SBI-publ.

SBI-SÆRTRYK
252

UDK 643.52:69.057.1(489)

Building Research and Practice,
Volume 2, Number 3, 1974

Klaus Blach, Georg Christensen:
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STATENS
BYGGEFORSKNINGSINSTITUT

I kommission hos Teknisk Forlag
København 1974

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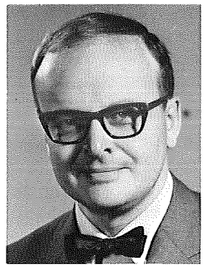
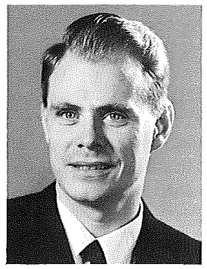
The development of industrialised building in Denmark, which has led to wide overseas use of some Danish systems, eventually stimulated the development of prefabricated bathroom box-units. There is now a wide range of such units in the country which offer a reasonable degree of user choice.



Klaus Blach is an architect at the Danish Building Research Institute. He is a member of the International Modular Group and has also conducted courses on standardisation, modular co-ordination and industrialised building in several countries.



Georg Christensen is a civil engineer. His work with the Danish Building Research Institute has latterly concentrated on the development of test-and-evaluation methods associated with the performance concept in building.

Industrialised building on a large scale started in Denmark about 1955. The main emphasis has been placed on technological development and so far a number of concrete building systems developed in Denmark are quite widely used, not only within the country but elsewhere in Europe and even as far away as the United States and Canada.

When looking at the construction process in system building it became apparent years ago that kitchens and bathrooms required a great number of work operations which often caused trouble on the building site, especially as many crafts were involved.

The first reaction to this was the development of the prefabricated kitchen, which was installed as furniture in a room already finished by other crafts. It was very easy to show that for a number of technical reasons and from an economical point of view this change was very successful.

Around the mid-sixties the same reasoning was applied to bathrooms and toilets, but the 'furniture approach' did not work in this case. It seemed first of all to be necessary to deliver the installations 'prefab', possibly with the sanitary appliances ready mounted – and this led to the idea of building complete bathroom box units.

In this period some ideas were tried out, but the economic facts showed in most cases that the time was not ripe for a radical change. However, the rise in labour costs continued and with better and more advanced planning systems it became even more obvious that the construction of bathrooms was a real bottleneck in the building process.

At the same time, user requirements for bathrooms were being re-assessed. Ever since the first era of functionalism, the 'clinical' bathroom had remained much the same, but in the late sixties it started to change. It became bigger (or an extra toilet with hand-basin was added separately in plans) and it was desired that the bathroom should contain more installations and fixtures and be able to accommodate more functions. This naturally tended towards turning the bathroom into an even more complicated affair.

For these reasons the idea to build completely finished bathroom boxes was taken up again about 1970, and within a very few years the production rate of bathroom box units for all kinds of building – eg dwellings and hospitals – had increased from about 100 units a year to nearly 10 000 units a year.

ISBN 87 563 0192 8

These figures must be seen in relation to the total production of dwellings which at the moment in Denmark is about 50 000 a year. The development has been aided by the introduction of new building materials (eg plastics) which are suitable for industrial manufacture of bathroom units.

Research and development stepped up

Danish manufacturers are now pooling their resources to ensure that a maximum of research and development work goes into the design of each type of bathroom box unit.

At the same time a certain standardisation may make it possible to limit the number of models from each factory. This should also enable each model to be designed even more carefully. Danish architects are already taking the box unit solution very much into consideration. Seen from the architect's point of view it is naturally an advantage to use bathroom box solutions which have been carefully designed and for which the responsibility for the total design rests in one place, with the manufacturer.

Seen in a wider perspective, however, his role as the designer of single, individual bathrooms could become a thing of the past in many cases. In future he will most likely select suitable bathroom components from catalogues.

If further technological development makes it more feasible to deliver bathrooms as large sectional units – eg a bathtub 'alcove' with walls, ceiling and installations – such units will naturally also be manufactured. Some systems of this type are already on the market. But this would not alter the major trend that easy-to-order bathrooms, in the form of ready-to-be-mounted components, will be available from catalogues.

Going modular too

Until recently, most bathroom units were tailor-made, ie designed to fit into the project they were meant for. This was a realistic approach during a pioneering period, when these units were mostly used in such large projects that costs could be amortised in a reasonable way.

Now they have, however, started to become modular. There are two reasons for this. First, it is now foreseen that they may also be used for smaller projects – a single- or two-bath room unit may be ordered for a villa. In this case the unit must be a stock item, and as most projects are modular designs, the unit must be modular also. Secondly, when bathroom units are modular, it becomes easier to consider their use in making the first layout sketches. For all modular designs such sketches are made on a modular grid. If bathroom units are available in modular sizes it is enough to indicate the dimensions on the sketch layout. The unit will then fit into the space allocated to it.

A similar procedure has been used for some years in connection with staircases and kitchens, where modular components for stair-runs, landings and kitchen equipment have also been developed to fit into modular carcass or envelope designs.

Fitting box-units into the building

The technology developed has not only solved many problems in relation to the box-units proper, but various solutions are also available for connecting the units to the surrounding building parts. They make it possible to order a room-size box-unit by its catalogue number and install it like a window or wall component The details vary according to the type and construction of the unit and to the construction of the surrounding parts. It is foreseen that two or three units may be placed adjoining each other (viz. a scullery, a bathroom and a toilet) and that they may adjoin various wall-types.

To obtain economic solutions, several types of bathroom units are constructed in such a way that the exterior surface of several walls are ready for paperhanging or painting; ie the box-unit wall constitutes a partition for the room next to it.

Among the special details can be mentioned solutions for connecting vertical installations between storeys and for solving the doorstep problem, which occurs when flooring levels vary.

Models available

Models available on the Danish market are all designed to comply with the Danish Building Code. Some of them carry an approval by the Danish Housing Ministry where they contain features not covered by the code.

It should be noted that a model which complies with the code does not need – and cannot obtain – a special approval. And an approval by the Housing Ministry is not a special 'quality label'; it only indicates that a model – which contains new solutions – is just as good as those solutions which do not need approval. About a dozen different systems exist on the Danish market today. Six of the most typical are presented in figs 1–6 from the heaviest to the lightest. Further information is available from the Danish Building Research Institute (PO Box 119, 2970 Hørsholm, Denmark.)

Product

Reinforced concrete floor-slab, lightweight aggregate concrete walls and ceiling. Floor, walls and ceiling are assembled by vertical through-bolts, which are also used as lifting bolts. Interior lining on floor: mosaic tiles. On walls: glazed tiles, on ceiling porous paint.

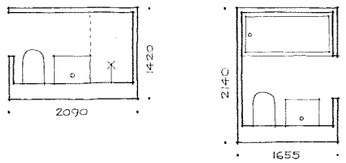
1

Production

E. Jørgensen Ltd., Box 49, DK-8700 Horsens

Types

Fourteen types as standard, including several for handicapped persons. Individual designs made to order.



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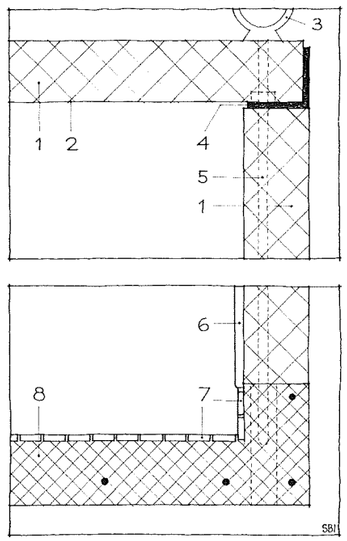


1 lightweight aggregate concrete; 2 porous paint; 3 eye nut for lifting; 4 steel frame; 5 through-bolt in cast-in tube; 6 glazed tiles; 7 mosaic tiles; 8 reinforced concrete.

Other information

1 Exterior surface of three walls ready for paperhanging or painting
2 Fire resistance 30 min (ISO/R834/1968)
3 Sound insulation, approx 37 dB
4 Prewired electrical installation
5 Various interior patterns and colour schemes
6 Floor heating equipment can be cast in

Product

Lightweight aggregate, foamed concrete box with reinforcement. Floor, walls and bathtub, resp. shower basin, are cast in one operation. 2

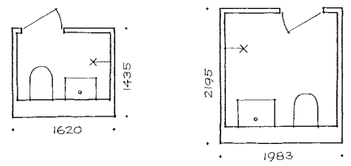
Interior lining on floor, walls and bathtub: GRP with a gelcoat finish. On ceiling: special paint. Floor: non-skid pvc floor covering.

Production

FLEXOVIT Ltd. Industriparken, DK-4800 Nykøbing

Types

Seven types as standard. Most also available as inverted types and with different arrangement of sanitary equipment.



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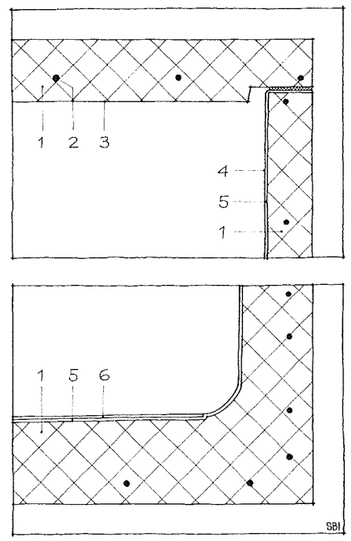


1 lightweight aggregate foamed concrete; 2 reinforcement; 3 porous paint; 4 0·4mm gelcoat; 5 1·5mm GRP; 6 1.5mm pvc flooring material.

Other information

1 Exterior surface of three walls ready for paperhanging or painting.
2 Various interior colour schemes.
3 Prewired electrical installation.
4 Sound insulation, approx 37 dB.
5 Fire resistance 30 min (ISO/R834/1968)
6 Water pipes, cast-in copper tubes, 15 ato.
7 Drains, cast-in PEH-tubes, class 0.5 ato.

3

Product

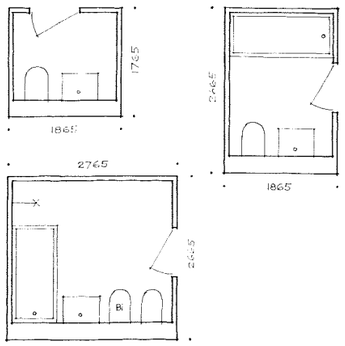
Box of separate floor-, wall- and ceiling elements. All elements are of sandwich type consisting of a core of rigid pu-foam between two 10 mm chipboards. Interior lining on floor and walls: pu-coating, 'Perginol'. On ceiling: porous paint.

Production

HOTACO Ltd., 24 Lundemarksvej, DK-4800 Holbaek

Types

Four types available as standard.



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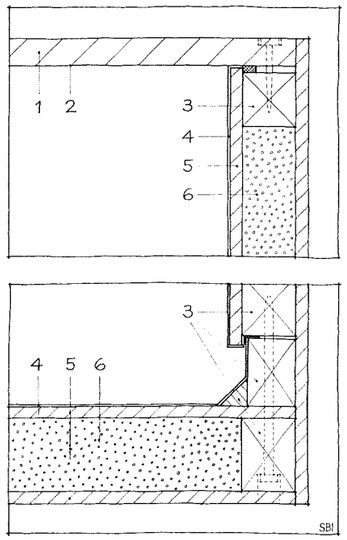


1 22mm rot-resistant chipboard; 2 porous paint; 3 pressure impregnated wooden framework; 4 pu-coating; 5 10mm rot resistant chipboard; 6 rigid pu-foam.

Other information

1 Exterior surface of three walls ready for paper-hanging or painting.
2 Various interior colour schemes.
3 Prewired electrical installation.
4 Fire resistance 30 min (ISO/R834/1968).
5 Units are available for assembling on building site.

4

Product

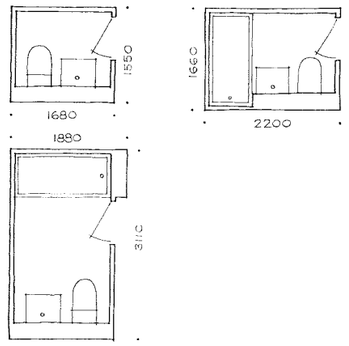
Box of welded tubular steel frame internally lined with 16mm rot-resistant chipboard, externally with 13mm fibreboard. Interior lining on floor: 1.5mm pvc floorcovering. On walls: 1mm plastic laminate. On ceiling: porous paint.

Production

FLEXABOX Ltd., 3-5 Sneppevej, DK-9900 Frederikshavn.

Types

Four types as standard. All types, including individual designs, produced to order.



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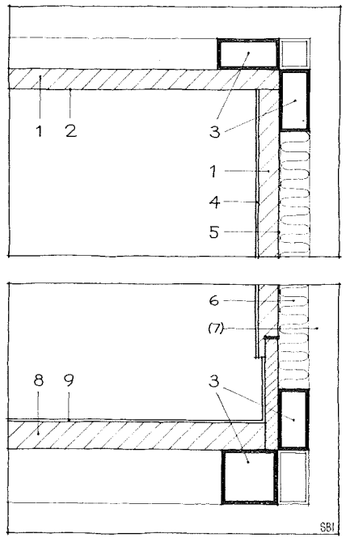


1 16mm rot-resistant chipboard; 2 porous paint; 3 tubular steel frame; 4 1mm plastic laminate sheet; 5 0.8mm plastic laminate sheet; 6 25mm rockwool; 7 external cladding when desired: 13mm fibreboard; 8 22mm rot-resistant chipboard; 9 1.5mm pvc flooring material.

Other information

1 Exterior surface of three walls ready for paper-hanging or painting.
2 Fire resistance 30 min (ISO/R834/1968).
3 Prewired electrical installation.
4 Various interior pattern and colour schemes.

5

Product

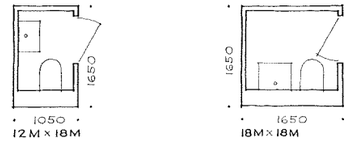
Box of separate floor-, wall- and ceiling elements. All elements are of sandwich type consisting of GRP, pu-foam and chipboard. Coating on all interior surfaces is a gelcoat-finish.
Bathtub is obtainable either separately or as part of box (bath cabinet).

Production

KBI-komponenter, 34 Tåstrupgrådsvej, DK-2630 Tåstrup.

Types

Many types, including inverted ones and types for handicapped persons.



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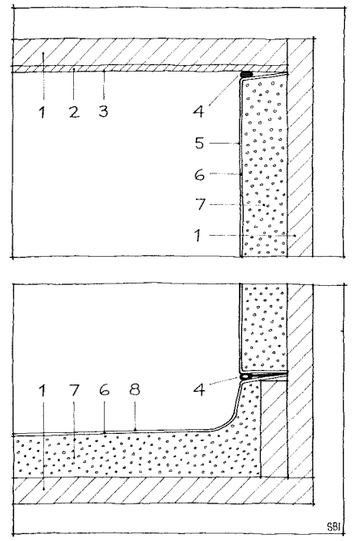


1 22mm rot resistant chipboard; 2 5mm asbestos-silicate sheet; 3 porous paint; 4 sealing strip; 5 gelcoat; 6 1.5mm GRP; 7 rigid pu-foam; 8 non-skid flooring of micro glass-beads.

Other information

1 Exterior surface of three walls is ready for paper-hanging or painting.
2 Prewired electrical installation.
3 Fire resistance 30 min (ISO/R834/1968).
4 Various colour schemes.
5 Separate bathtub can be folded up against wall.
6 Floor- and wall elements are available separately.

6

Product

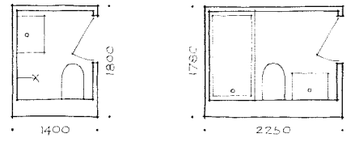
Box of sandwich construction consisting of GRP rigid pu-foam and chipboard. Floor, walls and bathtub, resp. shower basin, are cast in one operation. Ceiling element, also of sandwich type, produced separately and fastened on top of box with special adhesive. Coating on all interior surfaces is a gelcoat.

Production

SCANDIA-RANDERS Ltd. Postbox 200, DK-8900 Randers.

Types

Six types as standard. Also separate bath- and shower-cabinets and bathroom units for ships.



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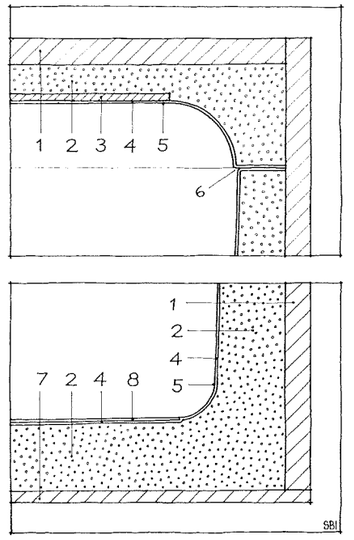

1 22mm rot-resistant chipboard; 2 rigid pu-foam; 3 5mm asbestos-silicate sheet; 4 2mm GRP; 5 0.4mm gelcoat; 6 glued joint; 7 10mm impregnated plywood; 8 1.5mm pvc flooring material.

Other information

1 Exterior surface of three walls ready for paper-hanging or painting.
2 All corners are cast with soft roundings to allow easy cleaning.
3 Fire resistance 30 min (ISO/R834/1968).
4 Prewired electrical installation.
5 Various colour schemes.