of doctor in Portuguese universities.

The s activities research leading to obtain the academic degree of Doctor take place in the Institute for Sustainability and Innovation in Engineering Structures (ISISE), which will be the host institution of applicants, without prejudice to the work can be carried out in collaboration between more than an institution.

The activities of research leading to obtain the academic degree of the selected fellows doctor should be framed in plan of the activities and strategy Institute for Sustainability and Innovation in Engineering Structures (ISISE), and should be developed under the Program PhD in Civil Engineering, School of Engineering, University of Minho.

The work plan may take place entirely or partially in a national institution (scholarship in the country or mixed scholarship, respectively).

The duration of the scholarships is, as a rule, annual, renewable up to a maximum of four years (48 months), and a scholarship cannot be awarded for a period of less than 3 consecutive months.

In the case of a mixed scholarship, the period of the work plan that takes place in a foreign institution cannot exceed 24 months.

3. GRANT RECIPIENTS

The Doctoral Research Grants are intended for registered candidates or for candidates who satisfy the necessary conditions to enroll in the Doctor 1 Program contained in point 2 of this Notice and who intend to develop research activities leading to the achievement of the doctoral degree n the Institute for Sustainability and Innovation in Engineering Structures (ISISE) , or in host institutions associated with it.

4. ADMISSIBILITY

4.1 Candidate's Admissibility Requirements

You can apply to this contest:

- National citizens or citizens of other member states of the European Union;
- Third-country citizens;
- Stateless persons;
- Citizens enjoying political refugee status.

To apply for the PhD Research Grant, it is necessary to:

- Be a master in the field of Civil Engineering or in areas considered similar, with a final classification equal to or higher than 14 values ;
- Reside in Portugal permanently and habitually, if the work plan associated with the scholarship is partially carried out by foreign institutions (mixed scholarships), a requirement applicable to both nationals and foreigners.
- Not having benefited from a PhD or PhD scholarship in companies directly financed by FCT, regardless of its duration.

4 .2 Admissibility Requirements for the Application

It is essential, under penalty of not being admitted to the Competition, to attach the following documents to the application:

- Elements of the identity card / citizen card / passport;
- Candidate's *Curriculum Vitae*, in Portuguese or English ;

- Certificates of qualification of the academic degrees held, specifying the final classification and, if possible, the classifications obtained in all subjects taken, or, alternatively, the candidate's declaration of honor on how he concluded his master's degree by the end of the term. application;
- Registration recognition d the academic degree master assigned end by foreign higher education institutions and converting the record of their classification for the Portuguese classification scale, or alternatively, the candidate's honor declaration that obtained the recognition of the degree abroad equivalent to the master's degree until the end of the application period;
- Motivation letter, in Portuguese or English, with selection by the candidate of a work plan, in accordance with point 5 of this notice.

Regarding the aforementioned admissibility requirements, the following should be noted:

- In the case of grade master attributed per a foreign higher education institution, and to ensure that the principle of equal treatment to candidates who hold foreign degrees and national, it is compulsory to have recognition of this degree and the conversion of respective final classification for the Portuguese classification scale.

  The recognition of foreign academic degrees and diplomas as well as the conversion of the final classification to the Portuguese classification scale can be required in any public higher education institution, or in the Directorate-General for Higher Education (DGES, only in the case of automatic recognition). In this regard, it is suggested to consult the DGES portal through the following address: http://www.dges.gov.pt .
- Only candidates who have completed the cycle of studies leading to a master's degree will be admitted by the end of the application period. If they do not yet have the certificate of completion of the course, a declaration of honor from the candidates will be accepted as they have completed the necessary qualifications for the purposes of the competition by the end of the application period. The conce ss will the stock market is always subject to the submission of proof of ownership of the academic qualifications necessary for granting the scholarship.

5. WORK PLANS AND SCIENTIFIC ORIENTATION OF THE SCHOLARSHIPS

The work plans proposed in this notice, as well as the scientific orientation of the scholarships are indicated in the Annex. The candidate must indicate his / her preference in the motivation letter, indicating the plan to which he / she is applying (from 1 to 4).

6 . RATING CRITERIA

The assessment takes into account the marks obtained in the master's degree diploma [Criterion A], the experience professional, including experience professional relevant and publication s [Criterion B] and professional

selection interview conducted in English, including in particular the expression of capacity and critical sense, motivation and sense of responsibility and command of the English language [Criterion C] .

Applications considered admissible will be scored on a scale of 1 (one) to 3 (three) in each of the following evaluation criteria:

- Criterion A, weighing 4 0 %;
- Criterion B, with a weight of 30 %;
- Criterion C, with a weight of 30 %.

For the purpose of deciding on the granting of scholarships, applicants will be ranked according to the weighted average of the classification obtained in each of the two criteria, translated by the following formula, rounded to one decimal:

$$\text{Final Classification} = (40\% \times A) + (30\% \times B) + (30\% \times C)$$

For the tie, the ranking of the candidates will be made based on the ratings assigned to each of the evaluation criteria in the following order of precedence: criteria C and B criteria.

If the competition has more than 10 (ten) candidates admitted, only the first ten candidates classified based on criteria A and B and their respective weights will be considered for the interview. The remaining candidates will be assigned the classification minimum (1 point) to the criterion C.

Important notice for candidates with diplomas issued by foreign higher education institutions:

- Candidates with diplomas issued by foreign higher education institutions can apply and will be evaluated using the same criteria as candidates with diplomas issued by Portuguese institutions, provided that they present, in their application, proof of recognition of academic degrees and conversion of classification final for the Portuguese classification scale under the terms of the applicable legislation.
- Candidates with degrees nationality no proof of the final grade conversion to the Portuguese classification scale will be evaluated with a minimum grade (1 point) the criterion A .
- In any case, scholarship contracts with candidates with diplomas issued by foreign institutions will only be concluded upon presentation of proof of recognition of academic degrees and conversion of the final classification, as indicated above.

They are not eligible for grant of scholarship applicants whose application is evaluated with a final grade of less than 1 .5 points.

7 . EVALUATION

The candidates' evaluation panel is made up of the following elements, which may meet with a minimum of three elements:

- Paulo José Brandão Barbosa Lourenço, ISISE , University of Minho (panel coordinator)
- Daniel Vitorino de Castro Oliveira, ISISE, University of Minho
- Joaquim António Oliveira de Barros, ISISE, University of Minho
- José Manuel de Sena Cruz, ISISE, University of Minho

The evaluation panel will assess applications in accordance with the evaluation criteria contained in this Call for Proposals, considering the elements of evaluation.

All panel members, including the coordinator, make a commitment to respect a set of responsibilities essential to the evaluation process, such as the duties of impartiality, the declaration of any potential conflict of interest situations and confidentiality. At all times during the evaluation process, confidentiality is fully protected and ensured in order to guarantee the independence of all opinions produced.

Panel members, including the coordinator, cannot be advisors or co-supervisors of candidates with applications submitted to the competition.

For each application will be produced by the panel, one plug final evaluation where a clear, coherent and consistent arguments are presented that led to the ratings assigned to each of the criteria evaluation.

Minutes of the responsibility of all its members will be produced from the meetings of the evaluation panel.

The minutes and their attachments should include, necessarily, the following information :

- Name and affiliation of all members of the evaluation panel;
- Identification of all excluded applications and respective reasons;
- Final Evaluation Sheets for each candidate;
- Provisional list of classification and ranking of candidates, in descending order of the final classification, of all applications evaluated by the panel;
- COI statements from all panel members;
- Possible excuse for absence.

8 . DISCLOSURE OF RESULTS

The results of the evaluation are communicated via e-mail to the e-mail address used by the applicant to send the application.

9 . TERM S AND PROCEDURES FOR HEARING PRIOR CLAIMS AND APPEALS

After communicating the provisional list of the results of the evaluation, the candidates have a period of 10 working days to , if they wish, to give their opinion at the prior hearing of interested parties , under the terms of articles 121 and following d of the Code of Administrative Procedure .

The final decision will be rendered after the analysis of the pronunciations presented at the previous hearing of interested parties. The final decision may be filed within 15 working days, or , alternatively, an appeal may be filed within 30 working days, both counted from the respective notification. Candidates who choose to submit a complaint must address their pronunciation to the member of the FCT Board of Directors with delegated competence. Candidates who choose to submit an appeal must address it to the FCT Board of Directors.

10. GRANT GRANT REQUIREMENTS

Research scholarship contracts are signed directly with FCT.

The following documents must be sent, when granting the scholarship, for the purposes of contracting:

a) Copy of the civil, tax and, where applicable, social security identification document (s)[1];

b) Copy of the certificates of qualifications of the academic degrees held;

c) Presentation of the registration record for the recognition of foreign academic degrees and conversion of the respective final classifications to the Portuguese classification scale, if applicable;

d) Document proving registration and enrollment in the Doctoral Program identified in this Notice;

e) Statement by the supervisor (s) assuming responsibility for supervising the work plan, pursuant to Article 5-A of the Research Fellow's Statute (draft declaration to be made available by FCT);

f) Document proving the candidate's acceptance by the institution where the research activities will take place, guaranteeing the conditions necessary for its good development, as well as the fulfillment of the duties provided for in article 13 of the Research Fellow's Statute (draft declaration to be made available by FCT);

g) Updated document proving compliance with the exclusive dedication regime (draft declaration to be made available by FCT).

The granting of the scholarship is still dependent on:

- compliance with the requirements of this The vision of The PENING;
- the result of the scientific evaluation;
- the absence of unjustified non-compliance with the grantee's duties under a previous scholarship contract financed, directly or indirectly, by FCT;
- the FCT's budget availability.

Failure to deliver any of the documents necessary to complete the process of contracting the scholarship, within 6 months from the date of communication of the decision to grant the conditional grant, implies the expiration of the referred grant and the termination of the process.

[1] The availability of these documents can be replaced with, for the applicant's option, the classroom presentation on financing entity, which will keep the elements thereof that is relevant to the validity and execution of the contract, including the numbers of civil identification, tax and social security, as well as the validity of the respective documents

11. FINANCING

The payment of the scholarships will start after the return, by the candidates, of the duly signed scholarship contract, which should occur within a maximum period of 15 working days from the date of receipt.

The grants awarded under this call will be financed by the FCT with funds from the State Budget and, when eligible, with funds from the European Social Fund, to be made available under PORTUGAL2020, through, inter alia, the Northern Regional Operational Program (NORTE 2020), The Regional Operational Program of the Center (Centro 2020) and the Regional Operational Program of Alentejo (Alentejo 2020), in accordance with the regulatory provisions established for this purpose.

12. GRANT COMPONENTS

Scholarship recipients receive a monthly maintenance allowance in accordance with the table in Annex I of the RBI.

The exchange may also include other components, under the terms set out in article 18 of the RBI and at the amounts provided for in its Annex II.

All scholarship holders benefit from personal accident insurance for research activities, supported by FCT.

All scholarship holders who are not covered by any social protection regime can ensure the exercise of the right to social security through adherence to the voluntary social insurance regime, under the terms of the Contributory Schemes of the Social Security Social Security System, ensuring the FCT charges resulting from contributions under the terms and with the limits provided for in article 10 of the EBI.

13. PAYMENTS OF GRANT COMPONENTS

Payments due to the grantee are made by bank transfer to the account identified by the grantee. The monthly maintenance allowance is paid on the first business day of each month.

Payments for registration, enrollment or tuition components are made by FCT directly to the national institution where the fellow is enrolled or enrolled in the PhD.

14. SCHOLARSHIP RENEWAL TERMS AND CONDITIONS

The renewal of the scholarship always depends on an application submitted by the fellow, within 60 working days prior to the start date of the renewal, accompanied by the following documents:

a) opinions issued by the supervisor (s) and by the host organization (s) on the monitoring of the grantee's work and the evaluation of his activities;

b) updated document proving compliance with the exclusive dedication regime;

c) document proving renewal of enrollment in the cycle of studies leading to the degree of doctor.

15. INFORMATION AND PUBLICITY OF THE FINANCING GRANTED

In all R&D activities directly or indirectly financed by the scholarship, namely, in all communications, publications and scientific creations, as well as theses, carried out with the support provided for in the scholarship, the mention of financial support from FCT and the Fund must be expressed European Social Program, namely through the Northern Regional Operational Program (NORTE 2020), the Regional Operational Program of the Center (Centro 2020) and the Regional Operational Program of Alentejo (Alentejo 2020). For this purpose, the FCT, MCTES, ESF and EU insignia must be inscribed in the documents referring to these actions, according to the graphic rules of each operational program.

The dissemination of results of research funded under the RBI must comply with the rules for open access to data, publications and other research results in force at FCT.

In all exchanges, and in particular in the case of actions supported by community funding, namely from the ESF, monitoring and control actions may be carried out by national and community bodies in accordance with the applicable legislation in this matter, with mandatory supported scholarship holders existing collaboration and provision of the requested information, which includes carrying out surveys and evaluation studies in this area, even though the scholarship has already ceased.

16. NON-DISCRIMINATION AND EQUAL ACCESS POLICY

FCT promotes a policy of non-discrimination and equal access, so that no candidate can be privileged, benefited, harmed or deprived of any right or exempt from any duty due, namely, to ancestry, age, sex, sexual orientation, marital status, family status, economic status, education, origin or social status, genetic heritage, reduced work capacity, disability, chronic illness, nationality, ethnic or race origin, territory of origin, language, religion, political or ideological beliefs and affiliation union.

1 7 . APPLICABLE LEGISLATION AND REGULATION

This call is governed by this Opening Notice, the Scholarship Rules of the FCT Research, approved by Regulation No. 950 /201 9 , published in II of December 16 of the DR Series 2019 , the approved Research Grant Holder Statute by Law no. 40/2004, of 18 August, as amended , and by other applicable national and community legislation.

ATTACHMENT

PLAN 1: Combination of drones and fibres for the development of an advanced integrated approach for observation and rehabilitation of road pavements.

Supervisors: Jorge Pais, jpais@civil.uminho.pt; Fâbio Figueiredo, f.figueiredo@civil.uminho.pt

Brief Summary: The present proposal intends to act on the rehabilitation of road pavements through the design of an advanced pavement observation system and the design of materials with high performance. For the observation of pavements, the objective is to contribute to a better inspection in an urban environment using drones and subsequent image treatment for cracking identification. For the design of better paving materials, this project intends to develop high-performance asphalt concrete reinforced with fibres that allow extending the pavement life compared to traditional solutions. These procedures will contribute to the conception of an integrated approach for observation and rehabilitation of road pavements, with low costs maintenance.

Objectives: The quality of road pavements is ensured by: i) a system for assessing their quality that, for roads of lesser importance, is based only on the observation of the surface condition; ii) a system for managing the quality of pavements; iii) a suitable design method of pavement rehabilitation. These three stages of pavement rehabilitation are costly for the municipalities and road administration due to the extensive national and municipal road network, therefore is being essential to have advanced techniques for the construction and maintenance of pavements that increase their life. The present proposal intends to act on stages one and three of the pavement rehabilitation through the design of an advanced pavement observation system using drones and the design of materials with high performance using fibres.

For the development of this thesis, a methodology will be carried out based on the following steps: i) Development of a procedure for using drones to capture images of the pavement surface condition; ii) Analysis of static photos to identify pavement cracking; iii) Determination of the types and contents of fibres that provide the adequate post-cracking tensile capacity to the Fibre Reinforced Asphalt Concrete for the identified damage levels; iv) In situ verification of the performance of the solution developed in the laboratory; v) Establishment of an integrated procedure for observation and rehabilitation of road pavements.

Detailed description: The development of this proposal is based on the following six tasks: 1. Setting up a drone for image capture of road pavement surface; 2. Image processing and image capture configuration for crack identification; 3. Development of a Fibre Reinforced Asphalt Concrete; 4. Application of the Fibre Reinforced Asphalt Concrete in trial sections; 5. Monitoring on the trial sections; 6. Establishment of an integrated procedure for observation and rehabilitation of road pavements.

The first task of this proposal is related to the setting up a drone for image capture of road pavement surface and intends to configure a drone to capture images from the road surface to identify pavement cracking. In addition, this task aims at configuring the drone to capture images of the pavement in any situation of incidence of sunlight for which a procedure will be developed. Thus, this task comprises two activities, namely: 1.1. Selection of a drone with high capacity for photography suitable to identify pavement cracking; 1.2. Test and configuration of the drone for capturing images of the road pavements.

The second task of this proposal is related to the image processing and image capture configuration for crack identification and aims at identify cracks in the pavement from images taken with drones. This task will work in conjunction with task 1 to allow the configuration of the drone, by providing the settings for image capture to ensure that the images have the appropriate quality to be treated analysed. Thus, this task is composed of three activities, namely: 2.1. Selection of a software for identification of cracks; 2.2. Software testing for images taken with the drone; 2.3. Definition of the settings for image capture.

The third task of this proposal is related to the development of a Fibre Reinforced Asphalt Concrete and aims at developing a Fibre Reinforced Asphalt Concrete (FRAC) to be used in the rehabilitation of road pavements. This FRAC will be the basis for the next tasks of the project because it allows the design of the trial section and will contribute for the development of the integrated procedure for observation and rehabilitation of road pavements. Thus, this task is composed of three activities, namely: 3.1. Selection of fibres to be used in the FRAC; 3.2. Mechanical properties of the FRAC; 3.3. Development of a cracking damage model for the FRAC.

The fourth task of this proposal is related to the application of the Fibre Reinforced Asphalt Concrete in trial sections and will construct the trial sections for the application of the FRAC developed and tested in the laboratory in the task 3. The task will

be carried out with the support of the municipality of Braga for the provision of roads for the trial sections, as well as in the construction of the test sections which requires the production of the FRAC and its application. Thus, this task will have the following two activities: 4.1. Design of the trial sections; 4.2. Construction of the trial sections

The fifth task of this proposal is related to the monitoring on the trial sections and is dedicated to the monitoring of the performance of FRAC in the trial sections and comprises the following activities: 5.1. Traffic and weather data collection; 5.2. Periodic evaluation of the trial sections; 5.3. Analysis of images by the software developed in task 2

The sixth task of this proposal is related to the establishment of an integrated procedure for observation and rehabilitation of road pavements and its objective is the combination of all information of the laboratory characterization of the FRAC carried out in task 3, the information of the quality control of the trial sections obtained in task 4 and the information of the performance of the trial section obtained in task 5, for the development of a model that will express the performance of road pavements with FRAC. Thus, this task is composed by three activities, namely: 6.1. Application of ANN for the performance of the pavements; 6.2. Verification of the model for the available data; 6.3. Development of an integrated procedure for observation and rehabilitation of road pavements; The development of this proposal will occur during 3 years as defined the following timeline chart.

PLAN 2: Development of semi-flexible heavy-duty pavements: towards enhanced performance and sustainability.

Supervisors: Joel Oliveira, joliveira@civil.uminho.pt; Vitor Cunha, vcunha@civil.uminho.pt

Brief Summary: As a reflection of the importance that sustainability and the circular economy have in the European development strategy, the European Union recently identified "Climate action, environment, resource efficiency and raw materials" as one of the seven societal challenges to face in the near future. Taking that into account, the present work aims at developing paving materials for heavy-duty applications that incorporate a high percentage of recycled materials and industrial sub-products in their composition. The type of material to be developed in this work provides significant advantages in comparison to both concrete and conventional asphalt, having both rut resistance and a degree of flexibility. This hybrid mixture provides good rut resistance and a surface highly resistant to fuel and oil spillage. Such properties allow it to be used in industrial areas, airports and harbours, where those situations are frequently associated with heavy and slow traffic.

Objectives: The main aim of this research is to develop innovative paving materials for heavy-duty applications with high mechanical and durability performance, as well a strong sustainable character. The specific research objectives of this investigation can be identified as follows: Study different compositions of the asphalt mixture used as the recipient of the cementitious grout that fills its voids, in order to optimise the mix design in terms of recycling rate and porosity; Check whether recycled fibres can be included in the mixture to improve the post-cracking performance of the material under thermally or traffic-induced stresses; Develop a grout with adequate flowability to fill the voids of the asphalt skeleton of the mixture, if possible, incorporating industrial by-products or wastes to partially substitute cement; Carry out performance related tests to assess the durability of the material and its resistance to fatigue, under repeated loading conditions; Perform a Life Cycle Assessment of the developed material, in comparison to equivalent flexible or rigid pavement solutions;

Detailed description: Semi-flexible paving materials usually known as "grouted macadams" have been used in certain specialist pavements, where high bearing capacity and rut (permanent deformation) resistance are key characteristics. Rigid pavements are traditionally selected for this type of applications due to their excellent properties under permanent loads. However, cementitious materials tend to develop thermally induced cracking due to shrinkage/expansion under temperature variations (joints are normally created in the pavement to control the number and position of the cracks). Asphalt materials show a better performance in this type of situation, but are less resistant to permanent deformation under static (or slow moving) loads, due to their viscoelastic nature. Thus, this semi-flexible material has the potential to combine some of the best qualities of flexible and rigid pavements, namely absence of joints, long life and high bearing capacity. It also provides good protection against water ingress to the foundation since it has an impermeable surface.

This work intends to use alternative materials, maximizing the incorporation of recycled materials or industrial by-products in the manufacture of semi-flexible composite materials for pavement applications, in order to promote circular economy principles. Additionally, discrete recycled fibres will be used to improve the performance of this type of paving solution. Industrial fibres have been used for a long time in rigid industrial pavements to enhance the post-cracking behaviour and/or mitigate cracking due to shrinkage. On the other hand, its application in semi-flexible pavements is still reduced, as well as the application of recycled fibres is still rather novel when compared to the industrial ones. Thus application of recycled fibres in this type of pavement poses more demanding challenges regarding the composition's rheological behaviour, since fibre's geometric variability needs to be carefully assessed and investigated to assure that the porosity and consequent flowability of the asphalt skeleton of the mixture is not compromised. The latter is of paramount importance in order to obtain a homogeneous and long-lasting material (with full penetration of the cementitious grout). The composition of the grout will also be studied to assess the possibility of partially substituting cement by wastes or industrial by-products with pozzolanic properties pursuing a material with a strong sustainable character. A Life Cycle Assessment (LCA) of the solutions under study must also be carried out to fully understand the advantages of this type of solution when compared to traditional flexible (asphaltic) or rigid (cementitious) pavements.

To better understand the work that is going to be carried out, a series of tasks is presented: Task 1 – Literature Review; Task 2 – Selection of alternative materials with high potential to be incorporated in grouted macadams; Task 3 – Study of the optimal composition of the asphalt mixture that will be used as the skeleton for the semi-flexible material; Task 4 – Investigation of the type (size and shape) of recycled fibres to be used in the reinforcement of the material strength to improve its performance; Task 5 – Development of an alternative grout incorporating wastes or industrial by-products as cement partial substitutes; Task 6 – Life-cycle assessment of solutions with equivalent life expectancy produced with flexible, semi-flexible and rigid paving materials; Task 7 – Thesis writing up

PLAN 3: Strengthening of asphalt and cementitious concrete with bio-based materials.

Supervisors: Hugo Ribeiro Dias da Silva, hugo@civil.uminho.pt; Luís Luciano Gouveia Correia, lcorreia@civil.uminho.pt

Brief Summary: During the last decades, asphalt and concrete structures went through many extreme mechanical and environmental conditions, and many are needing repairing or rehabilitation actions. Fibers, polymers, and their composites solutions, are frequently used materials for both asphalt and concrete structural strengthening since they increase strength and flexibility. Nevertheless, fibers and polymers are not biodegradable, can lead to health damages, and are obtained from nonrenewable fossil resources. The matrix of asphalt mixtures – bitumen – and fiber reinforced polymers (FRPs) – e.g. epoxy, vinylester, or polyester – have a similar problem. European directives enforce the decrease of wastes and pollutants produced from nonrenewable resources. Therefore, this work mainly aims at using bio-based materials to strengthen asphalt and cementitious concrete, using new solutions obtained from renewable sources. The possibilities include bio-oil from fast pyrolysis of natural wastes, as bitumen substitute, biopolymers developed from that bio-oil, biochar as cement admixture, natural fibers, and bio resourced composites.

Objectives: The primary objective of this work is the development of new polymer-modified (PMB) asphalt mixtures and composite FRP solutions for concrete incorporating bio-based materials as a sustainable alternative to the nonrenewable fossil resources typically used for asphalt and concrete strengthening. This thesis aims to research not only the efficiency of using several bio-based materials for asphalt and concrete strengthening but also for repairing or healing mechanically damaged mixtures (evaluation of bio-regeneration potential).

These new solutions should increase the durability of asphalt and concrete structures by improving their strength and flexibility. Still, some processes of self or induced healing of cracking damage will also be analyzed (e.g., using bio-regenerator oils in asphalt mixtures and analyzing the carbonation potential of bio-chars when applied in cementitious concrete). The performance will be compared to that of i) conventional asphalt and concrete mixtures; ii) polymer-modified asphalt mixtures with commercial PMBs; iii) commercial FRPs concrete solutions. The final result should be economically, technically, and environmentally viable.

Some partial objectives are consequently envisaged: i) selection of bio-based material to be used in the study; ii) evaluation of the pyrolysis process, including the feeding waste and the resulting bio-oil and bio-char; iii) survey of bio-polymer production and use in PMBs; iv) evaluation of natural fibers and bio resourced composites for FRPs; v) design of new solutions for strengthened asphalt and concrete mixtures; vi) outline of test protocols to evaluate the durability; vii) definition of methods for repairing or healing and corresponding evaluation.

Detailed description:

The use of nonrenewable fossil resources or derived materials will be increasingly controlled in EU, thus becoming evident the need to research new solutions to substitute those materials in civil engineering works. Taking into account that the strengthening of asphalt and concrete mixtures is usually carried out using fossil fuel derived products (e.g., polymers, fibers, resins, among other), the objective of this work is to use bio-based and renewable materials to develop PMB asphalt and FRP concrete mixtures.

Bio-based materials are an excellent alternative to solve the fossil fuel depletion and can be selected among commercial options or custom made using a pyrolysis reactor and a convenient forestry or waste feeding source. Additionally, these technologies stand as potential viable solutions to improve the durability and sustainability of the strengthened concretes.

This project has several challenges because many bio-based materials are less resistant or are incompatible with the other components of asphalt or concrete mixtures. Thus, the first step of this work is very dependent on a comprehensive literature review to select the most adequate bio-based materials to be used in this study. Some of those materials can be commercially available (e.g., natural fibers), but other must be custom made using a pyrolysis reactor and processes of polymerization. The previous work and the good relations with Iowa State University, US, with the Polymer Engineering Department of UMinho and with CVR (Center for Waste Valorization) will help to find the most suitable solutions for these processes. Nevertheless, the careful study of the bio-oils, bio-chars and biopolymers obtained in this phase are essential for the success of these new products. These materials will later be used in the production of polymer-modified binders (PMB) that will be characterized rheologically in comparison with other commercial PMBs. Ductility, creep recovery and stiffness tests will be used to understand the performance of these new solutions. DSC, TGA and FTIR tests will also be used to evaluate other physical-chemical properties of these materials. Bio-oil can also be used as regenerator, and its healing or repair potential will be evaluated.

Simultaneously, the study of bio-based FRP solutions will also be challenging and will include the selections and characterization of the natural fibers and bio-resourced composites for substitution of epoxy resins. The use of biopolymers is also possible. Laboratory tests will be used to access the tensile properties of the FRP solutions and evaluate the bonding efficiency between the FRP and the concrete. It is also possible to use biochar or other solutions with bacteria to repair or healing cracked concrete (carbonation process). Biomaterials can also be used to produce an adhesive for bonding FRP and concrete composites, in addition to the development of a new FRP or new concrete mixes (with fibers or self-healing properties).

After selecting and characterizing the bio-based materials, the optimum solutions for the new PMBs and FRPs will be designed for ultimate applications in the mixtures. Again, rheology tests may be used for evaluation of the mechanical performance of the binders previously defined. Then, asphalt mixtures will be produced with the developed PMB, and concrete mixtures with the new FRP. Those materials will the carefully tested to understand their durability and resistance in comparison with conventional concrete without any strengthening element and commercially available FRP solutions. Finally, the success of the new bio-base solutions to repair or healing technologies developed in this work will be evaluated by measuring the increased fatigue cracking resistance of the new asphalt materials with bio-oil (as asphalt regenerator) or with biochar (as cement admixture to improve the carbonation method) in comparison with a traditional mixture used in paving operations. Besides, all other performance-related properties of this innovative mixture should be assured to demonstrate the potential of this sustainable material to be used shortly in our roads. During all phases of the work, the student must carry out the analysis and discussion of results, and include the comments of the supervisors to achieve adequate solutions. The final task will be the writing of the PhD theses, to summarize all finding of this work, and some papers during the development.

Main tasks of the project: Task 1: Literature review on the topic presented; Task 2: Selection or definition of bio-based materials to be studied; Task 3: Characterization of bio-based materials, including the fast pyrolysis process and the study of the polymerization process to obtain the new bio-polymers; Task 4: Characterization of the natural fibers and bio resourced composites for FRPs; Task 5: Design of PMBs and FRPs with the bio-based materials to be used in the mixtures; Task 6: Production of asphalt and concrete mixtures and evaluation of their durability; Task 7: Study of repairing or healing potential of the new solutions; Task 8: Analysis and discussion of results; Task 9: Writing of the thesis and other dissemination results;

PLAN 4: Development of Optimised Earthen Building Elements

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Brief Summary: Currently, with the growing concern in adopting more sustainable technical solutions, the interest in earth as a building material has been renewed. The present proposal has as main objective the development of constructive earthen building solutions capable of meeting the requirements of safety, durability, comfort and hygiene proportional to the expectations of the modern world. Thus, it is expected to optimise the thermal behaviour of earthen products from the incorporation of low-cost materials with a lower carbon footprint and incorporated energy, without neglecting the optimisation of its mechanical and structural performance. The desired products will represent more economical solutions, with reduced environmental impact, in a perspective of contribution to sustainable development. The results of the study will assist professionals who intervene in rehabilitation and conception of new buildings using earthen construction.

Objectives: The main objective of this PhD proposal is to improve the thermal performance of earthen building materials without impairing their mechanical behaviour. To achieve this objective, this research will develop solutions that incorporate low-cost materials into the earth mixtures, with a lower carbon footprint and embodied energy, including natural materials and industrial by-products. Sustainable materials that demonstrate its thermal insulation potential and its feasibility of application during the literature review will be analysed. As a result, it is expected to improve the functional performance of earthen building elements that meet the current thermal and mechanical requirements and have reduced environmental impact and high economic life cycle performance.

To achieve these goals, a set of specific objectives are defined: i) to assess the state of the art of earthen construction; ii) to identify in the literature the materials with the highest potential to improve the thermal insulation of earthen products, without worsening the mechanical and structural properties; iii) to characterise thermophysical properties of earthen building elements currently available; iv) to develop new earth mixtures by the incorporation of the previously selected materials, to optimise their thermal, mechanical and environmental life cycle properties; and finally, v) to analyse the contribution of the earth solutions in reducing the environmental impact and improving the sustainability of the construction sector, based on the life cycle assessment of the products developed, comparing them to the current solution available in the market.

Detailed description: This proposal was established by the need for building materials and elements that present, simultaneously, reduced environmental impact and adequate thermal behaviour. Earthen constructions fit into this scenario, mainly because they have low materials processing, consume lower energy, and the earth is a local material that can be 100% recyclable or reused. The abundance and ease of access to raw materials can also contribute to decreasing the capital cost of constructions, compared to the ones that use traditional techniques. However, previous studies show that it is essential to develop solutions to improve the thermal insulation of earthen elements used in the building envelope, without compromising their mechanical behaviour. Within the scope of the reVer+ project, the possibility of developing a new product with high market potential was identified, based on the incorporation of materials with less thermal conductivity in earth mixtures.

In this context, the present study aims at developing optimised earthen building elements, through the development of optimised earthen mixtures, that can be applied both in new buildings and in the sustainable renovation of existing ones. This will allow for a more resistant, durable, economic and, above all, sustainable construction. To carry out this study, the research methodology embraces a comprehensive strategy, which will be based on a literature review involving different researches with similar objectives to the one to be developed. Considering the analysis of current scientific and technological developments, it will be possible to adopt an investigation method that will allow achieving the proposed objectives. With this established method, a Research and Development cycle will be implemented, qualified through: Quantitative and qualitative analysis; Laboratory validation; and Development of durable and sustainable solutions in traditional and vernacular construction.

The work will start in Task 1 “Survey of state of the art”, which aims to understand the best and most recent solutions at national and international level for optimising the properties of earthen building elements. In this scenario, it is essential to identify sustainable materials that added to earth mixtures have the potential to improve thermal properties, without jeopardising the remaining physical properties of the final product. This task will be subdivided into: i) the analysis of normative framework, based on the breakdown of articles and international standards, to identify the most appropriate methods to achieve the research objectives; and ii) the identification of materials (natural and industrial by-products) to be used in the optimisation of the thermal behaviour of earthen products, without affecting their mechanical and structural

performances. With expected duration of 9 months, this task establishes the bases for the development of subsequent tasks, gathering the necessary information to support the guidelines adopted in the study.

The first task interacts directly with Task 2, "Characterisation of the earthen products already available in the market", where the characterisation of the earth that composes the earth-based products currently commercialised (Subtask 2.1) will be carried out, as well as the characterisation of its thermal, mechanical and structural properties (Subtask 2.2). The results obtained here will be used as a reference in the development of new solutions that meet the thermal and mechanical regulations of Portuguese and international standards. The first quarter of this task will be developed in parallel with the last quarter of Task 1, lasting for the following semester.

Task 3, "Optimising the thermal properties of earthen building elements", involves the development of new earth mixtures to produce earthen building materials that are thermally optimised by the incorporation of sustainable materials with reduced thermal conductivity. These building elements will be developed to fit the functional requirements of a wall to be used between the indoor and outdoor environments or between a heated and a non-heated area. All products developed will be subjected to the same experimental analysis used for the reference samples (Task 2). This task will last for 18 months.

Next, in Task 4, "Life Cycle Assessment of the developed earthen building elements", the environmental and economic life cycle performance of the new earthen solutions will be analysed, considering the current sustainability needs. This task is directly related to the previous ones, establishing a comparative analysis between the optimised solutions developed and those currently available on the market. The assessment of economic performance (Subtask 4.1) should be based on the standard EN 15643-4:2012 and will include capital and maintenance costs; the evaluation of environmental performance (Subtask 4.2) should be carried out following standard EN 15804:2012. The deadline for the execution of this task is nine months.

Task 5, "Thesis writing", corresponds to the compilation of the results obtained throughout the PhD to serve as a future reference for research studies in this area and to allow the practical application of the knowledge developed in the construction sector. Finally, Task 6, "Dissemination of results", is fundamental to the success and implementation of the results of this study. In this task, the main results obtained will be published in national and international conference proceedings and indexed international journals (at least 4 papers, 1 per year). All tasks are in line with the objectives proposed in this study and were structured following the same logical sequence, to guarantee the sustainability and economic potential of the developed earthen building solutions. Tasks 5 and 6 will start at the end of Task 1 and will last until the end of the study.

To mitigate the risks associated with unforeseen circumstances during the execution of the research, its planning was carried out with margins for final adjustments to the physical schedule. The main challenge involves possible difficulties in optimising the earth mixture used in the earthen building elements, due to the lack of adherence of the sustainable material or the reduction of the mechanical capacity of the earthen building materials to values below the normative limits. Precisely for this reason, different types of materials to be used in the earth mix will be studied, in addition to adjustments in the composition and dimensions of the earthen building elements to be proposed.