

# INTED **2016**

10th International  
Technology, Education and  
Development Conference

7-9 March, 2016  
Valencia (Spain)

# CONFERENCE PROCEEDINGS



**10** years together for **education.**

**Published by**  
IATED Academy  
iated.org

**INTED2016 Proceedings**  
10th International Technology, Education and Development Conference  
March 7th-9th, 2016 — Valencia, Spain

**Edited by**  
L. Gómez Chova, A. López Martínez, I. Candel Torres  
IATED Academy

**ISBN: 978-84-608-5617-7**  
**ISSN: 2340-1079**  
**Depósito Legal: V-337-2016**

Book cover designed by  
J.L. Bernat

All rights reserved. Copyright © 2016, IATED

The papers published in these proceedings reflect the views only of the authors. The publisher cannot be held responsible for the validity or use of the information therein contained.

# EXHIBITION STRUCTURAL POINT: STRUCTURES CONSTRUCTION MOCK-UPS

**B. Piedecausa-García, J.C. Pérez-Sánchez, J.M. Mateo-Vicente, P. Palma-Sellés**

*Universidad de Alicante (SPAIN)*

## **Abstract**

The exhibition "STRUCTURAL POINT: Structures Construction Mock-Ups" shows a special emphasis on building structures. This exhibition is made up of 50 detailed mock-ups that show every constructive element, joints and specific details in buildings, where different types of materials (metal, wood and reinforced concrete) have been used. This work has been made by the students of the Building Engineering Degree, as a main exercise in the subjects called "Structures Construction I and II".

Moreover, this activity has been complemented by parallel events during its exposure time at the Museum of the University of Alicante in order to open the degree at a university level, using the exhibition as a meeting point of leading professionals, important specialized construction companies and also, as a promotion of the degree for prospective college students.

Finally, it is important to consider that many different elements related with constructive techniques play a key role in the building process: the best construction systems must be used, the most efficient solutions must be considered and the materials must be chosen carefully. All these concepts are basic to be included in the exhibition as they consider essential topics in the field of construction for the students of the degree in the Polytechnic School. In conclusion, the realization of this exhibition has served as global meeting point for students, professionals and future college students.

Keywords: Structures, Construction, Exhibition, Mock-Ups, Building Engineering.

## **1 INTRODUCTION**

The Spanish university has been already immersed for some years in the European Higher Education Area; however, this new condition still supposes numerous changes to achieve regarding the way we have carried out educational activities so far. To do so, we can consider different areas related with new methodologies and learning processes between teachers and students [1] [2] regarding a more active participation both in the classroom and at home.

The present work considers a new proposal for the Building Engineering Degree in the Polytechnic School at the University of Alicante that allows acquiring other core competencies for the professional practice of future graduates. We believe that complementary activities outside the classroom are really necessary in the case of subjects related to architectural construction, as they generate new proposals and solutions that truly involve more than mere attendance to classes.

Many different elements related with technique play a key role in the art of building: materials must be chosen carefully, the most efficient solutions must be attained, and the most suitable construction systems must be used. Those are fundamental concepts in the field of construction and essential in the training of students in technical studies, who must base the development of their professional practice in compliance with the multiple regulations [3] [4] of the building sector.

## **2 OBJECTIVES**

In construction subjects, focusing only on academic knowledge in the classroom (treating both theoretical and practical aspects) can restrict, in certain cases, the development of certain training skills for students [5]. In our opinion, it is especially important that our students acquire other complementary skills such as the constructive conception, design of new solutions, manual work, focusing on different sizes or the use of actual building materials for the production of scaled mock-ups; all of them are key concepts that have been developed theoretically in the subjects of Structures Construction I and II [6] [7] [8]. These aspects have been applied in the present exhibition to complement the university student learning.

Due to this, the main objective of this paper is to present, analyse and discuss the development of a constructive mock-ups exhibition as a new teaching methodology used in the subjects of Structures Construction I and II within the Building Engineering Degree at the University of Alicante. This proposal allows to complement the constructive and technical knowledge acquired by our students and to improve their design, scale and representation skills (essential for a professional practice in the future) (Fig. 1).



Figure 1. Mock-ups for the exhibition. Left image: mock-up of foundations footings. Right image: mock-up of a reticular forging.

To this end, the exhibition entitled «STRUCTURAL POINT. Structures Construction Mock-Ups» puts a special emphasis on building structures (Fig. 2). It is made up of 50 detailed mock-ups that show every joint, detail and constructive element of the buildings, where different types of materials (reinforced concrete, wood and metal) have been used. The works have been made by the students of the Building Engineering Degree.



Figure 2. Identificative poster for the exhibition.

### 3 MATERIALS AND METHODS

The main topics studied in those subjects have been identified in four different blocks considering:

- Foundations
- Concrete walls
- Different types of structures
- Forgings

These general blocks were subsequently represented by building models (mock-ups) at several scales, gradually covering different stages of professional work for Building Engineers, through an activity which has an important constructive dimension and a real professional application.

The proposed methodology is based on the organizational process used by the recovery, repair and reconstruction of different building mock-ups made by our students over the past five years. For more

than four months, a team of professors, staff and students of the Building and Urbanism Department has proceeded to paint, complete, add reinforcements, install missing pieces etc. in the 50 finally selected models.

In order to establish a priority and to control each activity (implemented, in progress or pending implementation), a database was developed to share all the information between the members of the group (Fig.3) which identified certain information for each mock-up (an order number, a tag code, a representative image, a brief constructive description, its conservation status, pending tasks, dimensions of the mock-up and the existence of a file with additional information for each construction element , among others).

Figure 3. Database developed.

Considering the constructive theme of the exhibition, all the material is divided into 4 families (each identified with a certain colour (Fig. 4)) corresponding to:

- Grey: 7 details of reinforced concrete foundations (shallow and deep) that collect footings, slabs, plates and piles.
- Green: 7 mock-ups about reinforced concrete walls (load walls, soil retaining wall and other retaining walls).
- Blue: 29 details of structure (stairs, details and industrial buildings) of different materials such as metal, wood, concrete and mixed.
- Red: 7 mock-ups on forging (unidirectional and bidirectional) considering beams, slabs, forged with composite slabs.

| LEYENDA          |                          |            |                |                        |  |                |
|------------------|--------------------------|------------|----------------|------------------------|--|----------------|
| FAMILIA          |                          |            | CÓDIGO         | MAQUETAS SELECCIONADAS | Nº MAQUETAS/GRUPO                      | TOTAL MAQUETAS |
| CIMENTACIÓN H.A. | SUPERFICIALES            | ZAPATAS    | CS_Z           | 11, 44                 | 7                                      | 50             |
|                  |                          | LOSA/PLACA | CS_P           | 07                     |  |                |
|                  | PROFUNDAS                | PILOTES    | CP_P           | 06, 13, 17, 41         |  |                |
| MUROS H.A.       | DE CARGA                 | MCA        | 15             | 7                      |  |                |
|                  | DE CONTENCIÓN DE TIERRAS | MCO        | 01, 42         |                        |  |                |
|                  | PANTALLA                 | MPA        | 05, 30, 40, 43 |                        |  |                |
| ESTRUCTURA       | ESCALERAS                | EE         | 03, 04, 22     | 29                     |  |                |
|                  | DETALLES                 | MÉTALICOS  | ED_ME          |                        | 25, 33, 34, 35, 36, 38, 39, 45, 46, 47 |                |
|                  |                          | H.A.       | ED_HA          |                        | 09, 18, 21, 32                         |                |
|                  |                          | MADERA     | ED_MA          |                        | 27, 29, 37, 48, 49                     |                |
|                  |                          | MIXTOS     | ED_MX          |                        | 16, 50                                 |                |
|                  | NAVES                    | MÉTALICAS  | EN_ME          |                        | 20, 23, 24, 31                         |                |
|                  |                          | MADERA     | EN_MA          |                        | 28                                     |                |
| FORJADOS         | UNIDIRECCIONALES         | VIGUETAS   | FU_V           | 02, 12, 26             | 7                                      |                |
|                  |                          | LOSA       | FU_L           | 14                     |  |                |
|                  | COLABORANTE              | FU_C       | 08             |                        |  |                |
|                  | BIDIRECCIONALES          | RETICULAR  | FB_R           | 10, 19                 |  |                |

Figure 4. Mock-up families considered.

## 4 RESULTS

After this experience, we have proved that, by performing clearly defined three-dimensional construction details for each of the families mentioned and representing them in scale mock-ups, students face different construction problems globally, discussing the best construction and material solutions. Moreover, this new methodology has allowed reflecting on the proposals the more suitable options [6, 7, 8] to solve every problem according to the scale used and encouraging new learning strategies.

It is also important to say that, apart from the specific three-dimensional analysis of the constructive element shown for each of the mock-ups, other complementary products were generated related to the identification of the model: a brief description of constructive and structural systems and a specific QR Code to download additional documents in the personal mobile of any visitor to the exhibition (Fig.5) are available by using a conventional code reader.

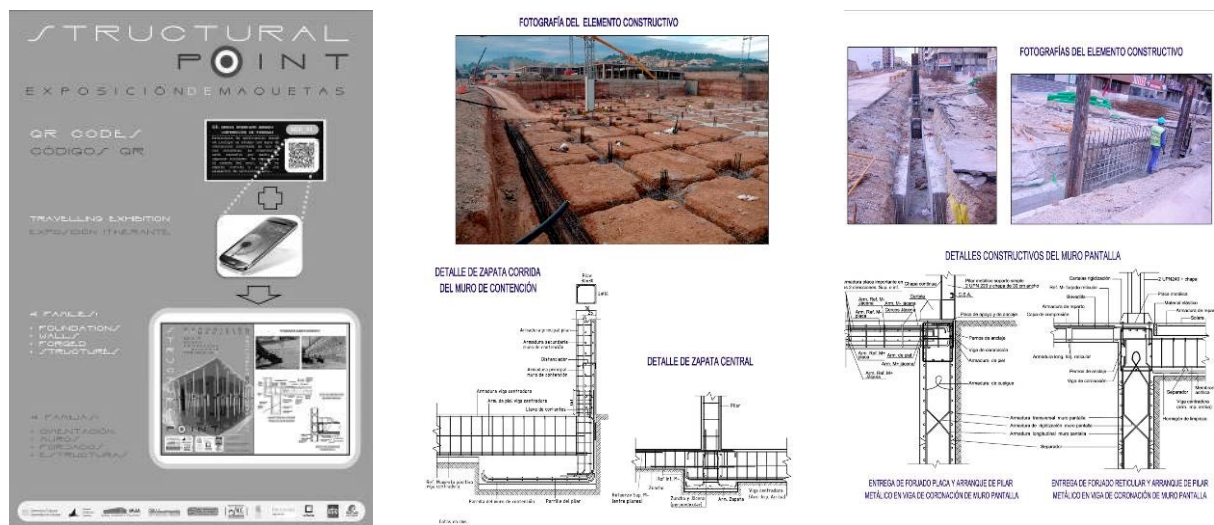


Figure 5. Download poster and additional information sheets.

After all this previous work, the show was inaugurated on February 6, 2015 at the Museum of the University Alicante (MUA) (Fig.6), with the presence of Andrés Montoyo, Director of the Polytechnic School (EPS), within the scope of the Cultural Month 2015. The exhibition was coordinated by Juan Carlos Perez and Beatriz Piedecausa, teachers of the Polytechnic School and members of the research group MSCE - Materials and Construction Systems for Buildings.

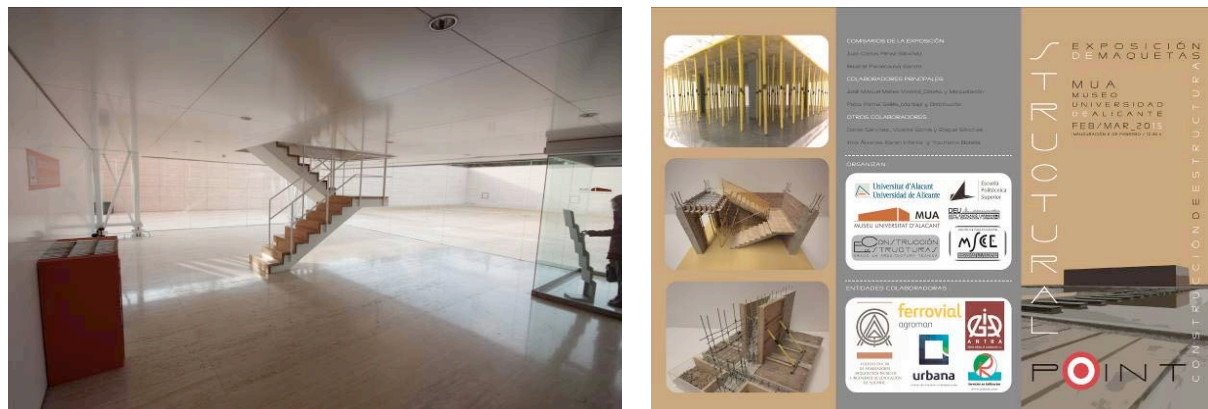


Figure 6. Location and triptych of the exhibition.

The opening day was completed with different conferences in the field of construction, which took place the same day in the Auditorium of the Polytechnic IV. The lectures, which were attended by over 100 students (Fig. 7), dealt with the following topics:

- Innovation in construction, talk given by the company Antra.
- Intervention Damaged Structures, talk given by the company Urbana de Exteriores.
- Pathologies in construction, talk given by Pascual Urban (Building Engineer with extensive professional and teaching experience in the subject Structures Construction I and II of the Building Engineering Degree).



Figure 7. Poster for microconferences and image of the exhibition opening ceremony.

The exhibition «STRUCTURAL POINT. Structures Construction Mock-Ups» remained open to the public at the Museum (MUA) from February 6 to March 23. During this time, a tour was raised inside the exhibition identifying the different families mentioned above; this main activity was complemented by other parallel events such as:

- The visit of students from different high schools in the province of Alicante interested in starting to study technical degrees at the Polytechnic School during the next academic year (2015-2016), promoting complementary activities in the construction for future college students (Fig.8).

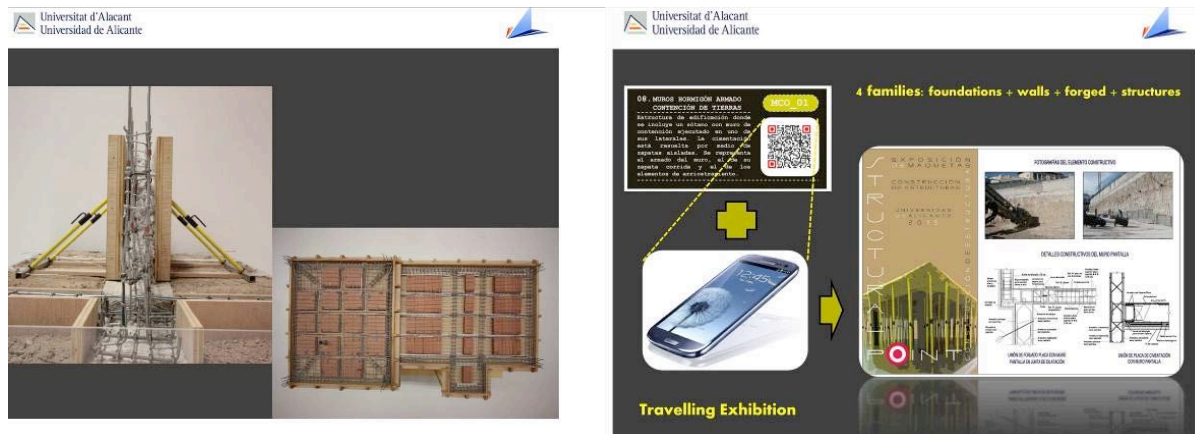


Figure 8. Slides for promotion talks to high school students.

- Establishing a meeting point for leading professionals of architecture as well as important specialized construction companies. In addition to the collaboration of different entities of the University of Alicante (Polytechnic School, Museum of the University of Alicante, Department of Building and Urbanism, MSCE - Materials and Construction Systems for Buildings and the teaching unit of Structures Construction), other important entities in the construction sector also collaborated in the exhibition (Colegio Oficial de Aparejadores, Arquitectos Técnicos e Ingenieros de Edificación de Alicante and 4 companies: Ferrovial Agroman, Urbana, Antra and Refortec) .
- Develop a change of location in the usual teaching practice of the cited subjects allowed the realization of alternative activities outside the classroom to enable a practical check, visual and physical, of the different constructive solutions previously studied in class (Fig.9).



Figure 9. Constructive explanations in the subjects Structures Construction I and II, inside the exhibition building.

## 5 CONCLUSIONS

This proposal has shown the use of an exhibition activity as a complement to traditional teaching, presenting a more active work among students related to manual processing of three-dimensional scale mock-ups. Thus, compared to a conventional situation in which mainly the contents of the subjects are assimilated in a "final test", the authors are committed to continue working in parallel activities, where students are involved in the construction of their own structure, creating a particular constructive element. This new processes do not have a single solution but allow each student to show their personal interest and skills by developing singular 3D models.

In addition to this main result, the realization of the exhibition in an open and accessible environment for all audiences has served as a global meeting point for current students, professionals and prospective students. Moreover, regarding the parallel events organized during the exposure time it is important to consider that:

- the visit of prospective students from high schools in the province served as a means of opening the Building Engineering Degree to a level of pre-university studies.
- the exhibition served as a place of convergence between leading practitioners of architecture due to the participation of companies and organizations in the field of construction (Fig. 10), promoting the connection between experienced professionals in daily practice and future graduates, allowing to establish ties of relationship between the two sectors.
- the possibility of changing the teaching location for the subjects of Structures Construction I and II allowed constructive considerations from other complementary viewpoints.



Figure 10. Construction companies participating (left) and organizers of the exhibition (right).

In conclusion, the development of the exhibition «STRUCTURAL POINT. Structures Construction Mock-Ups» has shown the interest of students in this type of complementary learning activities in the Building Engineering Degree, presenting wide participation both during the opening and the performed conferences, serving as an example of the importance of introducing new teaching methods in the construction subjects.



## REFERENCES

- [1] Barkley, E.F. (2007) Técnicas de aprendizaje colaborativo: manual para el profesorado universitario. Madrid: Ediciones Morata.
- [2] De Miguel Díaz, M. (2006) Metodologías de enseñanza y aprendizaje para el desarrollo de competencias. Orientaciones para el profesorado universitario ante el espacio europeo de educación superior. Madrid: Alianza Editorial.
- [3] Código Técnico de la Edificación (2006). Madrid: Boletín Oficial del Estado, Ministerio de la Vivienda.
- [4] EHE-08: Instrucción de hormigón estructural (2009). Madrid: Comisión permanente del hormigón.
- [5] Orden ECI/3855/2007, de 27 de diciembre, por la que se establecen los requisitos para la verificación de los títulos universitarios oficiales que habiliten para el ejercicio de la profesión de Arquitecto Técnico (2007). Madrid: Boletín Oficial del Estado, núm. 312.
- [6] Pérez Sánchez, J.C.; Piedecausa García, B.; Mateo Vicente, J.M. (2015). Exploring CE1. Construcción de Estructuras. Alicante: Editorial Club Universitario.
- [7] Pérez Sánchez, J.C.; Piedecausa García, B.; Mateo Vicente, J.M.; Palma Sellés, P. (2015). Exploring CE1. Vol. 2. Construcción de Estructuras. Alicante: Editorial Club Universitario.
- [8] Pérez Sánchez, J.C.; Piedecausa García, B.; Mateo Vicente, J.M. (2015). Exploring CE2. Vol. 1. Construcción de Estructuras. Alicante: Editorial Club Universitario.