Transport and site erection. Transportation is normally carried out by trucks. The maximum economical distances vary between 150 and 350 kilometres, depending on the type of products transported, the traffic infrastructure, the population density, and so forth. When rail or maritime transport is used the maximum cost-effective transport distance can reach 2,000 kilometres. The erection procedure can affect the maximum weight of the units depending on the accessibility of the site and the capacity of the lifting crane. This should be taken into consideration at the start of the final design work.

Building services. The installation of building services can be integrated into the building system (Fig. 9). A major advantage of this is that the precast structure can be designed according the specific requirements of the building equipment. Elements can be provided with a variety of holes, and fixings can be cast in the units; many additional means are available on site after the erection of the precast building.

Precast offers marked advantages for building services. For example, the thermal mass of concrete is used efficiently to store thermal energy in hollow core floors, which leads to substantial savings in heating costs. Another example is the possibility of using cast-in ducts, boxes or chases for electrical fittings. Internal rainwater pipes are sometimes cast in columns or façade units. Large prefabricated conduits for ventilation and other pipes can be installed inside double ceilings or along projecting spandrel-façade units during the erection of the precast units.

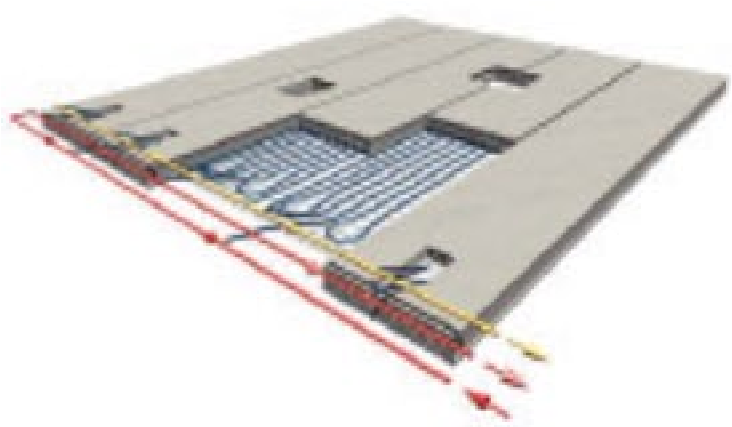

Fig. 9. Incorporation of floor heating ducts in hollow core slabs to activate thermal mass

Quality assurance and product certification

Quality assurance and plant certification are important undertakings in prefabrication. They are the response to an ever-increasing market demand for quality in products and services. The quality assurance and the quality control of precast concrete members are initiated at two levels: an in-house quality-assurance programme with continuous internal control, and plant certification with quality-control supervision by an independent body. The certification of precast concrete production plants offers confirmation by an independent inspecting body that quality products can be manufactured and that the in-house control system functions smoothly.

Confirmed capability means that a plant is well equipped and the people who operate it are competent to produce quality products. They achieve this through the inspection of their production operations, materials, equipment, personnel and products for conformity to the Plant Certification Program. This means that the producer has the capability, by virtue of personnel, facilities, experience and an active quality assurance programme to manufacture quality products. Plant certification evaluates a plant's overall ability to maintain sound production procedures and an effective in-house quality-assurance programme. Quality control requires much more than achieving concrete strength. Many other factors also play a role in the quality control of precast concrete products. Some of the most important are:

- completeness of work orders and product drawings;
- testing and inspection of the materials selected for use;
- accurate manufacturing equipment;
- proportioning and adequate mixing of concrete;
- handling, placement and consolidation of concrete;
- curing;
- dimensions and tolerance control;
- handling, storage, transportation and erection of members.

The procedures to be followed for quality control are normally based on ISO 9001 or EN 29.001 standards. Specific quality assurance and certification programmes formulated by precast concrete federations and institutes also exist. The Precast/Prestressed Concrete Institute, USA, has published quality control manuals for plants and the production of precast and prestressed concrete products. The FIP Commission on prefabrication published a guide to good practice on *Quality assurance of hollow core slab floors* in 1992 and the *fib* published *fib* Bulletin 41 *Treatment of imperfections in precast structural elements* in 2007.

Worldwide proven solutions

Precast concrete structures deliver excellent solutions worldwide. The pictures that illustrate this paper (Fig. 6 ÷ 8, 10), offer an idea of the immense potential that precast concrete possesses and to inspire enthusiasm for this versatile product.

Fig. 10. Residential building with precast insulated sandwich panels

The precast industry has developed concrete mixes as well as moulding and surface finishing techniques that give concrete units a highly-refined aspect. The technique is called architectural concrete to indicate that the material and the way it is produced and applied contribute to the architectural and aesthetic character of the project. What strikes one most in the current conception of buildings is the wide variety in the design of façades. This greater freedom has also affected a change in the choice of the materials used. Instead of internal concrete structures exposed through water washing, sandblasting or other techniques popular in the past, the finishings seen today are reconstructed natural stone, polished concrete and brick or stone veneering, amongst others. Currently some of the key concepts in façade design are aesthetics, the use of natural or traditional materials, flexibility, individualism and comfort.

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