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Pipe rack construction in Spain

A rather new field of application of precast concrete structures can be witnessed in the form of special constructions for the oil industry. The project under consideration in this article is from Spain. In the past, pipe rack frames (Fig.1) supporting elevated pipelines would usually come along as steel or in situ concrete structures. It now seems that a number of successful applications [1] of precast concrete for such structures are opening up new horizons for the precast concrete industry in this important filed of industry.

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Precast concrete offers a lot of relatively well known advantages such as the speed of construction, the reduced number of workers on building sites and less dependence on weather conditions. In addition, precast concrete offers the possibility of dismantling structures on account of the way these elements are jointed.

The most important issue of precast concrete structures is the jointing technique employed in a given project. The same applies to pipe rack precast concrete structures. Special products (see [2]) play an important role in contributing to the effective jointing of precast concrete elements. The Spanish project that is in the focus of this article has once again demonstrated that a popular special product called a column shoe and originally developed for connecting columns [3] to foundations can be successfully employed for beam connections as well.

Recently performed research [4] and experience gathered from earthquakes have confirmed that precast concrete structures can successfully withstand earthquakes just the same as any other appropriately designed and executed structure. This important lesson has been learnt from the recent (6 April 2009) severe earthquake in Italy's L'Aquila region. To the surprise of many, prefabricated frame structures survived this incident very well and the main problems that prefabricated structures encountered were jointing failures among external wall panels and internal load bearing structures.

Pipe rack frame structures

In a number of projects carried out by the Spanish company Repsol, pipe rack frames consist of bulky multi-storey columns and composite beams. (Figs. 2, 3). For the design and production of columns and beams, the relevant European standard [5] is applied.

Columns

Columns of a cross-section 600 by 600 mm feature concrete corbels that in some cases are projecting to all 4 directions usually at different heights. The corbel projection usually amounts to 350 mm and shows a minimum height of 450 mm. The main function of corbels is to support the beams and to transfer the loads from the beams to the columns. Typical columns are shown in Fig. 4.

Beams

Beams are designed as a composite concrete structure. The overall height of a composite beam is 800 mm. Its bottom part is produced as a precast element with protruding shear reinforcement to ensure a composite action with the in situ concrete upper layer. The upper beam edges are equipped with shell lining to avoid the use of formwork when casting the upper beam part. In the bottom part of beams, Peikko column shoes are installed. Usually four rather large fastening plates are provided on both sides of beams. Beams are illustrated in Fig. 5.

Frames

The structural frame concept is based on a rigid connection between columns and their foundations and also between beams and columns. Frame joints are designed in such a way that they can carry off both negative and positive bending moments. In this way, frames can handle both transverse and

Fig. 1: Overall view of the construction site

Fig. 2: View of precast concrete pipe rack structure

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Fig. 3: Pipe rack structure under construction

longitudinal forces (e.g. wind, earthquoke) without ony need for additional stiffening elements.

Joints

Joints between columns and foundations

Columns are fixed to foundations by means of anchor bolts and special steel base plates. The weight of such a base plate in the case of this project was between 660 - 830 kg. The base plates shown in Fig. 6 were produced by Deltabeam Slovokia.

Fig. 4: Multistorey column featuring special steel base plate