

# RESEARCH AND INNOVATION EXHIBITION

*8 - 11 June 2006*



BUILDING SOLUTIONS FOR A DEMANDING WORLD

Bouygues Construction, one of the world leaders in construction, engineering and electrical contracting/maintenance, posts sales of more than 6 billion euros and has more than 40,000 employees throughout the world. Since its very beginnings, the Group has been a key player in innovation, and its achievements contribute to the progress of the entire sector in which it works. Devising new kinds of projects, automating the work we do, or working to achieve sustainable construction are just some of the major challenges engaged by its engineers, integrated design offices, and partners.

What follows are examples of innovations shown at the Bouygues Construction stand at the Research and Innovation Exhibition held on 8-11 June 2006, at the Paris Expo venue, Porte de Versailles.

### Immersed-tube and instrumented tunnelling machines



As the undisputable world leader in tunnelling, Bouygues Travaux Publics masters every tunnelling technique, from the most traditional to the most innovative. Specialised in tunnel boring machines (TBM), the company has already designed the – at the time – largest earth-pressure-balance machine in the world (15 m diameter) and had it built for the 9-km-long tunnel on the high-speed rail line between Amsterdam and Rotterdam. Today, Bouygues Travaux Publics engineers are working towards two new objectives: on-site (on the seabed) construction of immersed-tube tunnels, and instrumentation of cutters.

Cutters for hard-rock TBMs are rotary discs placed over the entire surface of the cutterhead. They work in a hostile environment (high temperatures and pressures, impact, vibration, humidity) and are relatively inaccessible.

The new electronic system designed by Bouygues Travaux Publics, known as “Mobydic” provides constant real-time data on the status and operation of the cutters. This therefore facilitates mechanised tunnelling, including under difficult geological conditions (hard rock and soft ground, below the water table). After preliminary development and off-site testing, two prototypes were successfully operated on the Lok Ma Chau tunnel project in Hong Kong. The latest design is currently being used on the Mont Sion tunnel on the A41 tunnel in France.

### Bridge sliding on self-propelled multi-wheeled transporters



Bouygues Construction designed and built the 125-km-long stretch of the A28 motorway between Rouen and Alençon in a record time of 48 months. In order to reduce disturbance to infrastructure crossed by the new road, Quille, a Bouygues Construction subsidiary, developed a new procedure for placing overpasses which is known as “Transpra”.

This innovative process involves placing bridge structures for intersecting roads, motorways, and railways with self-propelled multi-wheeled transporters.

The process involves building a bridge a short distance from the road or railway it is to be placed on, so as not to disrupt traffic, then, in the space of a weekend, moving it into place using a hydraulic “centipede”. Transpra reduces placement time by 33%, relative to a rival method, places bridges to within accuracy of 5 millimetres, and makes overall cost savings of 15%. The modular transporters are capable of carrying a structure weighing 2,500 tonnes at a speed of 40 metres per hour.

## Stability of tall buildings



For many years Bouygues Construction has been a specialist in tall buildings, both in France and internationally. It has been one of the main contributors to construction of the Paris-La Défense business district (Fiat, Total, Opus 12, Grand Arch, Coeur Défense, etc.) and is also highly active in leading Asian megacities. Particularly complex projects such as these call for innovation in all respects. Since they are located in highly built-up urban areas, special measures are required for safety and logistics. But the most important, albeit invisible innovations are those for guaranteeing the stability of buildings, irrespective of foundation settlement, wind force, or earthquake hazards.

The people at Bouygues Bâtiment Île-de-France are currently building the T1 Tower (185 m high) and are renovating the Vista building (77 metres) in La Défense, while Bouygues Bâtiment International is building the tallest apartment buildings in Singapore (245 metres) and Bangkok (210 metres).

## Spinning fibre-optic cable on power lines



In France, the boom in applications using new communication technologies requires telecommunications networks to be extended. This is particularly true for broadband connections to isolated rural areas.

Between 2003 and 2009, RTE, a subsidiary of EDF, the French national power authority, is to deploy 10,000 km of fibre-optic cable. To help RTE, Transel, an ETDE subsidiary specialised in the design, construction, installation, and maintenance of power networks, has, together with Nexans, developed an innovative procedure: a robot which spins fibre-optic cable directly

onto the cables of existing high-voltage transmission lines. Such a cable-spinning robot will be on display on the stand.

## Sustainable construction serving future generations



The subsidiaries of Bouygues Construction are specialised in the construction of buildings of all kinds (offices, individual and social housing, etc.) throughout the world. Their in-house design offices implement innovative construction techniques and materials for buildings of HQE® high environmental quality. Here are some examples of innovations in this respect.

### **Thermal breaks**

Bouygues Bâtiment Île-de-France has developed a construction process that reduces heat loss through the external walls of buildings, producing a 10 to 20% saving in heat consumption. It consists of thermal breaks: an additional strip of thermal insulation is placed between floor slabs and internal walls and the external walls. Floor slabs are supported by the external walls by only a few specific reinforced-concrete connections.

### **Building management system**

A building management system uses a central programmable logic controller (PLC) to control a wide range of building services. For instance, it will manage heating and lighting remotely. Using remote sensors, the BMS gathers information about lighting, a compressed-air system, air conditioning, etc., and centralises and analyses it. The system can be used for remote programming of operating times, for collection and recording of data, and can make for savings in energy and maintenance.

A BMS system was installed in the Les Mureaux (France) municipal authority building that was handed over in October 2004.

### **Solar tubes for heating domestic hot water**

A solar tube is welded to a heat pipe (very good heat conductor) inside a glass vacuum tube. The heat pipe is connected to a high-efficiency condenser. The absorber is heated by the incident radiation of the sun and transfers the heat to the condenser. This system provides savings on heating, reduces greenhouse-gas emissions, and promotes renewable energy resources.

### **High-performance concrete**

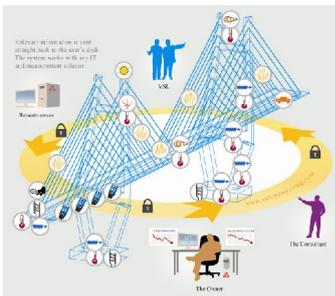


Together with Lafarge and Rhodia, Bouygues Construction has designed and patented a particularly strong concrete called Ductal®. Not only marketed but also used by VSL, Ductal® is much appreciated for its resistance to corrosion, abrasion, carbonation, and impact. Consequently it is perfect for structures built in aggressive environments, in a marine atmosphere or in an industrial situation, for example, while also being ideal for buildings open to the public where safety and maintenance criteria are critical.

Made with fine pozzolanic materials ("reactive powders"), Ductal® exhibits exceptional mechanical characteristics and durability (lifetime greater than 100 years). There are several applications, including architectural work, loadbearing structures, protective walls, etc.

The stand will exhibit a trampoline of Ductal® concrete developed by VSL in Australia to illustrate the flexibility inherent to use of such a concrete.

### **Monitoring of large bridges**



To guarantee the safety of users, large bridges have to be permanently monitored. VSL has developed a procedure for real-time surveillance of bridge reactions, using around 1,000 sensors from which information is immediately available on a secure extranet site.

A VSL extranet gathers and transfers readings and the results of checks carried out on the bridge directly to the user's computer. The software installed on the bridge gathers and filters raw readings (static and dynamic phenomena) and transmits the data to the server. It can manage the acquisition of data from one to 1,000 sensors for all kinds of project.

This system can:

- take readings right from the start of a project,
- be installed temporarily on existing structures to track various parameters,
- monitor the behavioural evolution of complex structures over a period of time.

## Satellite guidance of earthmoving plant



Earthmoving is a vital prerequisite to the start of large road or rail infrastructure projects, for example. The performance of earthmoving contractors depends largely on their ability to use plant to grade layers of materials as regularly as possible so as to facilitate the placement of blacktop or rails. DTP Terrassement, a Bouygues Construction subsidiary, is using an innovation implementing satellite navigation systems to guide earthmoving plant.

The guidance system involves connecting the blade or bucket of a machine (bulldozer, hydraulic excavator or grader) to an on-board computer program containing project data. This enables the blade or bucket to be precisely positioned, in real time, so as to comply with the design elevations and tolerances. Two kinds of guidance system can be used: satellite positioning (GPS) or dynamic positioning (DPS).

This innovation substantially improves plant efficiency and ensures a constant level of accuracy. Its other advantages include reduced setting out (no pegs), and fewer staff on foot around the plant, which makes for a safer site.

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