ENERGY EFFICIENT, SUSTAINABLE, RECYCLED CONCRETE SANDWICH FACADE PANEL

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CIP SIP ECO/11/304438/ SI2.626301-ECO-SANDWICH

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The plant for the production of prefabricated sustainable reinforced concrete ECO-SANDWICH® wall elements is structured as a single technological unit. Therefore, the entire production process is fully automated, and requires a very small number of workers.

The products are manufactured on steel casting tables with dimensions of 3.80 × 10.80m. The production process starts with the cleaning and scrubbing of the casting tables, and drawing of product outlines. This part is done on a plotter with the use of a brush. The rotating brush moves across the entire surface of the manufacturing table and cleans all the concrete and cladding that remained from the previous production process. All completed designs are entered into the central computer. The concrete form plotter then outlines the product on the surface of the manufacturing table. The production line includes an automated plant for cutting and preparing of the reinforcement, concrete plant with a concrete spreader (a device which distributes the concrete within the moulds), a steam camber (curing of concrete elements), a turning table and a movable working table (on which elements are being steam cured and afterwards tilted to the angle of 75° from which position they are being handled by an overhead crane up to the point of placing them onto the transportation vehicle).

The modern computer operated production plant enables great precision during production, that results in a quality product and meets all design requirements to keep up with the global trend of fast prefabricated building.
The ECO-SANDWICH® system is a sustainable prefabricated facade wall panel system made from recycled aggregate.

ECO-SANDWICH® is a ventilated prefabricated facade wall panel utilising recycled construction and demolition waste (CDW) and mineral wool produced using innovative and sustainable Ecose® technology for reduction of primary energy consumption in the building stock. ECO-SANDWICH® is the result of the cooperation between Croatian scientific institutions and the industry, under which extensive research was conducted with a view to develop a new product and to improve production facilities at the same time having in mind the needs of construction industry and trends in economy.

The ECO-SANDWICH® project received funding within the framework of the CIP Eco-Innovation 2011 Program.

The ECO-SANDWICH® facade wall panel consists of two layers of concrete, interconnected through stainless steel lattice girders and high performance thermoplastic resin ties. 50% of the total aggregate quantity needed for the production of the concrete layers has been replaced with recycled aggregate obtained from construction and demolition waste (CDW). The inner (load-bearing) layer of ECO-SANDWICH®, is made of recycled concrete aggregates, while the outer facade layer is made of recycled brick aggregates. To achieve superior thermal insulation properties, innovative Ecose® mineral wool is used, produced using the Ecose® technology (Ecose® technology mineral wool uses natural resins as binders instead of formaldehyde in the production process). The facade wall system reduces the effect of thermal bridges to a minimum, due to its careful installation and connection to the load-bearing structure. The features of the Ecose® mineral wool will not deteriorate over time; it contains no artificial colors and is fully recyclable.

Between the Ecose® layer and the outer concrete layer, a 4 cm ventilated layer is inserted to prevent damping of the insulation material. The inner and outer layers of concrete are interconnected with stainless steel lattice girders and high performance thermoplastic resin ties. The inner concrete layer is connected to the load-bearing structure of the building (columns, walls) using stainless steel connections.

This panel represents a complete exterior wall of a building which contains thermal insulation with a ventilated layer and, from a static aspect, is self load-bearing, attached to the load-bearing frame of the structure.
The ECO-SANDWICH® facade wall panels are extremely durable and have low maintenance costs, and they provide numerous benefits compared to products offered by the competition. The panels enable economically efficient and fast construction, they are of high aesthetic value, and the elements can be uninstalled and re-used, which gives them an especially long life span.

The possible applications of the ECO-SANDWICH® facade wall panels are numerous, but mainly they involve construction of very low energy buildings, as well as refurbishment of existing buildings into passive buildings as part of energy efficiency.

The possibilities also include construction and refurbishment of:

- RESIDENTIAL BUILDINGS
- WAREHOUSES
- FACTORIES
- FOOD PROCESSING PLANTS
- SUPERMARKETS
- FARMS
- COLD STORAGE FACILITIES
- RESTAURANTS AND HOTELS
- PETROL STATIONS ETC.

Surface treatment
The outer surface of the three-layered element is smooth, made of natural concrete, in natural colour or painted. If provided, the painting of the facade of the element is done on the building. The inner surface is smooth and, after finishing, it is ready to be painted.

Dimensions
Maximum dimensions of the elements are 8.0 × 4.0 m; that is, the actual width and height depend on the geometry of the building (designed facade raster) and the possibilities of the crane compared to the weight of the elements.

Connections of the ECO-SANDWICH® facade panel can be produced as a:

a) LOAD-BEARING JOINT - connects the panel laterally to the load-bearing reinforced concrete structure, its being calculated in advance.

b) OPEN JOINT - between two ECO-SANDWICH® facade panels, in the form of horizontal and vertical joints. Into 1-2 cm wide joints, depending on the length of the element and conditions of construction, a rock wool rope of round cross-section is pressed, after which the joint is sealed using EI90 two-component, permanent, elastic, fire resistant sealing, in line with the instructions of the manufacturer.

The finishing elements - uppermost and lowest - are protected with a horizontal strip of galvanized or copper sheet metal.

c) CLOSED JOINT - internal joint between the ECO-SANDWICH® facade panels and load-bearing structure of structure are filled with EI90 fire resistant sealant.

Transportation of ECO-SANDWICH® panels
The wall panels are laid down vertically and transported in specially prepared pallets using a special vehicle which uses hydraulic devices to lower the entire pallets to the ground. ECO-SANDWICH® facade wall panels are kept at the construction site in the same position. The panels are transported to and installed onto the building using a tower crane or truck crane.

Quality control
Quality control of the ECO-SANDWICH® wall panels is carried out in each stage of the production. Built-in materials (concrete, reinforcement, anchors and connections) are controlled systematically by collecting evidence of their quality, in line with regulations. ECO-SANDWICH® facade wall panel is CE marked and has the Declaration of Performance in accordance with the EU Construction Products Directive and the relevant harmonised European Standards. The Declaration of Performance gives all information about the essential characteristics of the product and meets all relevant requirements of product safety directives.

U < 0,20 W/m²K
INSTALLATION OF ECO-SANDWICH® FACADE PANELS

The ECO-SANDWICH® facade panels are installed according to the installation plan onto the constructive reinforced concrete slab, after all of the load-bearing frame of the structure walls of the relevant storey have been completed. Facade elements are connected to the load-bearing frame of the structure using steel framing channels and adjustable bolts (all stainless or galvanized steel).

A scaffold is required for installation. Horizontal and vertical joints are done from the scaffold, into which rock wool rope of round cross-section is pressed, and then the joint is sealed using Ei90 two-component, permanent, elastic, fire resistant sealing slurry, in line with the instructions of the manufacturer.

HEALTH AND SAFETY

The ECO-SANDWICH® facade panels are lifted using a tower crane with certified ropes and properly functioning hooks and fuses. During the installation of ECO-SANDWICH® facade wall panel all regulations concerning occupational safety and health needs to be required. The wall can be manipulated once it has reached a height of minimally 30 cm above the depositing location.

The prefabricated facade panel hangs on the ropes until it has been stabilized, overseen by the line manager.

During each working process the workers, which have received training in occupational health and safety, use their protective equipment. The work is carried out under supervision of the line manager. All participants in the installation process have to adhere to the occupational health and safety measures, as set out in the applicable rules and law.
Vertical section of intermediate floor slab - Detail 1

- Internal load-bearing layer 12 cm
- Ecose® mineral wool 20 cm
- Ventilated layer 4 cm
- Exterior facade concrete layer 6 cm

Vertical section of intermediate floor slab - Detail 2

- Internal load-bearing layer 12 cm
- Ecose® mineral wool 20 cm
- Ventilated layer 4 cm
- Exterior facade concrete layer 6 cm
- UPN profile

Vertical section of intermediate floor slab - Detail 3

- Internal load-bearing layer 12 cm
- Ecose® mineral wool 20 cm
- Ventilated layer 4 cm
- Exterior facade concrete layer 6 cm
- Adjustable metal cantilever

Vertical section - Connection with lower part of the window

- Internal load-bearing layer 12 cm
- Ecose® mineral wool 20 cm
- Ventilated layer 4 cm
- Exterior facade concrete layer 6 cm
- Airtight sealing tape
- Metal screw built into the concrete every 50-90 cm
Vertical section - Connection with upper part of the window

1. Internal load-bearing layer 12 cm
2. Ecose® mineral wool 20 cm
3. Ventilated layer 4 cm
4. Exterior facade concrete layer 6 cm

Airtight sealing tape
L-profile
Ventilation profile

Vertical section - Connection with upper part of the window, detail with the roller blind box

1. Internal load-bearing layer 12 cm
2. Ecose® mineral wool 20 cm
3. Ventilated layer 4 cm
4. Exterior facade concrete layer 6 cm

Airtight sealing tape
L-profile
Ventilation profile

Vertical section - flat roof

1. Load bearing tape for drip edge
2. Sheet metal
3. Metal bond with hole for anchor bolt
4. Fire protection: Mineral wool tape EI 90
5. Sealing tape EI 90
6. Permanent elastic sealing slurry
7. 1-layers of flat roof

Internal load-bearing layer 12 cm
Ecose® mineral wool 20 cm
Ventilated layer 4 cm
Exterior facade concrete layer 6 cm

Airtight sealing tape
Horizontal section of building corner - Detail 1

- Reinforced concrete column
- Sealing tape EI90
- Permanent elastic sealing slurry
- Internal load-bearing layer 12 cm
- Ecose® mineral wool 20 cm
- Ventilated layer 4 cm
- Exterior facade concrete layer 6 cm

Horizontal section of building corner - Detail 2

- Adjustable metal cantilever
- Reinforced concrete column
- Sealing tape Elgo
- Permanent elastic sealing slurry
- Internal load-bearing layer 12 cm
- Ecose® mineral wool 20 cm
- Ventilated layer 4 cm
- Exterior facade concrete layer 6 cm
SAFETY
- Increased safety of workers
- Fire resistance class: 90 minutes

QUALITY
- Lower possibility of construction damage (water condensation, mold and mildew occurrence...)
- Production in the controlled environment in the factory

ENERGY
Building options:
- Energy class A+
- Passive houses
- NZEB (Nearly zero energy buildings)
- U-value < 0.20 W/m²K
- 46% reduction of energy use during the 50 year life-cycle compared to concurrent products

SPEED OF CONSTRUCTION
- 70% faster construction compared to classic masonry walls
- Dry construction process

HEALTH
- Sustainable insulation materials
- No formaldehyde, phenol or styrene
- Airborne sound reduction index: 53 dB

ECOLOGY
- 39% reduction of CO₂eq emissions during the 50 year life-cycle compared to concurrent products
- 50% reduction of natural resources use compared to concurrent products
- 50% more recycled construction and demolition waste
- Easily recyclable

COST
Relative relationship of the prices of construction systems regarding the system masonry+ETICS (EPS)

*cost comparison: construction of building envelope for a family house using different construction systems, house with the surface area 450 m²