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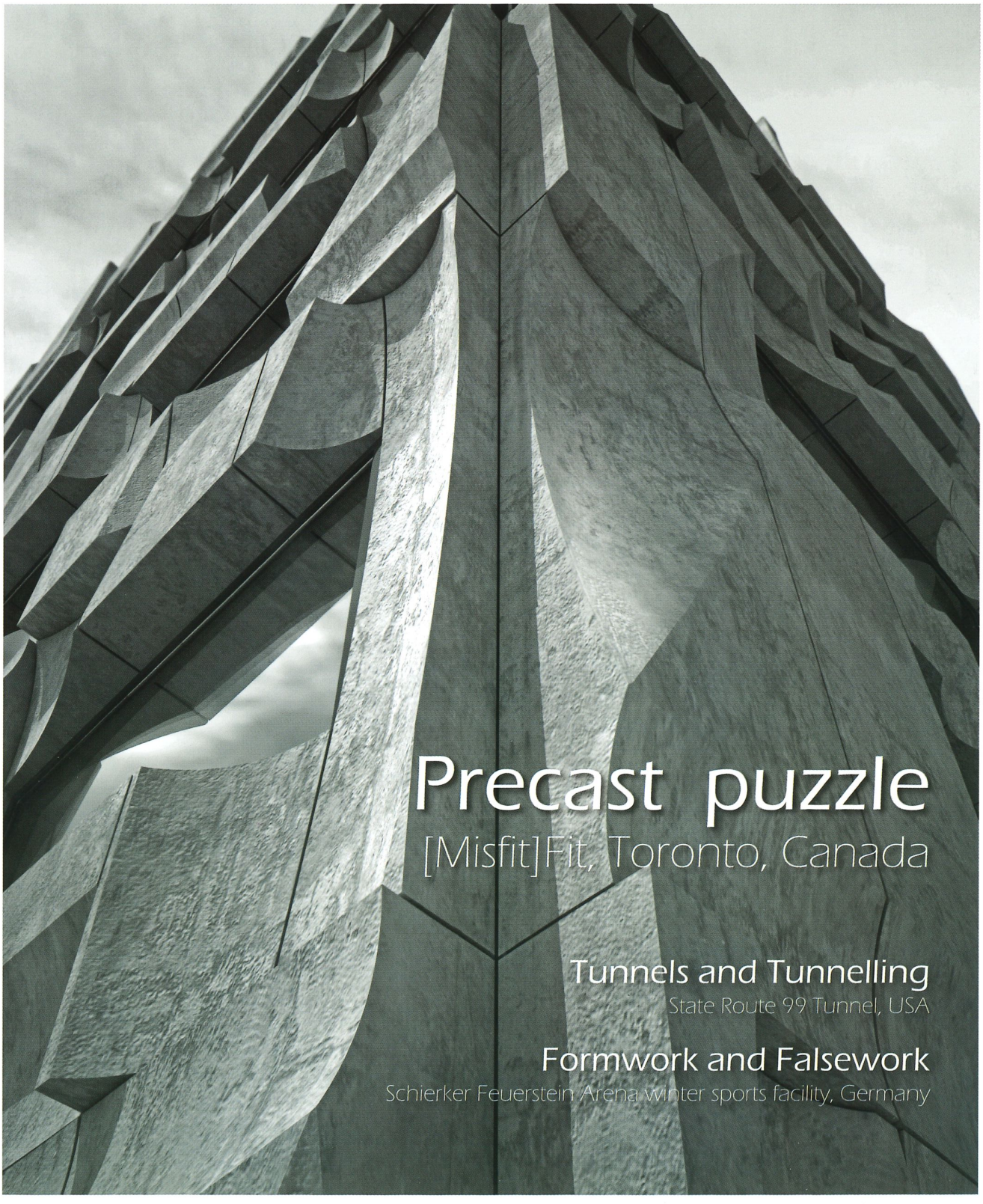


Precast puzzle

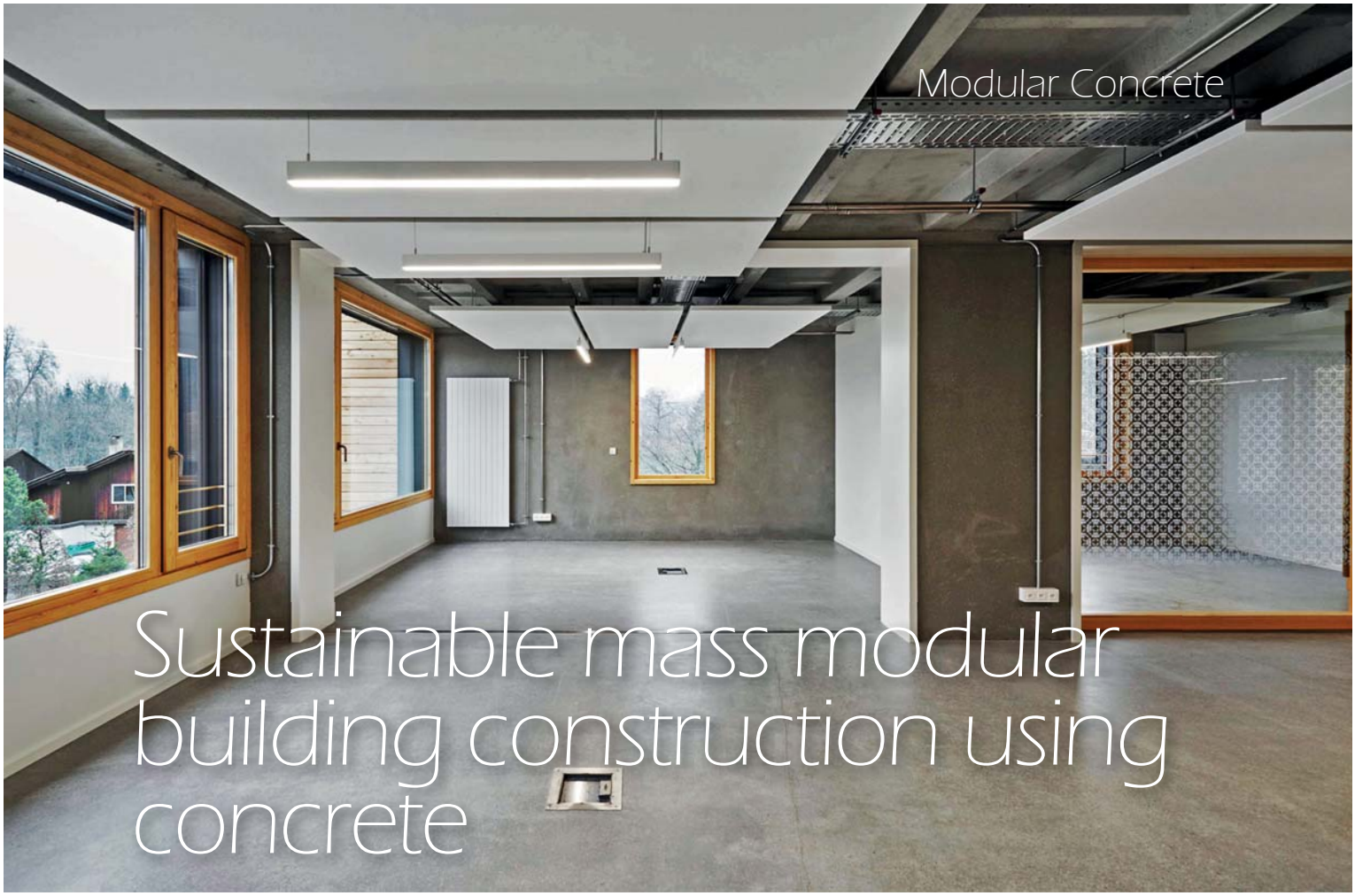
[Misfit]Fit, Toronto, Canada

Tunnels and Tunnelling

State Route 99 Tunnel, USA

Formwork and Falsework

Schierker Feuerstein Arena winter sports facility, Germany



Sustainable mass modular building construction using concrete

In 2009, CompactHabit introduced the eMii system (Spanish acronym for 'integral industrialised modular building') to enable the large-scale production of off-site finished concrete modules. The system involves the manufacture of three-dimensional, four-sided monolithic modules of reinforced concrete which pass through an assembly process of various components, building services and materials until they leave the production facility, fully equipped and with the interior finished to customer specifications.

Paco Conde, CompactHabit, Barcelona, Spain

As a sustainable system based on repeating units of varying sizes and heights, CompactHabit's scope ranges from student dorms to multi-family dwellings, hotels, schools, and other institutional markets. The system is currently in use in Spain, France and Switzerland.

The production solution adopted for the CompactHabit module involves the manufacture of a single piece of concrete in two braced stages. To achieve this, a mould was developed, as well as proprietary formwork that enables horizontal concreting phases, thereby solving the problem of mix placement from above. The mechanical formwork can be adapted to different lengths and widths.

The module's structural element is a ribbed concrete prism that varies in size, depending on the project. This structural element serves as the frame for the remaining features – façades, installations, flooring, interior cladding, kitchen, bathrooms and appliances. The modules are transported by trailer to the site location where a heavy-load crane sets them in place. Once in place, the modules are connected to each other and the vertical utility services are installed on the exterior of the module, with no need to access the interior. Using this procedure, buildings of up

Above and below: The interior of Compacthabit modular offices in Emmenbrücke, Switzerland.

Above left: Formwork can be adapted to different lengths and widths during production of the modular units.

to eight storeys can be erected, without any additional structures. In addition to the speed of assembly, this structural system also represents a considerable improvement in the building's response to seismic activity.

As independent structural elements, a certain amount of movement can occur without the risk of structural cracks or damage. The modules fit together with elastic joints and are subsequently screwed together at the joints to facilitate dismantling of the modules if necessary. A building can be moved to a new location in exactly the same manner as when it was initially built. It can be returned to the factory to replace worn elements, change finishes, repair flaws and return it to a usable condition. Importantly it is possible to place buildings temporarily on sites destined for alternative use in the long term. The concept of this 'nomadic', demountable building opens up new opportunities in land management.

Benefits of modular construction

- Use of the reinforced concrete structure produces a monolithic building, creating important added value such as sound insulation, thermal inertia, fire resistance, earthquake resistance, and durability.
- This form of construction creates a structural system composed of self-supporting floating modules, with anti-seismic capacity.

Below: The modular units are carefully lowered into position.

Above inset: Completed exterior of Compacthabit modular offices built in Emmenbrücke, Switzerland.
Above: Assembly line showing large-scale production of Compacthabit modular units.

- The developed structural technique comprises a modular stacking system which uses an innovative jointing method and floating supports. These features allow each building unit to act independently of its adjacent unit, meaning a huge improvement in acoustics and adaptability of the structure to the building's movements, particularly with regard to seismic activity. This is due to the fact that the system joints and elastic elements create a break in the continuity of the building, preventing structural damage.
- As the building joints and assembly elements are mechanical, neither mortars nor concrete are needed. The system offers huge gains in terms of speed of erection, thanks to the large unit dimensions and ease of assembly. Modules are simply gravity-connected, with hardware and elastic joints. The building continues to grow, self-supported, up to eight storeys; no further structural additions are required. The crane-assembly capacity on-site is 500—1000m^2 per day (one shift), depending upon the specific project.
- The innovative dry jointing system permits dismantling of the building at any time, as the modules can be recovered without any alteration or damage during the disassembly process. The recovered modules can then be used in other modular buildings without the need for modification or refurbishment. A concrete-framed building which is removable and transportable represents a new concept in building construction.
- The industrialised off-site manufacturing process permits continuous monitoring of quality – an important advantage compared with traditional construction methods. This industrialisation also ensures product traceability – something very difficult to implement in other building systems. The building process and the subsequent quality control allow higher legal requirements for quality, meaning a general improvement in standards without increasing costs.
- The design–build process can offer benefits of increased collaboration and flexibility.
- The construction system saves on construction time, achieving reduced time frames of 25% and 30% compared to a similar project built with traditional systems.
- The application of industrial processes in the construction of a building means a significant reduction in accident rates and improved conditions at work.
- The floating structural system and double walls and floors provide outstanding insulation and acoustic performance, which are critical for comfort and well-being.
- The eMii building process is designed under the criteria of deconstruction, control and waste reduction: for every 100kg of waste generated in traditional construction, the eMii system will generate less than 28kg for the completed building. The thermal and acoustic insulation of each module maximises energy efficiency and significant savings in consumption, conforming to the 'A' rating energy certification for buildings. During the life of the building it is expected that energy savings and CO_2 reduction will increase by 35–60%.

Modular offices

Architects NRS In situ recently designed a 'nomadic' modular structure for Brezelkönig in Switzerland – the first such structure to be built in Switzerland. The organisation's office building was technically outdated and contaminated with pollutants, and also not large enough for the future requirements of the business. The architect's modular design fitted the client's wish to generate value which was not necessarily location-dependent, and could be relocated or extended as required. Compact habit's concrete modules have a high mass and exposed concrete surfaces which create a unique spatial feeling that is comparable to a solid construction. Conventional modules in wood or steel containers would not provide the same level of comfort and didn't meet the client's requirements.

The building is composed of nine modules, which have been clad with a high-quality double-standing seam façade. The building consists of a ground floor and two higher standard floors. The ground floor holds the access to the building, reception, meeting room, dining facilities for workers and an outdoor terrace. The other floors house the office space. Each module is 15m long × 3.68m wide × 3.4m high. ■

Assembly and installation of modular unit.