



# Research and innovation in construction: Collaboration in the last quarter century

*Investigación e innovación en construcción: colaboración en los últimos 25 años*

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## Abstract

This article summarises the developments in construction R&I since the nineteen nineties in the context of collaboration between private companies, research institutes and universities. Such cooperation has adopted the form of both continuous participation in R&I fora and partnering in specific research projects.

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## Resumen

Este artículo resume algunos aspectos de la I+D+i en el sector de la construcción, acontecidos desde los años noventa del siglo pasado, en relación con la colaboración entre las empresas y los organismos de investigación, a través tanto de la participación continua en foros en los que se aborda la I+D+i como de actuaciones puntuales en proyectos I+D+i en cooperación.

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*Palabras clave:* Innovación en construcción; Plataformas tecnológicas

## 1. Introduction

The need to heighten competitiveness in productive industries has called for new forms of collaboration among companies, research bodies (universities and both research and technological institutes) and the end users of each industry's products. The construction industry, aware of that need, has been participating since the nineteen nineties in research, development and innovation initiatives. This article discusses some of the R&I-related initiatives undertaken in construction since the last decade of the twentieth century and the first two of the twenty-first.

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## 2. Last decade of the twentieth century

Spain's accession to the European Union opened up new prospects for collaboration in R&I, with the country's participation in Framework Programmes in general and in Brite-Euram for construction-related proposals in particular. These projects were implemented by consortia involving six to ten European partners.

By way of example, during those 10 years Spain participated in Brite Euram projects on optimisation of aggregate crushing, the development of porous concrete pavements and the design of models to simulate the behaviour of concrete structures subject to decay induced by reinforcement corrosion, freeze–thaw processes or the alkali–aggregate reaction. Those projects, headed respectively by French, Dutch and English partners, were highly

rewarding not only for the technical results but also for the introduction of new forms of partnering between companies and research bodies from different European countries. That collaboration prompted the establishment of relations that transcended technological developments.

Nationally, the experience acquired in Eureka R&I projects implemented with Spanish support paved the way for initiatives of interest. By way of example, collaboration among Spanish CSIC<sup>1</sup> (IETcc<sup>2</sup> and Cenim<sup>3</sup>) and Swedish (CBI<sup>4</sup>) research institutes and Geocisa ([www.geocisa.com](http://www.geocisa.com)), a Spanish company, led to the development of devices for the non-destructive measurement of reinforcement corrosion in concrete structures. That project launched a whole new generation of devices presently used the world over.

In the same time frame, a group of European construction companies and material manufacturers created ENCORD ([www.encord.org](http://www.encord.org)) to explore R&I partnering formulas from an industrial perspective. The aim was to further participation in European projects and share experiences, among others, around the difficulties involved in including project results in production streams (innovation). ENCORD later joined a broader network going by the name of Eccredi ([www.eccredi.org](http://www.eccredi.org)), in which companies, professional associations, research institutes, universities and other stakeholders participated, primarily to unify strategies and liaise between construction industry R&I and the European Commission [1,2].

Participation in such fora generated new possibilities for collaboration and broke the ground for lobbying the European Commission to include construction industry priorities in calls for research and development projects. Briefly, the decade ushered in countless new R&I opportunities in the construction industry, although Spanish participation in European initiatives was not overly intense.

### 3. The first decade of the twenty-first century

The significant advances in R&I witnessed in this decade in both Europe and Spain were not lost on the construction industry.

Europe-wide, so-called integrated R&I projects were launched which, while similar to those prevailing in the preceding period, envisaged consortia with more members (20–30) and much larger budgets [2]. Such projects included initiatives in modular buildings and new approaches to city design with some of their services positioned underground, new developments in soil surveying and more efficient underground construction.

Significant change also took place in Spain with the furtherance of so-called singular strategic projects (Spanish initials, PSE) and CENIT<sup>5</sup> projects involving large consortia and budgets. The construction industry initiatives implemented under the former were reminiscent of the European integrated

projects undertaken in similar domains. The latter conducted studies on sustainable construction and the construction and operation of motorways, among others.

A European Commission analysis of the experience acquired with R&I projects found their impact on European industry competitiveness to be insufficient. In 2004 the Commission consequently launched its Technological Platform initiative. Such Platforms can be used to define a given industry's vision of the future and the concomitant R&I priorities to be addressed by 2020–2030, as jointly established by companies, research institutes, universities, end users and other stakeholders. That exercise gave rise to so-called Strategic Research Agendas.

The construction industry responded enthusiastically and in the summer of 2004 launched the European Construction Technology Platform, ECTP ([www.ectp.org](http://www.ectp.org)), headed by a group of companies that formed part of the aforementioned ENCORD group. Spain played an active role through its construction majors and both research and technology institutes. ECTP defined its 2020 Vision and a number of versions of its Strategic Research Agenda. Some of its R&I priorities were included by the European Commission in calls announced by the Directorates General of Research and Innovation and Transport.

ECTP launched the E2B Energy Efficient Buildings initiative to address high energy consumption in buildings. The initiative was subsequently adopted by the European Commission as one of the main pillars, along with the green car and the factory of the future, of its 2008 Recovery Plan [3]. In addition, the Ad hoc Industrial Group created by the Commission and industry representatives defined a series of roadmaps that established many of the area priorities listed under the FP7 and H2020 programmes. ECTP also put forward the ReFINE (Research for Future Infrastructures in Europe) initiative to drive R&I in transport infrastructures, in light of the lack of Framework Programme calls specifically addressing these issues [2].

The 'local' nature of the construction market persuaded the industry that the European Construction Platform initiative should be replicated in member countries. National platforms were consequently established in a number of European States. In light of the prominence of Spanish organisations in ECTP, the Spanish Construction Technology Platform, PTEC ([www.plataformaptec.es](http://www.plataformaptec.es)), was one of the first to be launched after the summer of 2004. Ever since, it has played a key role in furthering construction industry innovation [4].

In the early years, like the European scale ECTP, the Spanish initiative defined its Vision document and the Strategic Research Agenda. It was within PTEC where the scope of the major singular strategic and CENIT projects envisaged in those years was defined and where the large consortia required to undertake them were formed.

A significant initiative undertaken in that first decade by the European Commission identified so-called lead markets, acknowledging sustainable construction as one. The initiative aimed to identify the obstacles to innovation in the markets earmarked and spur policies between the European Union and Member States that would favour the application of the new technologies available in such markets. The objective was to

<sup>1</sup> Spain's National Research Council.

<sup>2</sup> Eduardo Torroja Institute for Construction Science.

<sup>3</sup> National Centre for Metallurgical Research.

<sup>4</sup> Technical Research Institute.

<sup>5</sup> Consorcios Estratégicos Nacionales en Investigación Técnica [strategic national consortia for technology research].

generate strategies that would help remove the hindrances to innovation.

#### 4. The second decade of the twenty-first century

The present period has been heavily impacted by the financial crisis begun in the latter years of its predecessor, which has compromised the continuation of many of the R&I initiatives undertaken previously.

##### 4.1. Activities in Spain

The construction industry has sponsored a number of R&I projects, most prominently the ones submitted to the CIEN<sup>6</sup> programme on subjects such as 3D printing in buildings, maintenance and repair of road and motorway pavement and improvements in tunnelling procedures.

The Spanish Construction Technology Platform has played an important role in furthering R&I in construction. In early 2013, it defined its new strategy based on three main pillars:

- Internationalising R&I among PTEC members
- Furthering innovation
- Enhancing the construction industry's image through R&I

Five PTEC working groups have been active in this period: two are strategic (R&I internationalisation and furtherance of innovation) and three theme-based (city of the future, transport infrastructures and construction processes). In addition, the platform has organised:

- Ten workshops to pool PTEC member experience in several areas and initiatives (protection for innovation; technical approvals for innovative solutions and their acceptance by third parties, including insurers; SMEs and construction innovation; the digital transformation: construction 4.0)
- Fourteen open fora that aim to further contact between PTEC members and other organisations in Spain to fuel construction innovation initiatives. Meetings on subjects such as innovation in the urban environment, transport infrastructures and construction processes were held in Barcelona, Bilbao, Madrid, Málaga, Santander, Seville, Valencia, Valladolid and Zaragoza. By way of example, one on innovation in construction processes was held at Seville in November 2016 [5] and another on innovation in transport infrastructures at Madrid in November 2017 [6].

In Spain in this period other efforts have focused primarily on furthering innovation in construction, an area generously addressed in the Spanish platform's [7] working programme, including items such as:

- Public procurement and innovation
- Protection of innovation
- Innovation culture in the private and public sectors
- Technical approvals for innovative solutions and their acceptance by third parties, including insurers

In connection with the first item, the construction industry deems that innovation should be client-driven, for the client is often a national, regional or municipal government. Here the recent transposition of European directives on public procurement should play an important role in according innovation more weight in such contracts. Although the Public Procurement of Innovation PPI [8], launched towards the end of the preceding decade, has failed to make a sufficient impact on the construction industry, initiatives using this tool will hopefully be possible with the waning of the crisis. Innovation in public procurement was amply debated at the Eighth PTEC Forum held at IETcc headquarters, Madrid, in 2008 [9], with authorities representing the Ministries of the Economy and Competitiveness, Finance and Public Works, as well as the regional governments of Valencia and Extremadura.

With respect to the second item, PTEC has sponsored initiatives in conjunction with the Spanish Patent and Trademarks Office (Spanish initials OEPM), a PTEC collaborating member. Progress in this area has been hindered, however, by the existing provisions on protection for technological developments and the certain provisions of public tenders that in practice rule out any mention of patented solutions in tenderers' quotes.

The want of innovation culture in companies and clients is an issue to be addressed in the future, although PTEC has organised a few events on the subject. All the stakeholders in construction must be lured out of their comfort zone and encouraged to accept innovation whenever the risk lies within reasonable limits.

One of the main obstacles encountered in this regard is related to technical approvals for innovative solutions acceptable to third parties, including insurers. This is the core subject of one of the PTEC working groups [7], which has drafted a paper identifying the shortcomings in the ad hoc assessment of the many innovations introduced on site and in engineering design.

Lastly, large corporations and construction holding companies have shown an interest in hosting startups' initiatives as a way to expedite corporate change and develop new construction materials, components and processes.

##### 4.2. International cooperation

The European Construction Technology Platform, ECTP ([www.ectp.org](http://www.ectp.org)), embarked on a new stage in this period, merging with the Energy Efficient Buildings initiative to constitute a single association structured around five commissions:

- Active ageing and design
- Energy efficient buildings
- Heritage and regeneration
- Infrastructures and mobility
- Materials and sustainability

<sup>6</sup> Programme that finances large R&D projects involving the effective collaboration of two or more business groups.

PTEC engages in ongoing communication with ECTP and networks with national construction platforms in Austria, Belgium, Cyprus, Denmark, France, Germany, Greece, Hungary, Italy, Lithuania, Norway, Poland, Portugal, Slovenia, Spain, Sweden and UK. This network, coordinated by PTEC, aims to further collaboration among the countries involved and ECTP in innovating the European construction industry.

In 2014–2017 PTEC also participated in REFINET (<http://infrastructure.ectp.org/csa-refinet>), a coordination support action (CSA) that fosters R&I in transport infrastructures.

In this decade, the European Commission has sponsored initiatives for collaboration between European countries and the United States. The most prominent include:

- EraNet Plus Infravation, which financed nine R&I projects for roads with European and US partners under a European Conference of Directors General of Roads (CEDR) (<http://www.cedr.eu/>) initiative
- Twinning projects, which identifies European projects for which similar projects are underway in the US, leading to contacts and meetings to further collaboration among the consortia involved
- Symposia in which European and US organisations participate to discuss R&I-related subjects, including analysis of the application of research results to transport infrastructures on the two continents [10].

## 5. Final remarks

The vast changes taking place today will affect the construction industry and require new strategies to drive innovation in areas such as:

- The environment and compliance with circular economy criteria and demands to intensify recycling in buildings and infrastructures, both during and after construction
- Global warming, a reality that affects both transport infrastructures (flood-prone and coastal areas) and buildings and their energy efficiency
- The digital transformation to so-called Construction 4.0 with revolutionary change in the construction industry that will call for innovative policies
- The integration of initiatives, such as those originating in startups, in large companies' strategies
- The Public Procurement of Innovation PPI, an excellent tool to demand innovation of the government buyer, but scantily used in the construction industry. Industry reactivation (presently visible in building but still awaited in civil construction), in conjunction with the transposition of European directive-mediated legislation on public procurement, is expected to drive innovation in construction.

- The launch of a new European R&I Framework Programme, 2020–2027 (FP), that will prompt R&I collaboration, providing the construction industry is able to persuade Community authorities and Member States to prioritise R&I as it deserves in light of the industry's weight in the European production sector. All the foregoing is to be supplemented by national initiatives under national scientific and technical research and innovation plans.

Lastly, innovation and entrepreneurial culture must be furthered in university training and policies should be implemented to favour understanding and collaboration between companies and research institutions and universities. European and Spanish construction, road, railway and energy efficiency technology platforms should continue to play an instrumental role in driving collaboration in R&I.

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