Bonneagar Iompair Éireann
Transport Infrastructure Ireland

TII Strategy for Research and Development

Transport Infrastructure Ireland
September 2019

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EXECUTIVE SUMMARY

Transport Infrastructure Ireland was established as from 1 August 2015 when the Railway Procurement Agency was merged with the National Roads Authority under the Roads Act 2015. TII's primary functions are:

- To provide an integrated approach to the future development and operation of the national roads network and the light rail infrastructure network throughout Ireland, and
- To secure the provision of safe and efficient networks of national roads and light rail.

TII has overall responsibility for planning and supervision of construction and maintenance works on these networks. Its remit extends to any training, research and testing activities necessary for the execution of its functions in areas of project planning, construction, maintenance and operations.

TII recognises the value of research and the important role it plays in achieving strategic objectives. In 2007 TII initiated a Research Strategy to ensure that all its research activities were carried out in a coordinated way. The aim of the Research Strategy is to promote practical measures that will contribute to quality enhancing and/or cost reducing innovation and achieve an appropriate balance between safety, cost and sustainability. The Research and Standards Section manages TII Research and coordinates all the research activities across the different areas associated with the provision and operation of TII's road and rail networks.

The Research Strategy provides the basis for the ongoing research activities within TII. It provides for both short-term commercial research services in response to the business needs of TII and longer-term research projects at PhD or post-doctoral level. It also provides the basis for TII involvement in collaborative research and other ad hoc research initiatives necessitated by business needs. The Research Strategy supports TII's Corporate Strategy and overall goals as outlined in the TII Statement of Strategy 2019-2023.

The content for the research programme is developed by TII on an annual basis in line with the framework outlined in this document and in response to current research needs as identified by individual TII staff members and other stakeholders. The annual research programme reflects changes in priorities and new areas of interest. A key element of all TII research projects is an implementation plan to ensure the implementation of the research results in a practical and timely way.

1. Introduction

The world continues to undergo unprecedented development in new and emerging technologies. Developments in science and technology are occurring very rapidly and the demands that these place on the operation of road and light rail networks require continuous consideration in response to the changing needs and preferences of the travelling public and business. To ensure the success of TII in carrying out its objectives, it is vital that a culture of research and innovation is embedded within the organisation to take full advantage of state-of-the-art materials, techniques and procedures.

A key element of this culture is an active research programme, developed by and maintained across the whole organisation to support TII's mission to provide high quality transport infrastructure and services, delivering a better quality of life and supporting economic growth. TII is committed to investing in research and development so that its networks are able to meet current and future requirements to the satisfaction of all stakeholders. It must be able to engage designers and contractors, and assess and challenge engineering solutions from a knowledgeable standpoint, understanding both the technical detail and the economic, environmental and social implications.

The benefits of research to TII are as follows:

1. Research provides an effective mechanism for maintaining up-to-date standards and specifications;
2. It enables procedures and systems to be developed for the efficient and cost-effective management of very valuable national assets;
3. It ensures that state-of-art materials and methods are identified and used;
4. It ensures that TII is positioned and looking well ahead at potential advancements and innovations in order to anticipate and exploit technological developments in good time and
5. It facilitates the professional development of TII staff and helps them to stay abreast of current advances in science and technology.

As TII does not have any significant internal research capability, it commissions research services from external parties and organisations as and when required.

In 2007, TII created the Research Strategy to ensure that all research activities were carried out in a structured and coordinated way. This updated document continues to provide the basis for TII's approach to research and the ongoing research activities within TII.

TII develops its research programme annually in line with this strategy and in response to current research needs as identified by individual TII staff members and other stakeholders. The programme closely aligns with TII's Corporate Strategy and reflects changes in priorities and new areas of interest. A key component of each research project or initiative adopted under the programme is an implementation plan to ensure that the dissemination and implementation of the research results in a timely and practical way.

2. Formulation of Research Strategy

2.1. Background

TII's Statement of Strategy 2019-2023 [TII 2019], hereinafter referred to as the Corporate Strategy, describes the vision, mission, values, strategic goals, strategic actions and commitment to performance of TII, in the context of the business environment in which they are carried out. Figure 1 sets out the overarching environment within which the Research Strategy operates.

Figure 1. Basis of TII Corporate Strategy (TII, 2019).

This environment reaffirms TII's Mission to "*provide high quality transport infrastructure and services, delivering a better quality of life and supporting economic growth*" and the Strategic Objectives that flow from this mission which are:

- **Safety:** Improve national road and light rail safety
- **Sustainability:** Apply sustainability principles in developing and operating road and light rail systems
- **People:** Maintain, enhance and harness the capability of the TII team, promoting values of collaboration, innovation, integrity and spirit of public service
- **Consolidation:** Invest in maintenance, renewal and development of road and light rail infrastructure and systems to

	maintain and enhance quality of service and controls and to establish a steady state investment pattern
• **New Infrastructure:**	Lead the cost efficient and effective delivery of national road, light rail and metro elements of the National Development Plan
• **Engagement and Collaboration:**	Continue commitment to effective communication, teamwork and partnership with external parties in pursuit of our mission
• **Service:**	Continue to build collaborative relationships with local authorities, similar organisations, stakeholders and customers to maximise the benefits of the services we provide

These objectives shape the Research Strategy outlined in this document and assist in the identification and delivery of the TII research programme. This approach serves to provide a context that is closely linked to TII's strategic objectives and to develop an appropriate organisational structure adequately resourced to achieve the research objectives. It also helps to identify and take account of any research deficit relating to uniquely Irish conditions. Access to good quality, up-to-date and reliable information is key to effective policy-making, the setting of objectives and the implementation of effective standards and practices.

2.2. Overarching Policy Themes

Using the TII Corporate Strategy a number of broad Policy Themes were identified that assist in the development of the TII Research Strategy. The intent of these themes is to focus on the requirements for better efficiency, sustainability and safety across all spheres of activity of TII and relate to materials, standards and procedures within the context of network construction, maintenance and operation. The policy themes are:

1. ***Materials***
   Development of innovative materials in both new construction and maintenance; Development of a circular economy by optimising the use of natural resources and recycled materials and minimising waste; Improvement of the durability of transport infrastructure.

2. ***Standards and specifications***
   Development and maintenance of up-to-date standards and technical documents for road and light rail infrastructure in line with international best practice and compliant with national and European legislation; Production of new standards and specifications based on new developments in technology; Encourage innovation in design and maintenance activities; Modernisation of TII's operations by incorporating digitalisation into its asset management systems.

3. ***Environment/Sustainable construction***
   Consideration of environmental issues across all of TII's road and light rail operations: Effects of climate change; Reduction of waste; Conservation of natural resources; Alternative energy sources; Reduction of energy consumption; Consideration of energy consumption in the way roads are

planned, built and operated; Implications of connected and autonomous vehicles in the planning and design of road networks; Alternative fuels; Improved durability of roads and bridges.

4. ***Safety***
   Contribution of infrastructure to casualties and fatalities; Improved safety of road and rail users and road workers; Safety and accessibility of vulnerable users; Improved skid resistance; Interaction between road, vehicle and driver; Understanding driver behaviour; Improved structural safety; Development of passive safety; Incident management.

5. ***Value for money***
   Improved global competitiveness; Procurement methods; Risk identification and allocation; Development of better monitoring and inspections methods and procedures as part of a sustainable asset management system; Making better use of existing infrastructure; Targeted maintenance regimes; Improved traffic modelling and planning.

6. **Transportation and land use**
   Traffic growth predictions; Land take-up at grade separated junctions; Influencing driver behaviour; Development of traffic models; Intelligent transport systems; Integrated transport systems; Inter-modal studies.

7. **Heritage**
   Consideration of impact of roads on society; methods for archaeological investigations; other social issues.

These policy themes provide a framework for carrying out all TII's research activities. They provide the basis for the development of the Annual Research Programme, the conclusions of which assist TII staff in providing and operating TII's transport networks in a more efficient and effective way.

2.3. Research Objectives

The main aim of the TII research programme is to enable TII to carry out its mission of "*providing high quality transport infrastructure and services, delivering a better quality of life and supporting economic growth*". Research is one of the key ways that TII informs operational policy and sets standards. Emphasis is on:

- what is likely to be the TII needs,
- ensuring that state-of-the-art techniques are used,
- filling knowledge gaps where they exist,
- implementing the research conclusions and integrating the research outputs in a timely and effective way.

The research programme covers all areas of TII responsibility including planning, design, construction, maintenance and operations. The research commissioned by TII generally focuses on short-term goals driven by current business plan targets. Longer-term, more fundamental research may also be undertaken where appropriate. During

the process of developing research topics, stakeholder engagement is encouraged to help shape of the research programme at an early stage.

TII uses the research programme outputs to:

- provide and/or improve standards, specifications and procedures,
- identify, encourage and facilitate innovation,
- assist in the professional development of staff and enhancement of TII operations.

3. Scope of TII Research

TII staff members who have a need for research contribute by identifying the key priority areas of research. They assist in developing research topics for inclusion in the annual research programme and act as technical advisors for the research projects commissioned. They are also responsible for the implementation of the conclusions and outputs of the research.

3.1. Research commissioned by TII

As TII does not have any in-house research capability, it commissions its research from external research providers. The research projects commissioned by TII mainly fall into three types:

- Academic Research
  TII commissions this type of research as Research Fellowship projects at Doctoral and Post-Doctoral level. It is publicised as the TII Fellowship Programme and its focus is to enable universities and institutes to apply for financial support for PhD and post-doctoral programmes covering subjects that are relevant to the aims of TII. The Call for Proposals is specific to research topics identified by TII, although other topics submitted maybe considered. PhD programmes are normally 3/4 years while post-doctoral programmes can be one to three years in duration.

- Commercial Research
  TII commissions this type of research as shorter-term research projects in response to specific TII business requirements. The projects are commissioned either as part of an annual TII Call for proposals or on an ad-hoc basis throughout the year in response to immediate business requirements. These projects have shorter timelines than academic research and focus on providing solutions to specific problem facing TII staff.

- Collaborative Research
  TII collaborates with a number of national and European organisations to procure jointly-funded research projects. In some cases, TII staff are directly involved in specifying the research requirement – an example of this is the CEDR Transnational Research Programme described in the next section. In other cases, TII simply acts as an industry partner, providing information and/or technical advice and/or funding for a project of interest. Considerable benefit is gained from collaborative research as access to a large project or

specialist expertise can be gained for a relatively small financial contribution. It also provides a very effective means of knowledge transfer and the opportunity to tap into high quality research and leading-edge science and technology. Collaborative research is encouraged as it presents much greater value for money by pooling resources and avoiding duplication.

3.2. CEDR Transnational Research Programme

The Conference of European Directors of Roads (CEDR) has developed a research strategy to promote collaboration between its members to meet their operational needs in running a safe, efficient and sustainable road network. A key element of this strategy is the CEDR Transnational Research Programme (TRP) which operates through a series of annual research calls on topics that address the needs of European road authorities. TII has been heavily involved in the development of the TRP procedures since 2008 when the first programme was launched.

The aim of the TRP is to procure high quality research and provide outputs that all CEDR members can implement to contribute to a safe, sustainable and efficient road network across Europe. CEDR members fund the CEDR TRP on a voluntary basis. Each research programme typically has a 4-year timescale. The overall aims of the TRP are:

- To assist CEDR members in their problems and challenges
- To provide advice on research issues at the request of the NRAs
- To promote collaborative programming and transnational financing and procurement of road research between CEDR member countries
- To promote dissemination of results from the TRP and other research programmes.

TII has participated as a funder in 18 of the 29 programmes organised to date and has served as programme manager for the 13 programmes organised in 2012, 2013 and 2015.

More information on the TRP and the research programme carried out to date can be found at https://www.cedr.eu/research-program/research/.

3.3. Implementation of research

Implementation of the research outputs is a key element of the TII Research Programme and is the main indicator used to measure the success of a research project. To ensuring that the research outputs can be implemented, a well-defined project specification with a clear description of the expected project deliverables is required. All research proposal are expected to include an implementation plan to indicate how the results can be used by TII.

3.3.1. *TII Pilots and Trials system*

TII has developed a Pilots and Trials system to provide a mechanism for proposing, initiating and monitoring innovative materials, products or processes on its networks. The system provides a formalised approach to obtaining approval for carrying out a

pilot or trial and a structured way for the monitoring and recording of the results to maximise learning outcomes. The outcomes of a pilot or trial are used to inform the development of new or revised standards, specifications or technical guidance. The system can be used to provide documentary evidence to facilitate approval of products or processes where CE marking does not apply. A guideline document RE-PTP-07003 (https://www.tiipublications.ie/document/?id=1528) outlines the processes for the management of Pilots and Trials projects using a dedicated website developed by TII.

3.3.2. *Technology Readiness Levels*

TII is developing a series of Technology Readiness Levels (TRL) as a tool to assist in the deployment of innovation on its transport networks. TRLs are a systematic metric to support the assessment of the maturity of a particular technology in advance of deployment. TRLs are used by TII as a mechanism for:

- Ensuring transparency in the deployment of innovations;
- Ensuring efficiency by streamlining market engagement; and
- Identifying and managing the risk to TII in deploying innovative technologies on its networks.

The TRL system and the framework for its use is currently being developed as part of an overall innovation strategy for TII: the associated documents are due to be published by the end of 2019.

4. Management of Research at TII

4.1. Responsibilities

The Research Programme is under the direct responsibility of the Research and Standards Section. This includes:

- On-going development of the TII Research Strategy
- Identify and prioritise topics for inclusion in annual research programme (with TII Specialists and stakeholders)
- Manage the performance and delivery of research projects with technical advice from TII Specialists
- Develop relationship with key stakeholders
- Develop relationship with research providers (universities, consultants, *etc.*)
- Communicate research activities to the TII Board and to TII staff and key stakeholders
- Maintain contact with EU and national research initiatives
- Collaborate with international organisations such as CEDR.

4.1.1. *Research Mentors*

A clear linkage is required between TII research projects and those responsible for particular areas of specialisation within TII. This ensures that the TII research is integrated into TII core activities and that the research outputs are effectively

disseminated into standards, specifications and practices. An internal network of specialist Research Mentors has been set up across TII with responsibility for:

- Maintaining familiarity with worldwide trends in research in their area of specialisation
- Maintaining awareness of recent research publications in published journals, at conferences, etc.
- Identifying research priorities within their area of responsibility
- Collaborating with the Research and Standards Section with respect to research projects, including review and commentary on draft reports and assessment of service provider performance
- Ensuring the dissemination and effective implementation of research outputs through TII's publications.

The areas of specialisation are:

- TII Policy
- Bridge management and maintenance
- Structures and Eurocodes
- Environment
- TII Standards
- Pavement Technology
- Asset Management
- Traffic Transport Modelling
- Planning and Land Use
- Route lighting
- Archaeology
- Contract documents
- Project Management and Works requirements
- Road Safety
- ITS
- Road Signs and Lines
- Network Operations
- Geotechnics
- Tolling Operations
- Geographical Information Systems
- Rail Safety
- Light Rail: Standards
- Light Rail: Track
- Light Rail: Rolling stock
- Power and Systems

This list covers the key areas of current interest to TII. It will be supplemented to meet demands and additional Mentors may be added if appropriate.

4.2. Research Management

TII manages the Research commissioned using the following principles:

- Well-organised targeted annual Research Programme with a clear statement of expected outputs and benefits;
- Identification and selection process to ensure that the research projects align with TII's Corporate Strategy;
- Individual projects prioritised based on current needs and available funds;
- Research projects procured on a competitive basis in conjunction with the TII Procurement Sections to ensure transparency and value for money;
- Research to focus on solutions to short-term goals driven by current business needs but will not neglect fundamental research aimed at longer-term benefits;
- Individual research projects incorporate a dissemination plan to ensure that the conclusions and outputs are relevant to TII and implemented in an effective and timely fashion.

The formulation of the annual Research Programme adopts a Value Management process. This is a style of management dedicated to motivating people, developing skills and promoting synergies and innovation with the aim of maximising overall performance.

The first stage of the process is to identify general research themes and topics by TII staff with input and advice from external stakeholders where appropriate. The themes and topics are then evaluated against the policy themes and strategic objectives of TII as outlined in this document. Following this evaluation, topics are selected for possible inclusion in the research programme. To ensure that the selection is carried out equitably and represent both the needs of TII and value for money, an Expert Group will oversee the process. This Expert Group consists of 4/5 senior TII staff members with experience in research projects and an in-depth knowledge of the operations of TII. A project specification is prepared for the selected topics, giving the background to the problem being investigated, outlining the objectives of the project, and presenting what TII expects to gain from the project. This helps to focus the project on the high-level goals of TII as outlined in the Corporate Strategy and assists in determining how the research will be commissioned.

Topics are prioritised and ranked on the basis of current needs and the funds available. The higher-ranked projects are selected and approval sought for including them in the annual Research Programme. A preliminary Research Programme is devised prior to each financial year in order to define budgets and timescales for new and ongoing projects.

4.3. Procurement

TII commissions Research projects based on the principles of openness, transparency, fairness and competitiveness whenever possible. Appropriate use is made of TII's corporate procurement processes. Where appropriate, a different procurement process may adopted in which case Director approval is sought.

4.4. Budget

TII maintains a multi-annual research budget to fund the annual research programme in line with the framework outlined in this document. The research programme is formulated each year to provide for short-term business oriented projects in response to specific needs as well as longer-term fundamental research where appropriate. Additional areas of research needs may become apparent from time to time and new research areas may be added to the programme as the need arises. The research budget is managed by the TII Research and Standards Section with technical advice and management provided by experts across all Divisions within TII.

The primary focus of the research is to provide support for the development of standards, specification and technical guidelines.

4.5. Communication

The communication system that TII has developed internally to facilitate the exchange of information relating to research activities is based on the network of research mentors described above. The purpose is to collate research needs and ideas, evaluate proposals, prioritise the projects, provide effective technical management, and disseminate results of the Research Programme.

The network of Mentors ensures both a top-down and bottom-up approach. The top-down approach allows potential projects to develop from the Corporate Strategic Goals. Using the bottom-up approach, the technical specialists of TII identify research projects to solve particular problems or assist in carrying out processes in a more effective way. In both cases, the high-level goals underpin and justify the research activities.

Communication is necessary to inform all stakeholders (including members of the public, universities, institutes, consultants, contractors and other interested bodies) of the TII Research Strategy and the evidence and reasoning that underpin it. Use is made of the TII website to publicise the Research Programme and to make the research results available. More specifically the promotion of the research outputs is achieved though journal publications, presentations at seminars and conferences.

Communication of the research activities is co-ordinated by the Research and Standards Section with assistance from the Research Mentors in the different technical areas. Use is made of the TII intranet to facilitate the flow of information throughout TII. Updates are prepared every six months and presented to the TII Board for comments and approval. Subsequently these updates are disseminated to TII staff through the TII Newsboard and other internal web-based information systems.

4.6. Performance Indicators

It is difficult to gauge the quality and success of research as it is often many years before the research results are fully implemented through standards and the benefits realised. High quality research can only be ensured if a high calibre research team is employed. Therefore, the selection process emphasises the track record of the research team and the relevance of the research outputs to TII’s goals. Value for

money is ensured though competition and transparency in the evaluation and selection process.

Management of each individual project is the responsibility of the Project Mentor with assistance from the Research and Standards Section. Progress of the Research Programme is monitored by the TII Audit Committee: performance is based on the following indicators:

- Number of projects commissioned
- Number of projects delivered
- Number of reports and papers published
- Quality of research and research outputs
- Communication of Research outputs
- Implementation of research outputs

Since the research programme was formalised in 2007 the portfolio of research projects has mirrored the objectives and challenges both internal and external to the organisation. The projects put in place have covered a number of technical areas. The current research projects are listed in Appendix A. More details of the individual projects in terms of background, benefits to TII and outputs are available in the profiles available on-line in the research pages of the TII website at https://www.tii.ie/technical-services/research/.

5. Collaboration

Effective engagement and collaboration with all stakeholders is recognised in the TII Corporate Strategy as a means of achieving its corporate objectives. Methods of collaboration within TII include:

- Contact with National bodies in Ireland such as SFI (Science Foundation Ireland), IRC (Irish Research Council), RSA (Road Safety Authority) and NSAI (National standards Association of Ireland);
- Involvement in European working groups and committees such as CEDR (Conference of European Directors of Roads), FEHRL (Federation of European National Highway Research Laboratories), ERTRAC (European Road Transport Research Advisory Council) and PIARC (World Road Association);
- Participation in EU funded research (eg, Horizon2020).
- Participation in jointly funded research projects such as the CEDR Transnational Research Programme.

TII keeps close contact with these organisations and maintains corporate membership of a number of them, including CEDR, FEHRL, ERTRAC and PIARC, to ensure that it is aware of international developments in road transport and of the opportunities for participating in collaboration research projects. A network of contacts at both national and international level is maintained to ensure that TII is aware of the opportunities provided by such collaboration projects. The advantages of collaboration include:

- Application of international best practice
- Reduced duplication of research

- Improved quality of research
- Increased competition and shorter timescales
- Wider choice of suppliers
- Exchange of knowledge with European partners
- Better value for money.

5.1. CEDR

TII is a member of the Conference of European Directors of Roads (CEDR), a platform for cooperation between the European national road administrations which currently has 29 members. CEDR is administered by a Governing Board, membership of which consists of the national road directors (or equivalent) from CEDR members, an Executive Board and a number of Working Groups focusing on particular technical areas: see https://www.cedr.eu/ for more information.

Aside from it involvement with the CEDR TRP (see section 3.2), TII collaborates with CEDR in a number of other areas. The TII CEO and Director of Network operations serve on the CEDR Governing Board and Executive Board respectively and TII staff also participate in CEDR Working Groups Innovation, Safety and Environment.

5.2. ERTRAC

The European Road Transport Research Advisory Council (ERTRAC) is a European Technology Platform the members of which include industry, users, EU and national bodies, and research providers. It was established to mobilise all stakeholders, develop a shared vision, and ensure timely, co-ordinated and efficient application of research resources to meet the continuing challenges of road transport and European competitiveness. TII became a member of the ERTRAC Plenary group in 2008. The ERTRAC website is www.ertrac.org.

5.3. FEHRL

The Forum of European National Highway Research Laboratories (FEHRL) is an association of national institutes involved in transport and road engineering research. It was formed in 1989 and has a permanent Secretariat based in Brussels. It is governed by a General Assembly made up of the Directors of each of the national institutes. Currently it provides a coordinated structure for the interests of the twenty-nine national research and technical centres from the member states in the European Union, the EFTA countries and the rest of Europe.

The purpose of FEHRL is to encourage collaborative research between European laboratories and institutes in the field of highway infrastructure, leading to the provision of relevant knowledge and advice to governments, the European Commission, the

road industry and road users. More details of its activities are available on its website www.fehrl.org. As Ireland does not have a national research institute and TII was invited to become a member of FEHRL so that the interests of Ireland were represented. TII considers this membership as appropriate as it is important that TII's research programme can take on board what is happening internationally. To encourage wider Irish involvement in EU-funded projects, an Irish FEHRL Group was established. This currently includes UCD and TCD, as these universities have historically had a significant involvement in EU projects. There is potential for this Group to grow and to include other organisations as required.

The benefits to TII are:

Through FEHRL TII can influence EU policy on research themes

- TII can encourage Irish universities and organisations to be involved in EU-funded research projects
- TII can influence the direction of research projects through the direct involvement of FEHRL in these projects; this will ensure that Irish interests are taken into account
- TII can get access to the research results and can be involved in the dissemination process.

5.4. Transport Research Arena

Transport Research Arena (TRA) is a forum to bring together the various stakeholders with an interest in transport research, including transport authorities, consultants, contractors, car manufacturers, fuel producers and researchers. TRA provides an opportunity for all parties involved to meet and to present, exchange and disseminate the results obtained in research and development and is strongly supported by CEDR, ERTRAC and European Commission. The TRA theme is "greener, smarter and safer".

The first TRA conferences were held biannually and Ireland is under consideration to host the 2024 Conference in Dublin. The next conference will be in Helsinki in April 2020. TII is an active participant in TRA. See website https://www.cedr.eu/research-program/transport-research-arena/.

5.5. Bridge Owners Forum

The membership of the Bridge Owners Forum (BOF) consists of organisations responsible for managing and maintaining the national bridge infrastructure. It was originally confined to the major bridge owners in the UK (Highways England, London Underground, Network Rail, British Waterways, National Assembly for Wales, Transport Scotland, Department of Regional Development for Northern Ireland, *etc*.) and TII was invited to participate because of its common interest in bridge engineering problems and solutions. The BOF Forum meets three times a year to discuss and promote co-operation, collaboration and partnership amongst bridge owners. One of the purposes of the BOF is to identify research needs and commissions research

projects relating to bridges. Membership provides TII with access to the conclusions of this research. See www.bridgeforum.org for more details.

5.6. World Road Association

TII is a member of the World Road Association (PIARC). PIARC, a non-political, non-profit making association established in 1909, brings together the road administrations of over 100 governments and has members - individuals, companies, authorities and organisations - in over 140 countries. It was granted consultative status to the Economic and Social Council of United Nations in 1970. The PIARC website, www.piarc.org, provides details of all of its activities and links to the national PIARC associations.

5.7. Construction Industry Research and Information Association

The Construction Industry Research and Information Association (CIRIA) is a neutral, independent and not-for-profit body that links organisations with common interests and facilitates a range of collaborative activities that help improve the industry. The benefits of membership are that it provides access to all CIRA services and a cost effective research, information and training resource that keeps organisations up-to-date with emerging policies, requirements, developments and guidance. https://www.ciria.org/.

5.8. Irish Centre for Research in Applied Geosciences

The Irish Centre for Research in Applied Geosciences (iCRAG) is Ireland's national geoscience research centre supported by Science Foundation Ireland, the European Regional Development Fund, Geological Survey Ireland and industry partners. The iCRAG research programme was designed in response to the thematic area "Geoscience underpinning sustainable economic development", in the SFI call document. In recognition of the broad nature of this theme, the research programme therefore spans the spectrum of application areas linked to the geosciences, including raw materials, marine, groundwater and hydrocarbons. The programme consists of five cohesive topics or 'spokes', built around four enabling, mainly technology- and equipment-based, projects within the iCRAG Platform. The spokes, which comprise smaller scale into Targeted Projects, were selected strategically to build on demonstrable islands of scientific excellence and to leverage the maximum economic impact for Ireland. TII is an industry partner of iCRAG and has contributed funding to supporting the centre. https://www.icrag-centre.org/industry/current-icrag-partners/#d.en.375318

5.9. Geological Survey Ireland

Founded in 1845, the Geological Survey Ireland (GSI) is Ireland's public earth science knowledge centre and is a division of the Department of Communications, Climate Action and Environment. In addition, it acts as a project partner in interpreting data and developing

models and viewers to allow people to understand underground. It deals with a diverse array of topics including bedrock, groundwater, seabed mapping, natural disasters, and public health risks. TII has signed a Memorandum of Understanding with GSI to promote cooperation in research by working together on activities where there is alignment of strategy and objectives.

5.10. UK Tram

TII is a corporate member of UK Tram which brings together all organisations with an interest in the future development of light rail in the UK and Ireland, ensuring it remains a viable, cost-effective and consistently improving transport option: for more information see https://uktram.com/about-us/. The membership consists of organisations from all sides of the industry including network operators, infrastructure and rolling stock maintenance organisations, passenger transport executives, local transport authorities, local government, concessionaires, manufacturers and equipment suppliers, industry advisors and expert consultants.

UK Tram takes a leading role in both promoting the sector and representing its interests in terms of technical standards, safety and legislative changes. It co-ordinates a range of professional sector forums dedicated to promoting best practice, stretching performance standards, transferring knowledge and expertise and driving innovation and technical excellence.

5.11. Other organisations

TII keeps close contact with a number other national and international bodies that have an interest in promoting the technologies relating to road infrastructure and operations. This includes Engineers Ireland, Science Foundation Ireland (SFI), Irish Research Council for Science (IRC), the Institution of Civil Engineers (ICE) and the Institution of Structural Engineers (IStructE) in the UK.

TII is also involved, directly or through CEDR, with other research bodies including:

- ECTP: European Construction Technology Platform
- ITF: International Transport Forum
- OECD: Organisation for Economic Co-operation and Development
- JTRC: Joint ECMT/OECD Transport Research Centre
- FERSI: Forum of European Road Safety Research Institutes
- ECTRI: European Conference of Transport Research Institutes
- IBTTA: International Bridge, Tunnel & Turnpike Association

The list of roads related research topics being undertaken across Europe by these and other EU organisations is very extensive. It is in TII's interest, as well as those of the country as a whole, to maintain contact with these groups, this ensures that the Irish perspective is considered in the various research initiatives and TII has the tools to build and operate the road network safely and reliably.

6. Conclusion

This document presents the principles behind the TII Research Strategy and provides the basis for the ongoing research activities within TII. TII's approach to research can be summarised as follows:

- Ongoing Research Strategy developed in response to business needs
- Well-organised, well-targeted annual Research Programme
- Research topics identified by TII staff and stakeholders
- Value management process to ensure that the topics are aligned to TII's high-level objectives
- Research procured by competitive process to ensure transparency and value for money
- Clear statement of the benefits of carrying out the research and what TII expects to gain from the research
- Dissemination plan to ensure results are implemented in a timely and effective way.

7. References

TII Publications

TII (2019). Statement of Strategy 2019-23. Transport Infrastructure Ireland [Downloadable at https://www.tii.ie/tii-library/policies/statement-of-strategy-2019-2023/TII-Statement-of-Strategy_Approved_May_2019.pdf].

TII Publication RE-PTP-07003 *Pilot and Trial Project Management Guidelines*, February 2017. [Downloadable at http://www.tiipublications.ie/library/RE-PTP-07003-02.pdf].

TII Publication GE-POL-00000 *Guidelines for the Implementation of Innovation TII*, to be published

Irish Government Publications

DDTaS: Department of Transport, Tourism and Sport

- Statement of Strategy 2016-2019. [Downloadable at http://www.dttas.ie/sites/default/files/content/corporate/english/general/statement-strategy-2016-2019/statement-strategy-english-version-2016-2019.pdf].
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- Statement of Strategy 2018-2022. [Downloadable at https://www.nationaltransport.ie/wp-

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- Transport Strategy for the Greater Dublin Area 2016-2035. [Downloadable at https://www.nationaltransport.ie/planning-policy/greater-dublin-areatransport-strategy-2016-2035/].

National Planning Policy Framework
- Investing in Our Transport Future – Strategic Investment Framework for Land Transport (DTTaS). [Downloadable at http://www.dttas.ie/sites/default/files/content/corporate/english/general/sfilt-investing-our-transport-future/investing-our-transport-future.pdf].
- Project Ireland 2040 National Planning Framework. [Downloadable at http://npf.ie/].
- National Mitigation Plan July 2017. [Downloadable at https://www.dccae.gov.ie/documents/National%20Mitigation%20Plan%202017.pdf].

National Legislative Framework
- Road Acts 1993-2015. [Downloadable at http://www.irishstatutebook.ie/].
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European Publications

Highways Agency (2006). *The Highways Agency unit-level evidence and research strategy.* Highways Agency, UK. [Downloadable at http://www.ha-research.gov.uk/]. Check link

CEDR websites

Conference of European Directors of Roads (CEDR):
https://www.cedr.eu/

ERA-NET ROAD:
https://www.cedr.eu/strategic-plan-tasks/research/era-net-road/.

CEDR Transnational Research Programme:
https://www.cedr.eu/research-program/research/.

Other

European Road Transport Research Advisory Council (ERTRAC):
www.ertrac.org

Forum of European National Highway Research Laboratories (FEHRL):
www.fehrl.org

Transport Research Arena (TRA):
https://www.cedr.eu/research-program/transport-research-arena/

European Construction Technology Platform (ECTP):
http://www.ectp.org/

Organisation for Economic Co-operation and Development (OECD):
https://www.oecd.org/

International Transport Forum (ITF):
https://www.itf-oecd.org/

Joint OECD/ITF Transport Research Centre (JTRC):
https://trimis.ec.europa.eu/programme/joint-oecditf-transport-research-centre-network

Forum of European Road Safety Research Institutes (FERSI):
https://fersi.org/

European Conference of Transport Research Institutes (ECTRI):
https://www.ectri.org/about-ectri/

Bridge Owners Forum (BFO):
www.bridgeforum.org

World Road Association (PIARC):
www.piarc.org

Engineers Ireland (EI):
http://www.engineersireland.ie/home.aspx

Science Foundation Ireland (SFI):
http://www.sfi.ie/

Irish Research Council:
http://research.ie/

Institution of Civil Engineers (ICE):
https://www.ice.org.uk/

Institution of Structural Engineers (IStructE) in the UK:
https://www.istructe.org/

International Bridge, Tunnel & Turnpike Association (IBTTA):
https://www.ibtta.org/

Appendix A: Current Projects

The current research projects in the TII Research Programme, as at 1 September 2019 are listed in the following table. More details of the individual projects in terms of background, benefits to TII and outputs are available in the profiles available on-line as indicated below.

Table A.1: List of Current TII Research Projects

Programme	Project title	Research provider	Link to project details
CEDR Call 2013[1] Ageing infrastructure	X-ARA RE-GEN HI-SPEQ	AIT (AU) RODIS (IE) TRL (UK)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2013/call-2013-ageing-infrastructure/
CEDR Call 2013[1] Traffic Management	PRIMA UNIETD METHOD	AIT (AU) Motts (UK) TRL (UK)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2013/call-2013-traffic-management/
CEDR Call 2013[1] Safety	EUSIGHT PRACT ESRET	ARCADIS (NL) UniFi (IT) TRL (UK)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2013/call-2013-safety/
CEDR Call 2013[1] Energy efficiency	EDGAR FUNDBITS CONSISTEND REETS	BRRC (BE) CTU (CZ) TNO (NL) TRL (UK)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2013/call-2013-energy-efficiency/
CEDR Call 2013[1] Roads and Wildlife	SAFEROAD HARMONY SAFEBATPATHS ECOROAD ECOGUIDES	ALTERRA (NL) RODIS (IE) AU-BIOS (DK) RODIS (IE) Minuartia (ES)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2013/call-2013-roads-wildlife/
TII Research Programme	Friction After Polishing: A probabilistic framework for improved roads management	UCD (IE)	https://www.tii.ie/technical-services/research/
TII Research Programme	Determine the impact of national roads on Barn Owl populations and to inform the development of appropriate mitigation measures	Birdwatch Ireland (IE)	https://www.tii.ie/technical-services/research/
CEDR Call 2015[1] Climate Change: From Desk to Roads	DETECTOR WATCH MODBEAR	TRL (UK) DELTARES (NL) ARUP (IE)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2015/call-2015-climate-change-desk-road/
CEDR Call 2015[1] User Needs in a Multimodal Context	STTRIDE ISAAC	TRL (UK) SWOV (NL)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2015/call-2015-user-needs-multimodal-context/
CEDR Call 2015[1] Freight and Logistics in a Multimodal Context	FALCON FLUXNET	HAN (NL) MUST (DE)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2015/call-2015-freight-logistics-multimodal-context/
CEDR Call 2015 Building Information Modelling	INTERLINK	TNO (NL)	https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2015/call-2015-asset-information-using-bim/
CEDR Call 2016[1] Biodiversity	CONTROLINROADS EPIC ROADS	AIT (AU) NIBIO (NO)	https://www.cedr.eu/strategic-plan-tasks/research/call-2016/call-2016-biodiversity/
CEDR Call 2016[1] Water quality	PROPER LUNT MICROPROOF	Aalborg Uni (DK) Tauw (NL) TNO (NL)	https://www.cedr.eu/strategic-plan-tasks/research/call-2016/call-2016-water-quality/

Table A.1: List of Current TII Research Projects (continued)

Programme	Project title	Research provider	Link to project details
CEDR Call 2016[1] Safety	PROGRESS IRIS ADVERTS SANA 4-U	SWOV (NL) LUND () SWOV (NL) VTI (SE)	https://www.cedr.eu/strategic-plan-tasks/research/call-2016/call-2016-safety/
TII Research Programme	HGV Pavement wear analysis effects	RODIS (IE)	https://www.tii.ie/technical-services/research/
TII Research Programme	Delivering green infrastructure along linear assets	CIRIA (UK)	https://www.tii.ie/technical-services/research/
TII Research Programme	TRL Safety barrier terminal and transition approval list	TRL (UK)	https://www.tii.ie/technical-services/research/
CEDR Call 2017[1] New Materials and Techniques	PavementLCM CRAB for OERE FIBRA	Nottingham Uni (UK) Kassal Uni (DE) Cantrabria (ES)	https://www.cedr.eu/strategic-plan-tasks/research/call-2017/call-2017-new-material-and-techniques/
CEDR Call 2017[1] Automation	MANTRA DIRIZON STAPLE	Traficon (FI) TNO (NL) FEHRL (BE)	https://www.cedr.eu/strategic-plan-tasks/research/call-2017/call-2017-automation/
CEDR Call 2017[1] Collaborative Planning and Spatial Development	SPINTRENDS SPINDESIGN SPADE	AIT (AT) Stadebau (DE) Panteia (NL)	https://www.cedr.eu/strategic-plan-tasks/research/call-2017/call-2017-collaborative-planning-of-infrastructure-networks-and-spatial-development/
TII Research Programme	Structural health monitoring (SHM) for civil infrastructure	CIRIA (UK)	https://www.tii.ie/technical-services/research/
TII Research Programme	ITS Ireland CAV Bursary	ITS Ireland (IE)	https://www.tii.ie/technical-services/research/
CEDR Call 2018[1] Building Information Modelling	AMSFREE CODEC	AUS KA (DE) TRL (UK)	TBA
CEDR Call 2018[1] Noise and Nuisance	STEER SOPRANOISE FAMOS	Gromilund & Parthers AG (CH) Accoustic Technologies (BE) Force Technology (DK)	TBA
TII Research Programme	Monitoring and modelling of mechanical behaviour of Dublin Tunnel (iCRAG - Geohazard		https://www.tii.ie/technical-services/research/
TII Research Programme	Non-Destructive Testing (NDT) for civil structures	CIRIA (UK)	https://www.tii.ie/technical-services/research/
TII Research Programme	Smart Transport Ireland using Deep learning and AI		https://www.tii.ie/technical-services/research/

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