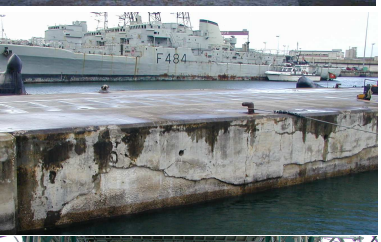
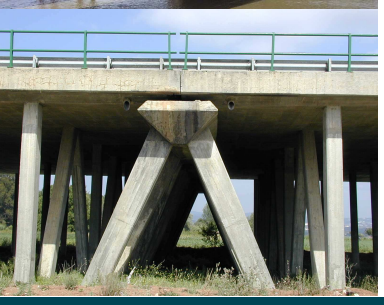
DURABLE TRANSPORT INFRASTRUCTURES IN THE ATLANTIC AREA

NETWORK

ACESSIBILITY & TRANSPORTS
PROJECT 2008-1/049

duratiNet





DURATINET

NEWSLETTER

Nr 03

January 2010

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ATLANTIC AREA Transnational Programme
ESPACIO ATLÁNTICO Programa Transnacional
ESPACE ATLANTIQUE Programme Transnational
ESPAÇO ATLÂNTICO Programa Transnacional

Investing in our common future

European Union
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INTRODUCTION

This Newsletter reports on the progress made during the first year of the DURATINET project and on the 2nd Consortium Meeting and the 2nd Trans-national Workshop that took place in Belfast on 20-21 June 2009. The Meeting and Workshop were hosted by the **Queens Belfast University** and organised by the project for the communication and dissemination of project activities between the partners and stakeholders.

Queens Belfast University (QUB) is an institution with a world-class academic reputation as reflected in the award of a Queen's Anniversary Prize in 2006, the fourth time the University has been honoured in this way. The School of Planning, Architecture and Civil Engineering of QUB has a strong international profile in both research and teaching. It brings together three prominent education disciplines areas, Planning, Architecture and Civil Engineering, and three internationally recognised interdisciplinary research centres, the Environmental Engineering Research Centre, the Centre for Built Environment Research and the Institute of Spatial and Environmental Planning. Led by Professor David Cleland, the School consists of around 60 academic staff supported by a School Manager and a team of researchers, administrative, computing and technical staff and a student body of 1,300 undergraduate and postgraduate students.

The Centre for Built Environment Research (CBER) integrates the Structures and Materials Research Team (SMART) from Civil Engineering and the Architecture Research Team (ART). It is a truly interdisciplinary Centre and provides a unique opportunity for architects and civil engineers to explore joint solutions to the problems faced by the Built Environment and the Construction Industries. CBER facilitates this by undertaking its activities within four research themes: Sustainable Buildings and Communities; Architectural Design Research; Structures; Structural Materials. For further information regarding the research activities of QUB's School of Planning, Architecture and Civil Engineering and Centre for Built Environment , please contact G Shannon [email: g.shannon@qub.ac.uk, telephone + 44 28 9097 5565].

*This is the 3rd edition of the **DURATINET Newsletter**. The Newsletter is one of the ways developed in the project for communication and dissemination of information on project activities. The format of the newsletter is mainly designed for on-line download*

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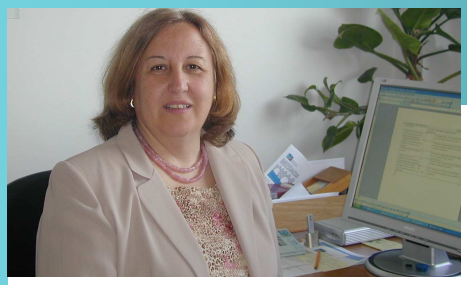
DURATINET PROJECT

Context

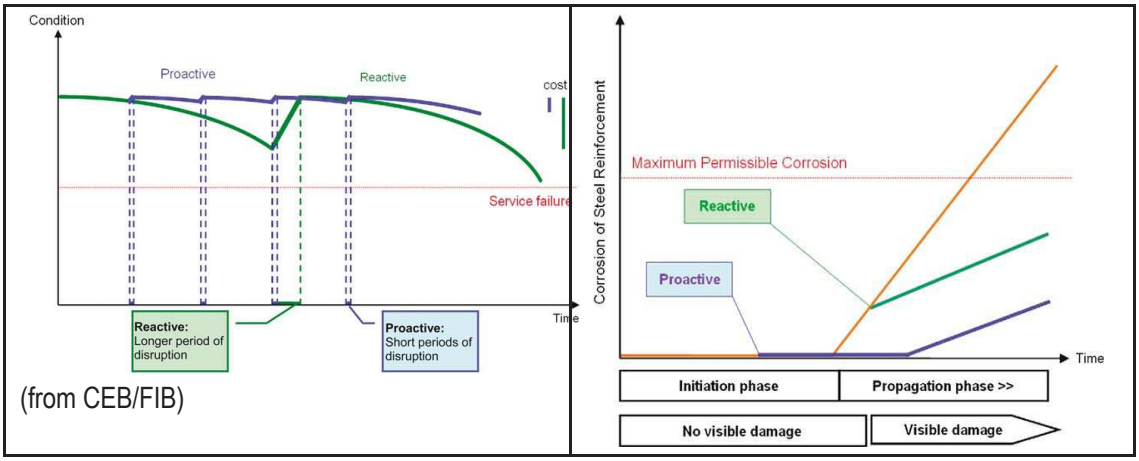


Project Leader

LNEC, PT

Most of the Atlantic Area is characterised by an aggressive marine environment which has caused extensive deterioration in the transport infrastructure of the region. This has a great impact on resources spending, environment sustainability and human safety. Much of the steel and concrete in the Atlantic Area is over 50 years old and many structures are in a severely deteriorated condition due to chloride contamination arising mainly from the marine environment but also from the use of de-icing salts for winter maintenance. Many of these ageing structures were built long before the establishment of the current design codes and loading specifications, and in many cases their carrying capacity is uncertain. This is of particular importance for bridges which are experiencing loads due to vehicles never envisaged by the original designers and builders.

To manage existing infrastructure effectively and efficiently, procedures and tools are needed to identify and evaluate defects and determine their effect on the performance of structures, both in terms of maintenance requirements and structural safety. Different inspection methods are required to evaluate the condition of different transport infrastructure types and components throughout s during their service life. The optimisation of repair decisions and the selection of repair methods to be used must be based on an accurate assessment methodology for the diagnosis of the deterioration mechanism and its future development. Both proactive and reactive maintenance strategies are required: while a proactive strategy is more effective in guaranteeing safety and minimising whole life costs, a reactive strategy will always be required due to difficulties in recognising the development of defects and the scarcity of resources which leads to maintenance backlogs.



(from CEB/FIB)

DURATINET is a network devised to facilitate an efficient exchange and transfer of knowledge on maintenance and repair, and to promote the durability, safety and sustainability of transport infrastructure in the Atlantic Area.

Guidelines for the assessment and repair of metallic and reinforced concrete transport infrastructure are being developed in the project. Aspects related to the technical requirements for the optimisation of maintenance, inspection methods and repair techniques for the different deterioration mechanisms are being given particular consideration in the development of the DURATINET manuals.

DURATINET PROJECT

Last Events and Dissemination Activities

The Trans-national Workshops organised every semester provide an excellent opportunity to communicate with industry, administration, contractors and all other stakeholders in the partner countries. The workshops include a series of presentations by the partners, as well as presentations from the local industry representatives and transport administrations. This is followed by a discussion period providing the chance to raise important issues and influence the direction of the DURATINET project. The aim is to exchange ideas and promote collaborative partnerships in the field of maintenance and repair of concrete and steel infrastructure. The main parties taking part in such events are the members of the project consortium, the public administrations, the project stakeholders and the potential end-users in this field. The Trans-national Workshops organised each semester take place in different countries in the Atlantic region.

2nd Trans-national Workshop

The 2nd Trans-national Workshop was held on the afternoon of 20 June 2009 at Queen's University, Belfast. The event was attended by 47 delegates including engineers responsible for maintenance and repair of infrastructure and products and repair systems developers in Ireland and Northern Ireland.

The Workshop was organised in two sessions.

Session 1 was devoted to presenting the DURATINET project, its objectives and progress to date. The project leader (Manuela Salta, LNEC, Portugal) gave an overall view of the objectives and expected results of the project: the various Work Group leaders presented more detailed information concerning the DURATINET activities, progress to date and future plans.

Session 2 included presentations by two end-users, the National Road Authority (NRA) of Ireland and McFarland Associates, a Belfast-based company concerned with the testing of concrete structures. Albert Daly, NRA, gave a general view of the NRA experience concerning the management of the bridge stock on the Irish National Road system and described the maintenance and repair strategies adopted. Brian McFarland of McFarland Associates presented information on traditional and newly-developed electrochemical repair techniques, and provided details of their application on range concrete structures in the UK and Ireland.

Session 1: Project presentation

DURATINET objectives, activities, end products and dissemination of results (M. Salta, LNEC, PT)

Probability Based Maintenance Optimisation Case Studies and Practical Application (A. O´Connor, TCD, IE)

Concrete maintenance and repair (S. Nanukuttan, QUB, UK)

Steel maintenance and repair (F. Schoeffs, GeM, FR)

Smart and green materials in structures (R. Nóvoa, UVigo, SP)

Session 2: Invited speakers

NRA: Maintenance and repair of bridges (Albert. Daly, NRA, Ireland)

Carbonation, Chlorides and Electrochemical Repair (Brian McFarland, McFarland Associates Limited, Northern Ireland, UK)

DURATINET PROJECT

Last Events and Dissemination Activities

2nd Consortium Meeting

The 2nd Consortium Meeting was held on 20-21 June 2009 at Queen´s University Belfast and was attended by 25 consortium members from 5 European countries, representing the 17 Institutions in the consortium.

During this meeting the progress made in the first semester of the project was discussed: this was evaluated by the Steering Committee to verify if the progress made was in agreement with the project plan. In addition, Work Group leaders presented the proposed activities for second semester. Based on these presentations, the milestones and deliverables for the second semester were confirmed in consultation with all partners.

After the meeting, partners and invited guests met informally at a reception and conference dinner hosted by Queen's University Belfast at the historic and scenic Belfast Castle. This provided the opportunity for informal but nevertheless important discussions to take place in relaxed and convivial surroundings.

Site visit to a highway bridge affected by chloride contamination

On 24 June, the DURATINET delegates visited a bridge in Northern Ireland which has experienced reinforcement corrosion due to chloride ingress. The bridge is on the M1, one of the busiest motorways in Northern Ireland. Corrosion damage was limited to the abutments and it was mainly caused by the ingress of water containing de-icing salt through leaking expansion joints. Steel reinforcement in the bridge abutments was found to be corroded with various areas of stained and spalled concrete apparent from a visual inspection. At the time of visit the structure was already earmarked for repair work. The inspection report was not available to make further observations or comments. However, it was possible to observe the existing damage on the bridge and to discuss the causes of the corrosion and the various repair solutions.

DURATINET website

The DURATINET website project is one important tool for the communication and dissemination of project activities among the partners and to the wider technical community. All the most important information relating to the project is available online. The public project publications can be downloaded from the website as soon as they have been prepared and completed. The website was created in the four official languages of the project consortium: Portuguese, English, French and Spanish. Registration to participate in the Trans-national Workshops or to be stakeholders or member of the Atlantic Area Cluster "Green and Smart Materials" can be made online via the DURATINET website.

PROJECT ACTIVITIES DEVELOPMENT

WG A 2—Maintenance decision tools and requirements for optimisation of repair

Alan O'Connor,
Trinity College
Dublin

A common problem among bridge owners/managers is the need to reduce spending whilst attempting to operate and maintain an increasingly ageing bridge stock which is subject to a loading intensity for which, in many cases, it was not designed. The problem is compounded by the ever-increasing volume of road traffic. As a result the past decade has seen increased interest by bridge owners and managers in the use of semi-probabilistic and fully probabilistic methods for the assessment of their bridges specifically within the context of (i) documentation of higher load carrying capacities such that unnecessary repairs and rehabilitation can be avoided, and (ii) planning maintenance interventions to maximise whole life performance with respect to budget outlay. Employed once a traditional deterministic assessment has identified a new repair/rehabilitate/replace scenario, the methods have been demonstrated to provide significant cost savings where the required safety of the structure at higher load levels can be assessed and optimised with respect to remaining required life.

The advantages of the application of advanced assessment methods are seen to increase with increasing complexity of the analysis. However, the more complex the methodology is, the less likely it is to be universally used. Recognising this fact, the aim of WG A2 is to demonstrate how alternative assessment methods may be employed as maintenance decision tools for the optimisation and repair of structures. However such methods are only as good as the information available concerning the lifetime performance/ deterioration characteristics of the construction materials considered, e.g. reinforced concrete and steel, and of the change in performance as a function of repairs which may be carried out. As such this WG leans heavily on results available from the other project WG's.

The main objective of this WG is to produce a guideline manual for maintenance planning and optimisation for reinforced concrete and steel infrastructure. The key aspects to be covered in this report are:

- A state-of-the-art review of available deterministic, semi-probabilistic and fully probabilistic assessment tools
- Procedures for the statistical modelling of damage mechanisms of reinforced concrete and steel and incorporation into the chosen analysis framework
- Modification of the aforementioned mechanisms to allow for the effects of repair
- Procedures for the updating of models based upon condition surveys, NDT information, etc.
- Optimisation of maintenance planning to maximise whole life performance with respect to available budget
- Worked examples

Agreement on the content of the manual and of interaction with other WP was made during the Lisbon meeting in Feb 2009. Since the meeting in Belfast in June 2009, the following progress was made:

- A questionnaire devoted to technical administrations and end-users has been developed by TCD in collaboration with other partners to acquire information on infrastructure stock and age distribution, complexity of management tools, etc.
- A state-of-the-art report on deterministic, semi-probabilistic and probabilistic methods has been under preparation by the University of Bordeaux.
- Three papers have been prepared by WG members for presentation at international conferences, all of which will be made available on the DURATINET website.

PROJECT ACTIVITIES DEVELOPMENT

WG A 3—Maintenance and repair of concrete

Sree Nanukuttan
Queen's University of Belfast
Belfast

Concrete structures offer engineers greater construction flexibility at a lower cost but not without challenges.

The long term behaviour changes in concrete structures may cause the embedded steel or cover concrete to deteriorate prematurely. In such cases, timely repair works need to be carried out to improve serviceability. Furthermore, any changes in usage condition of structures such as increase in traffic load or exposure conditions, etc, may require structures to be upgraded or rehabilitated to make them fit for purpose.

As most of the European Infrastructure is reaching a critical age in relation to repair and rehabilitation, there is a need to provide guidance on topics such as condition evaluation of structures, selection of appropriate repair strategy, performance of repaired materials, etc. Although, a few EU standards are now available for the selection of repair systems and products, this does not take into account the latest developments in the repair technology, and the wealth of knowledge and experience available from the practitioner and research community.

Therefore, a critical evaluation of the available methods and systems by considering the existing standards and best practice guides in consultation with expert team comprising of internationally leading practitioners, researchers and SME's would be highly beneficial for developing a guidance document for the effective maintenance management of concrete infrastructures.

Set against this context, the main objective of this WG is to prepare a Guideline on Repair/ Rehabilitation of Concrete Infrastructure. The key aspects to be covered in this manual are:

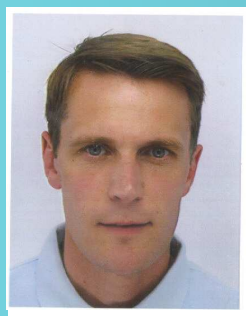
- Review of requirements for concrete durability
- Deterioration mechanisms
- Assessment of condition of structure
- Critical evaluation of available repair techniques

Consensus on the general content was made during the Lisbon meeting in Feb 2009. Following on from this, a detailed line-up of topics to be included was agreed in Belfast meeting in June 2009. The final table of contents for each chapter of the manual has been agreed and uploaded onto the web platform along with a few draft sections of the document.

It is expected that a first draft of the manual will be presented in Bordeaux meeting in Jan 2010 for discussion within the WG and to collect other contributions and views from the project consortium members.

PROJECT ACTIVITIES DEVELOPMENT

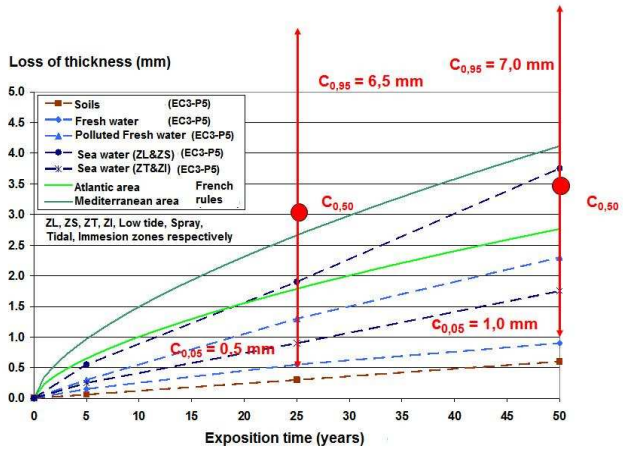
WG A 4—Maintenance and repair of steel



Franck Schoefs
GeM, Nantes University
Nantes

Metallic transport infrastructure in the Atlantic Area is subjected to several deterioration mechanisms, the main ones being fatigue (propagation of cracks) and corrosion (both generalise and localised). There are many techniques available for the evaluation of the structural condition of steel structures. However, the mechanisms of degradation particularly for structures in coastal regions are still not fully understood and their modelling in a probabilistic context is still a challenge.

The efficiency of repairs applied in specific areas of coastal structures (tidal and splash zones) is not well understood. Within the global objectives of the DURATINET project (optimisation of repair and inspection) the work of this group should provide basic information in terms of understanding the deterioration mechanism, modelling, inspection techniques, repair methods and their efficiency. This information will be based on practical experience from European countries and worldwide, supported by additional research where gaps exist. The figures below show the corrosion of steel sheet piles in a French harbour and the results of modelling of the corrosion (expressed as means and quartiles) compared to the French/European rules or standards.



The main objective of this WG is to prepare Guidelines on the repair/rehabilitation of steel infrastructure in the Atlantic Area with special emphasis on coastal structures. The key aspects to be covered in this manual are:

- Review of damage mechanisms of steel and protection systems for metallic structures
- NDT methods for in-situ inspection, interpretation of results and associated uncertainties; applicability of the different techniques, advantages and limitations
- Available techniques for the repair and protection of structural steel.

During the last semester of 2009, GeM, REFER, LCPC and LNEC worked together to build the table of contents of several chapters of the manual and began drafting various sections.

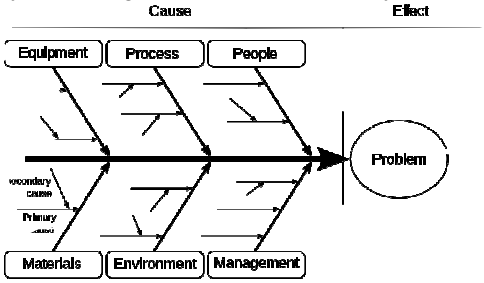
PROJECT ACTIVITIES DEVELOPMENT

WG A 5—QUALITY CONTROL NEEDS ON REPAIR PRODUCTS

Sylvie Yotte
Bordeaux University

This WG is concerned with quality control requirements and the evaluation of the reliability of repair products and systems, and the implications of the European standards on concrete and steel repair and protection to contractors and material suppliers. The needs for pre-normative activities related to standards and specifications on the performance of repairs will also be considered within this WG.

To guarantee the high performance of repair systems, effective quality control has to be applied to the whole supply chain, from the production of the repair materials to site application. The causes of the failure of repairs can be analysed through an Ishkawa Chart, a typical example of which is given below.



The first goal is to choose the right repair system and materials appropriate for the damage type. A bad application of a correct product could be due to bad equipment, lack of application guidelines (process, environment, safety, etc), inappropriate manpower (insufficient numbers, inexperienced operators, lack of supervision or quality control).

The work of the WG will focus mainly in two areas: development of guidelines for quality control of repair systems, and non-destructive tests for acceptance of applied repair materials.

To date, the WG has focussed on the implications of the harmonisation of European standards for concrete repair and steel protection systems on contractors as they attempt to comply with owners requirements. A guidance document containing technical conditions for the tender specifications relating to the rehabilitation of reinforced concrete structures in maritime environments is being developed. The document will include:

1. **Characterisation of the repair materials/techniques and acceptance tests**: including the requirements for water, aggregates, cement-based materials, additions and admixtures, metallic materials, composite and polymeric materials, electrochemical systems, painting and lining, specific materials for underwater repairs, formwork, spacers, joints, bearing and damping devices, abrasives, waterproofing, levelling and wearing layers.
2. **Works execution requirements**: including the preparation of repair materials and base materials, repair and reinforcement of concrete elements, painting and lining application, underwater repairs, electrochemical systems, prestressing, temporary structures, bearings, expansion joints, damping devices, waterproofing, metallic elements, quality control, works final report, safety and health plan.
3. **The measurement and evaluation criteria for repair works and materials:** In most cases the work execution requirements will be illustrated with simple drawings to better understand the procedure, as exemplified in the following drawing for beams and slabs repairs.

PROJECT ACTIVITIES DEVELOPMENT

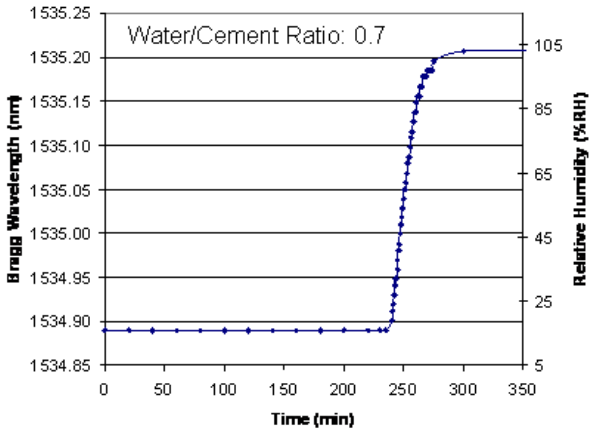
WG A 6—SMART AND GREEN STRUCTURAL MATERIALS

R. Novoa,
Vigo University
Vigo

In this WG the aim is the promotion of "Smart and Green Structural materials" in construction using, for example: "green" concrete incorporating by-products and recycled aggregates; corrosion resistant reinforcing steels; new stainless steel alloys for prestressing, smart structural materials with permanent monitoring, "nanostructured" coatings for steel protection; new developments and research areas on repair materials and more environmentally friendly systems for steel protection.

During the project first semester the members of the WG collected and classified available information on sensors for real-time monitoring of the degradation process, as well as on reinforcement more resistant to corrosion.

The use of embedded sensors on reinforced steel structures allows continuous monitoring of important degradation-related conditions such as carbonation, relative humidity, strain or corrosion rate. A first report was prepared concerning several types of sensors and the most recent developments in this field.



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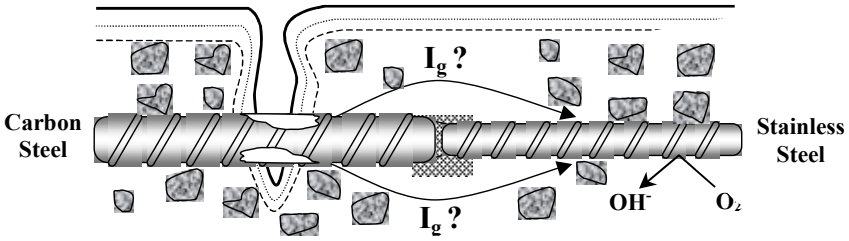
The corrosion resistance of reinforcement in concrete can be improved by using stainless steel or non-metallic bars (eg, carbon or glass fibre bars). These corrosion resistant reinforcement types can be used for repairs as well as for new structures in selected elements of the structure. There is a significant risk of galvanic corrosion between ordinary steel and stainless steel so care must be taken when different reinforcement types are used. These applications are currently well-established and have already been used in many structures world-wide. The developments needed mainly relate to new or less expensive steel alloys and on the application of stainless steel in prestressing systems.



PROJECT ACTIVITIES DEVELOPMENT

WG A 7—PERFORMANCE EVALUATION OF REPAIR SYSTEMS

Karim AIT-MOKHTAR
La Rochelle University

This WG deals with the monitoring of the behaviour of existing repaired reinforced concrete structures damaged by chlorides, carbonation, etc. The main focus of the WG is on the evaluation of the performance of the repaired structure and the interaction between the repair and the parent material. In this regard, the WG will investigate the different repair systems used in the different countries of the DURATINET partners. The WG will also investigating research and development into new repairs materials and systems.

During the last semester, two bridges were selected by the DURATINET partners for the monitoring of different repair systems: these are Barra Bridge in Portugal and Ferrycarrig Bridge in Ireland. These two structures were repaired several years ago and there is sufficient data available on their environment, structural condition, and properties of both the repair and parent materials to enable an in-depth evaluation to be made.

Barra-Bridge (Portugal)

Ferrycarrig Bridge (Ireland)

A draft Table of Content for the first WG report was agreed during the 2nd DURATINET meeting in Belfast and approved by partners during the last semester. The writing of the report has been initiated and will be presented at the Bordeaux meeting in January 2010.

Next Project Meetings

4th Trans-national Workshop & 4th Partners Meeting

June 2010

TCD - Dublin, Ireland

5th Trans-national Workshop & 5th Partners Meeting

January 2011

U. Vigo, Spain

Next issue:

NEWSLETTER Nr 04

June 2010

More information on DURATINET can be obtained from the website

www. duratinet.org

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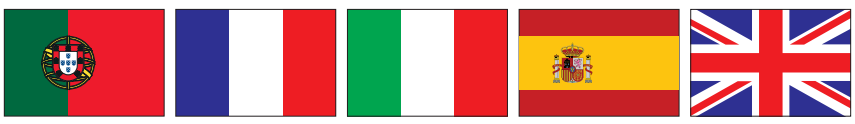

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