
INTERNATIONAL BUILDING EXHIBITION HAMBURG

# Smart Price House
# Case Study #1

October 2013

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# Imprint

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# A Introduction

## A.1 Smart Price Houses

The development of an affordable typology for housing in inner cities that enables people on middle and low incomes to own or rent urban residential property is one of the key tasks of any forward-looking city policy. The "Smart Price Houses" are focused on "intelligent" and aesthetically sophisticated modular constructions or designs involving inexpensive materials, as well as supporting self-assembly and encouraging input from building associations and groups. In short, this approach marks the reinterpretation of the prefabricated building as urban housing.

The "Smart Price" concept hinges on the implementation of cost-effective construction strategies that draw on experience and assets from the fields of prefabricated building, modular construction, pre-production, automation, and self-assembly, in order to develop ambitious and contemporary architectural solutions. The resulting building must not only be "contemporary" in terms of its architectural expression; it must also make a vital contribution to addressing socially relevant issues such as ecology, sustainability, energy and resource conservation, and the shifting of trends in community living, if it is to be considered innovative. Four "Smart Price" designs were implemented by March 2013, all of which make their own contribution to the "Smart Price" approach.

A central aspect of affordable construction is the way in which its models can be applied to other sites, particularly those that feature problems common in cities. This idea informed the themes for the "Smart Price Houses". To what extent are the models created here transferable without the additional assistance of Internationale Bauausstellung IBA International Building Exhibition Excellence funding or other subsidies? The intention is that the development of the "Smart Price Houses" will set new standards and thus establish prototypes for constructing such buildings at other sites.

The architectural and building services concept behind the "Smart Price Houses Case Study #1" will be detailed in this White Paper. The block showcases the prefabricated building concept as one of a total of three "Smart Price houses". Another point of focus is the clear presentation of the planning process, as various changes were made between the design stage and the implementation of the model project. The reasons behind these alterations were technical, financial, or functional, meaning that some original targets had to be adjusted.

Model projects are particularly liable to undergo planning changes; indeed, besides featuring innovative end products, building exhibitions also seek to test construction methods and processes. Only when the planning process is examined is it possible to ascertain whether a model building project can serve as a good example of the use of smart materials in the twenty-first century, or whether the concept needs to be reworked. In addition to technical details for experts, this White Paper is intended to provide an objective assessment of whether the model project fulfils this aim, and whether and to what extent it has ultimately succeeded in achieving the goals set out before the planning stage.

After this short introduction, the "Smart Price House Case Study #1" will be covered in brief, and then explained in detail. In particular, this presentation focuses on the high degree of prefabrication involved in the construction, in order to reduce costs, and the feasibility of the concept when applied to this building and subsequent projects.

# A. 2 Project Outline of Case Study #1

## FEATURES

- The modular system allows for different styles of living and can be adapted to individual needs.
- It uses a cost-effective construction system, to make use of abandoned inner-city areas.
- Low resource consumption is achieved through the use of wood and concrete as construction materials.

Fig. 1: View of the southwest façade, May 2013

Fig. 2: View of the north side, May 2013

The concept and plan for "Case Study #1" were devised by the firm of architects Fusi & Ammann, and mark a multifaceted response to the densification and re-urbanisation processes. This sophisticated inner-city prefabricated building system offers an innovative alternative to a property in the suburbs. The block of flats brings together urban living and family-friendly, flexible design, incorporating a garden and roof terraces. The prefabricated construction is the end result of highly effective manufacturing processes that enable the building to be erected in a cost-effective way.

"Case Study #1" can be built on vacant lots within densely developed urban areas, as part of a terraced or perimeter development, or as a free-standing apartment block. It can therefore be applied in many different settings, and thus serves as a model for development within metrozones. Its versatility comes from its modular space concept, which allows different space divisions and living configurations, even across whole floors. Like lofts, the interiors of the modules are clearly structured, with minimal decoration, and are extremely flexible. The adaptable floor plan leaves room for the residents to express their individuality, as well as allowing the space to meet their many and changing needs.

## PROJECT PARTNERS

### Architecture

- Fusi & Ammann Architekten, Hamburg

### Investor

- Schwörer Haus KG, Hohenstein-Oberstetten

### Technical Building Services

- Schwörer Haus KG, Hohenstein-Oberstetten

### Structural Design/Fire safety

- Schwörer Haus KG, Hohenstein-Oberstetten

### Construction Materials Partners

- Bau Info Center, Hohenstein-Oberstetten
- Kastell GmbH, Veringenstadt

### Other Project Partners

- Hamburg Energie GmbH, Hamburg

## PROJECT DATA

### Project Costs

- approx. € 1.85 million

### Plot Size

- 800 m$^2$

### Gross Floor Area

- 1.200 m$^2$

### Size of the functional units

- 45 - 140 m$^2$

### Construction Period

- December 2011 - December 2012

### Energy Standard

- KfW Efficiency House 55

### Energy Supply

- The energy design includes radiant ceiling heating, a controlled ventilation system with heat recovery, and connection to the "Wilhelmsburg Central Integrated Energy Network".

# B Case Study #1 Project Details

## B.1 Architectural Concept

Situated between "BIQ" and "CSH Case Study Hamburg", the building offers a total of nine residential units over 1,200 square metres. This pilot project, designed by Fusi & Ammann Architekten, is intended to explore the possibilities for reinterpreting prefabricated buildings in view of a changing urban landscape and different living habits, in particular among the traditional clientele for prefabricated housing. The result is a versatile townhouse with six loft apartments that can be adapted to the wishes of the future residents without any great effort. The modular structure demonstrates that this method is not the sole preserve of free-standing apartment blocks. It is hoped that this approach and solution can also be applied to vacant lots in densely built-up urban areas, or constructed as part of a perimeter development.

The modular assembly system and concept, based on a high degree of prefabrication, have resulted in a building that can be constructed quickly, cost-effectively, and on a wide range of inner-city sites. Above a basement floor are four full storeys with three smaller, stepped roof structures, opening to the west from the courtyard.[?] The building's cubature is staggered: the front part comprises three full floors that end in two symmetrically arranged roof structures, while the rear part of the building is four full storeys high, with only one roof structure.

The shape of the building is determined by two blocks that form a T. It is based on a 45 square

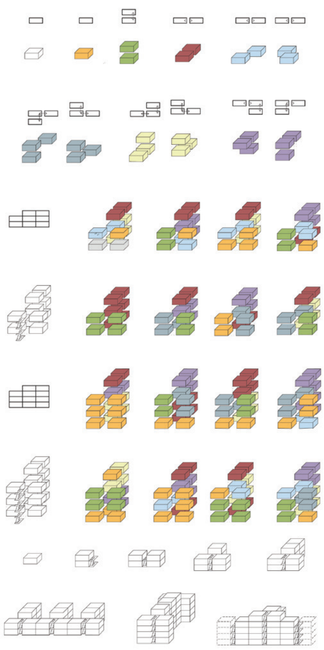

Fig. 4: Possible module combinations

metre module configured as a square, which is used twice within each block. While the modules are arranged immediately next to one another in the rear wing, in the front wing the stairs are located between the two modules.

The four modules per floor can be merged vertically or horizontally, in different ways and with separate floor plans. Each module has an installation duct running through it, which ensures maximum flexibility for the separate or common use of the various areas. The installation duct, with the bathroom, utility, and kitchen areas adjoining

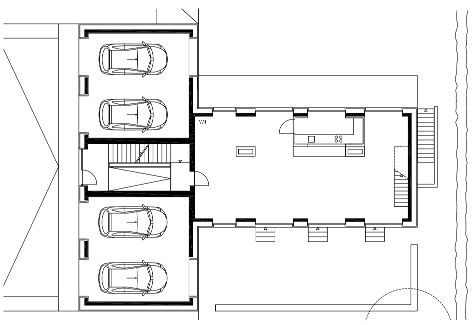

Fig. 3: Ground floor ground plan

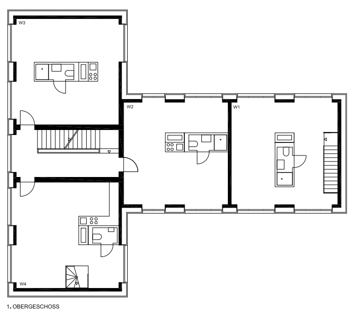

Fig. 5: First floor ground plan

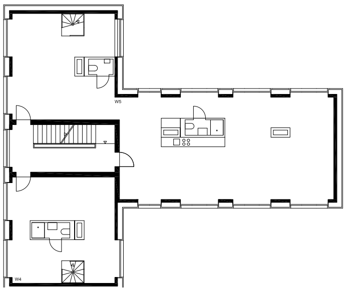

Fig. 6: Second floor ground plan

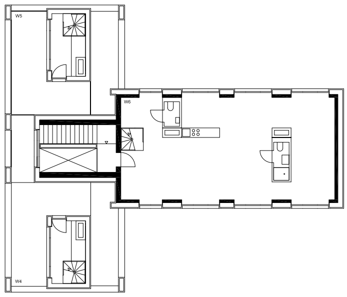

Fig. 7: Third floor ground plan

it, is thus the only structured element inside the building. All of the modules lack additional supports thanks to the ceiling structures that have been used. The interiors of the modules are therefore extremely versatile, and also have minimal design features.

Above the second floor of the front wing is the flat roof surface which is used as a roof terrace for both modules, which each have their own doorway. Access from the inside is via a spiral staircase, while it is also possible to leave the roof area via the stacked floor structure. Half of the roof surface above the third floor of the rear wing is also used as a roof terrace; access is arranged in the same way as the front wing. The remaining roof surface, about 70 square metres, is a sweeping green roof. The apartment on the ground floor of the rear wing has access to the garden. Four parking spaces are located on the ground floor, to the right and left of the staircase entrance.

The positioning of the windows is based on the arrangement of the modules. Together with the black-coated, fire protective, horizontally clad solid wood façade, these windows endow the building with an ordered and consistent punctuated façade. The block's external appearance is defined by its stark and striking cubature.

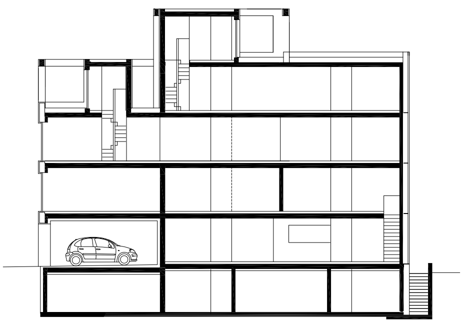

Fig. 8: Longitudinal section (east-west)

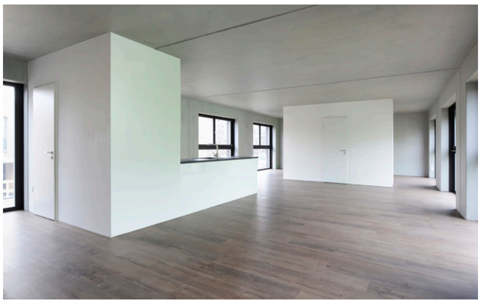

Fig. 9: Interior view, upper floor

Fig. 10: View of windows on façade

# B.2 Smart Price Concept

The building's concept stems from a fresh look at the "townhouse", and seeks to redefine this type of construction. The key characteristics of the townhouse are its identity and urban setting, which allow for a particular type of living. It is an expression of a changing society, and modern means of technical production can be used to provide appropriate solutions for diverse lifestyles. Townhouse construction is interpreted as an expression of balance between individuality and participation in public life within the city. For this reason, the apartment block has been integrated into the local district, while it is also distinguishable as a stand-alone building.

Another important feature of the project is that it can also be seen as a prototype for the hypothetical development of vacant lots within inner-city areas. With this in mind, the project has been designed so that the building type is versatile: instead of being constructed as a stand-alone block it could form part of a linear development or be implanted into an empty lot.

The basic concept interprets urban living as a system of constraints that permit the implementation of different lifestyles. The "townhouse" building type is therefore defined by its urban character, as on the one hand it contributes to the growth of the city, and on the other it enables its residents to practise a wide range of living options. For this reason, the block strives for maximum flexibility, effected by a clear system of fixed components that can be supplemented and given character by integrating new elements such as furniture, room dividers, and wet rooms.

The "Smart Price" approach for "Case Study #1" was primarily achieved by the high degree of prefabrication, the materials used, and the support-free construction of the ceiling elements to ensure extensive flexibility, as well as by the modular design itself. The structure and modular design will be explained in greater detail below, as these paved the way for the implementation of the innovative building concept.

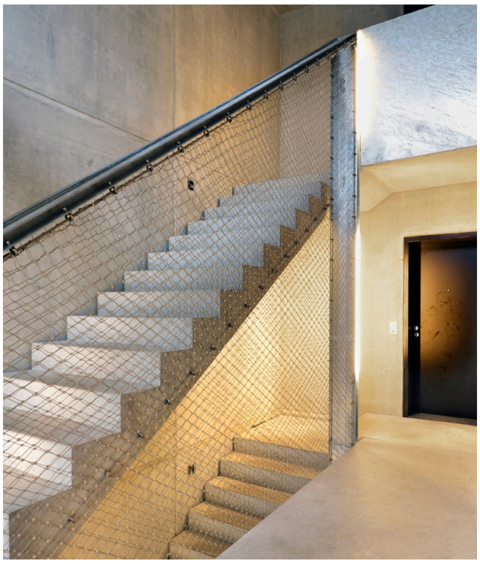

Fig. 11: Ground floor flight of stairs

**Modular Design**

The new modular system allows neutral and multifaceted modules to be mass produced, so these can be arranged in countless different configurations on demand. This added to the cost and complexity of the construction of this model building in Wilhelmsburg.

The basic spatial unit for the design of the "lofts" and the townhouse as a whole is a neutral module. This basic module can be industrially prefabricated, thus minimising construction expenditure for cost types 300 and 400 (in accordance with regulation DIN 276) through mass production.

This is based on the following considerations:

1. A lower and an upper prefabricated ceiling element: This ceiling element can be installed in different contexts and on different floors using a range of technical solutions. These options are demonstrated in "Case Study #1" in order to showcase the possibilities for adaptation. For instance, ceilings with technical solutions that can be lighter for the upper floors are chosen for building

multistorey townhouses. This option results in a less onerous load for these structures, which can be built with the same modules.

2. Two solid, parallel, load-bearing walls made of finished, exposed concrete elements, which are perforated in the window area: These supporting walls are attached to the ceilings by different means, individually developed to fit each type. These various sophisticated solutions illustrate the adaptability of the module to various versions of the townhouse building type. The finished exposed concrete elements allow townhouses to be built in other contexts, several storeys high but without any additional static or fire protection problems.

3. Perforated, suspended, insulated wood panel walls as a "shell": The wood panel walls are used as load-bearing and insulating walls in the construction of conventional prefabricated detached houses. In contrast, in "Case Study #1" they are conceived as supporting components that are fully industrially prefabricated in a factory and are delivered to the building site for quick assembly. The two wall components, finished exposed concrete parts made of solid reinforced concrete and a timber framework with integrated insulation, complement one another and create synergies for the new townhouse structure. Here, unlike with standard prefabricated detached houses, the relationship between solid precast parts and wooden prefabricated parts has been rethought.

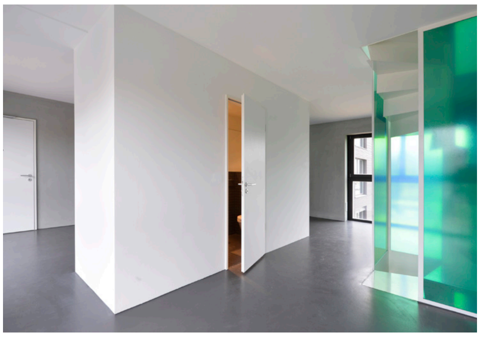

Fig. 12: Building services installation duct

Fig. 13: First floor loft

4. A duct made of drywall elements, which contains all of the building services installations and serves as a guide for the interior spatial divisions: The duct's dimensions were kept to a minimum in order to maximise the range of inner layouts. At the same time, it was fitted with a large number of terminal connections to enable the future kitchen elements and wet rooms to be repositioned. All other forms of spatial division such as furniture, sliding walls, textile or covered walls, and fixed dividing walls can be positioned around this duct.

5. Prefabricated modular wet rooms connected to the ducts: Unlike in traditional shipbuilding and hotel construction, the wet rooms can be repositioned by reconfiguring the apartments. If an apartment is newly divided up as the result of a generational change among the residents, new living requirements, or needs to be merged with another, the baths can be replaced or moved.

The module can be replicated multiple times, and joined together horizontally or stacked vertically. This form of assembly creates micro-lofts (basic unit 45 square metres), meso-lofts (90 square metres), and macro-lofts (140 square metres). If there is a generational change among the residents or if they have new living requirements, the

Fig. 14: Prefabricated wet room (type 1)

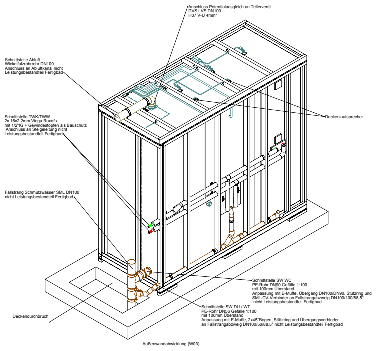

Fig. 15: Schematic diagram of wet room

macro-loft, which is constructed as a maisonette apartment on the ground floor and first floor of the building, can, for example, be redivided. Conversely, two micro-lofts or a micro-loft and a meso-loft that were initially built as separate apartments can later be merged. In a townhouse building a meso-loft or a macro-loft can be divided up into living and working areas either temporarily or long term.

The apartment block has an affinity with other buildings planned for the surrounding area. The building is laid out according to the points of the compass: all of the apartments are oriented either north–south or east–west. The module can be assembled around a prefabricated finished concrete element – the staircase – thus enabling many different possible variations. During the construction of other buildings the opportunity arose to position the staircase in a different way, or to supplement it with a lift, so that the block could accommodate more storeys than "Case Study #1" and thus hold a larger number of accessible apartments.

### The "Loft" as a Housing Space

The term "loft" refers to a type of space that is clearly structured, with minimal design features, and that can be used with different layouts in an extremely versatile manner. The "loft" space is the defining element of this apartment building, and is created by using a pared-down permanent structure. This space can be interpreted in a vast range of ways to suit different lifestyles, so that each design is different. An array of possibilities for dividing up the space allows it to reflect the degree of mobility of the individual user, so that changes can be made between night and day use, or between the areas used by different age groups.

The room layout of the lofts is thus extremely flexible, and they are especially intended for lower and middle income brackets, single parents with children, and large families. In addition, these spaces are ideal for a flexible mix of living and working. The size of the lofts can be altered depending on their residents' requirements, as the building is designed to be adaptable so that, subject to availability, lofts of every module type can be minimised or enlarged. The ground floor apartment has the use of a garden, while all of the other lofts (with two exceptions) have access to a roof terrace.

### Structure

The building is a composite construction. The primary structure consists of precast reinforced concretecomponents: the floors above the basement and the ground, first, and second floors consist of industrially prefabricated elements such as prestressed concrete false ceilings. The technical building equipment was integrated into the supporting and reinforcing exterior wall components at the factory. The non-load-bearing wood panel elements positioned in front of these provide protection against heat and the weather generally, as well as adding to the look of the

Fig. 16: Second floor loft

façade (as an alternative to solutions involving thermal insulation composite systems). The façade is clad in dark grey varnished spruce. Behind this is the WärmeDirekt exterior wall ISO+ by SchwörerHaus, with full mineral insulation. The ceiling above the third floor is also unsupported and made of solid wood with the underside left bare. The contrast between the light surface of the bare wood and the dark parquet serves as a design feature. According to building regulation §2 (3), "Case Study #1" falls into building class 4, which has high fire protection requirements that have been ingeniously met through the construction methods used.

## Exterior Wall Construction

The exterior wall is a concrete bracing wall covered in a wood panel wall. The double wall system allows vertical load transfer and reinforcement, primarily through the finished concrete components and the wall panels on the inner side. The curtain wall wood panel construction provides protection against heat and weather. Prior to this project, this system was used only in redevelopment. Using this combination in a multistorey building is a pioneering move.

The building therefore has a U-value of 0.134 watts per square metre per degree Kelvin ($Wm^2K$) and a sound reduction value of 58 decibels. Its fire resistance rating meets the REI 90 test standard. The wall structure is divided into the following components: the façade features wood cladding made of dark, varnished spruce, followed by patented, cement-bound solid Cospan (16 mm). SchwörerHaus developed their own synergy

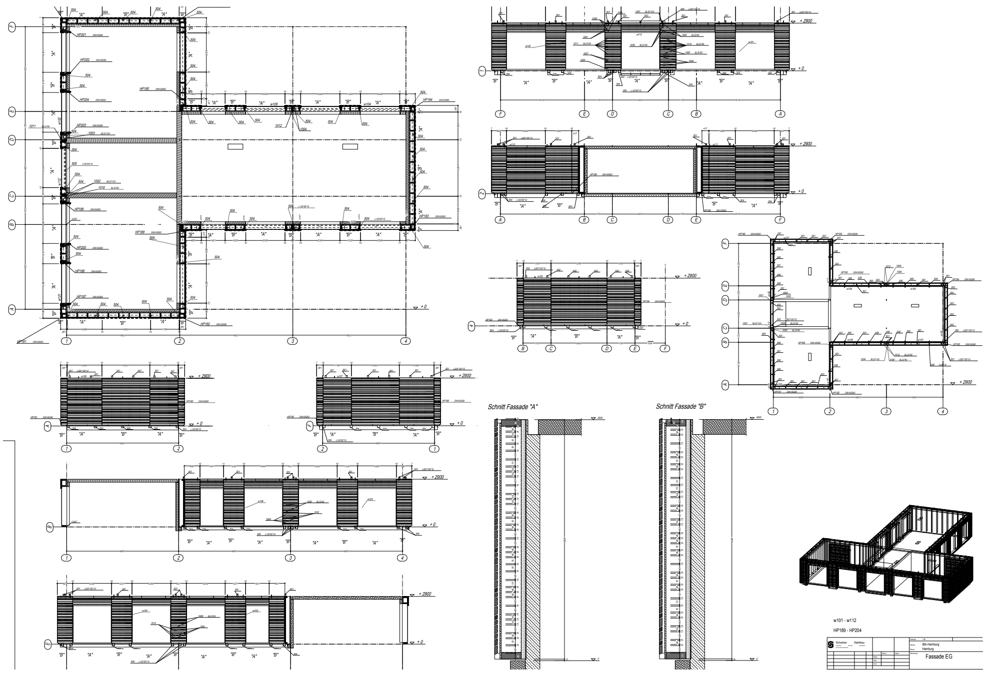

Fig. 17: Façade structure details

technology to optimise the draught-proofing of the building's shell. Attached to this are a timber framework with 240 mm thick mineral thermal insulation, protection against moisture, and another timber framework layer with 60 mm thick mineral thermal insulation. This additional timber frame with insulation ensures greater heat protection than a standard exterior wall. On the inside, 16 mm thick wood-based material board and 9.5 mm thick encapsulation are finished with plasterboard.

The use of concrete panels as the primary structure has the following advantages:

- The installations are applied to the solid concrete slabs and incorporated into the elements while in the factory.
- The vapour retarder remains intact during subsequent installations.
- The significantly higher wall mass improves the indoor environment by acting as mass storage with a balancing effect. At the same time, the concrete panels markedly improve noise and fire prevention.

The use of wooden wall elements as the secondary structure has the following advantages:

- The wall elements are fitted with windows and rendered in the factory.
- This cuts out local execution times, and drying and scaffolding times.
- The vapour retarder is protected behind the concrete shell.
- As the concrete shell takes care of the load transfer, the timber frame can be confined to the structurally vital cross-section to allow for thermal insulation.

The construction method avoids the need to use shuttering materials, while the pre-installation at the factory reduces the site assembly time, resulting in a shorter execution time. A wall surface can also be finished quickly. This means a reduction in construction costs and complies with the "Smart Price" approach.

### Ceiling Structure Details

Despite the variety of systems for ceiling structures, what they have in common is that they bridge the existing spans without supports, hence the building's versatility in terms of use and divisions.

In order to showcase a wide range of ceilings for multistorey buildings as part of the IBA, the building is designed to include a combination of three ceiling systems. The focus is primarily on the combination of different construction materials and their advantages, as well as the high level of prefabrication, which ensures an efficient and non-weather-dependent build. This range of ceilings is not structurally necessary for the Wilhelmsburg block but has been used specifically to demonstrate the diverse potential of the new modular construction system. The different ceilings mean a reduced load for multistorey

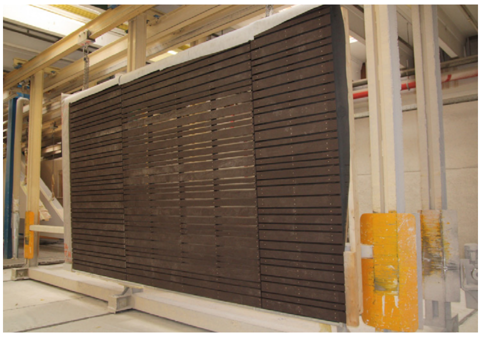

Fig. 18: Exterior wall cladding

Fig. 19: Exterior wall cladding and insulation

townhouses and allow for greater standardisation in the vertical supporting walls. In addition, mass production and the widespread implementation of the townhouse building type mean significant cost and time reductions, as well as energy savings transporting and assembling the building components. The systems meet the F90 fire protection requirements for storey ceilings as dividers, according to the building regulations. The special features of the individual ceiling systems are explained below.

The ceilings above the basement, ground, and first floors were constructed using the Variax system. This is a ceiling system featuring a combination of pre-stressed steel reinforcement and concrete steel reinforcement, a recently developed product that has never previously been produced in batches. The development of this system makes the high degree of flexibility achieved through the loft concept possible for the first time. The pre-stressing allows large spans to be bridged, so that the interiors can be laid out in a flexible way rather than determined by interior load-bearing walls; the structure is therefore minimal. As with the outer wall construction, a high degree of prefabrication shortens the building time. Reinforcement in the factory also contributes to rapid, problem-free assembly, as assistance is not required. Production in the factory is not dependent on the weather, thus ensuring higher quality. The reduced construction time and elimination of intermediate bases by eschewing load-bearing interior walls result in cost savings for underground working, building the substructure, and making a clean, smooth lower ceiling possible.

As transverse reinforcement and hoops can be installed as part of the Variax Pro system, these elements can be applied anywhere. It is possible to incorporate point supports and edge beams that fit with the ceilings. Individual loads can be concentrated and absorbed by the combined reinforcement. Notches in the elements can be quickly added in any form.

The ceiling over the second floor was designed as a solid wood and concrete composite ceiling hybrid construction. The tensions in the ceilings are absorbed by the upright discs of the glued laminated elements on the underside of the ceiling. The compression forces are dispersed by the cross-section of the top concrete layer on the upper side of the ceiling. The two materials were joined together using special screw connectors and assembled by experienced fitters.

Like the Variax Pro system, this arrangement allows large free spans. The modules are therefore unimpeded by the load-bearing partition walls or supports that would otherwise be necessary. The cross-laminated timber elements on the underside have a threefold function:

- Casing: they serve as a permanent casing for the concrete layer.
- Tension: they act as a static element to absorb the tensile stresses in the ceiling cross-section, instead of the statically necessary reinforcing steel that would otherwise be required.
- Ceiling soffit: the finished ceiling soffit can be applied to other upgrading processes such as making grooves to improve the space's acoustics.

This creates better noise and fire prevention, as no additional ceilings and thus no other fire protection measures are required. The use of wood, a renewable raw material, results in a reduction in carbon emissions during the build, and wide-span ceilings in a wood look are constructed with better vibration behaviour. The soffit was completed during the assembly.

This results in the following cost savings in comparison to a conventional design:

- There is no longer any need for the provision or use of cladding material.
- The use of reinforced steel is restricted to

structurally required reinforcement.

- The greater spans mean that fewer supports are needed.
- No additional ceiling plasterwork is required.

The ceiling above the third floor was built as a light wood and concrete composite ceiling using a hybrid construction method with insulation. The tensions in the ceiling are absorbed by a layer of wooden beams. Compressive forces are dispersed by the factory-made concrete slab on the upper side of the ceiling. Special screws join the two materials together. As a result, the U-value is 0.194 W/m2K. The ceiling incorporates a sound insulation mat, a concrete surface (which corresponds to the floor finish on the ground floor), a wood composite structure with mineral fibre insulation, an installation level, battening, and a plasterboard panel. The result is a ceiling structure that is almost free of thermal bridges, and can also be applied to heat-free areas. The use of reinforced steel is confined to structurally vital reinforcement, with the associated cost savings.

Tolerances can be eliminated due to the high-end, quality-controlled production of the concrete panel in the factory. This does away with the need for a levelling layer in the form of a conventionally incorporated floor finish. Heating coils are integrated into the concrete surface in the factory for the underfloor heating. The space between the timber frames can also be used to install building services technology while in the factory. The composite construction also improves the vibration behaviour of the structure. An impact sound insulation board is affixed directly to the smooth floor surface in order to improve impact noise and the acoustic decoupling of the floor structure.

The space between the timber frames is filled with insulating material while still in the factory. This structure is particularly appropriate for the transition to cold spaces and outdoor air. The composite section with insulated spaces and supporting concrete surface reduces the ceiling cross-section in comparison with structures that have overlying insulation. This also means that larger spans can be realised for the same cross-section. The high level of prefabrication significantly shortens the execution time on site, while reducing site logistics and interface problems.

# B.3 Building Services Concept

The energy design of this Efficiency House 55 (as per 2009 building regulations) is tied into the "Wilhelmsburg Central Integrated Energy Network", which integrates different buildings to form a "virtual" power station. The building is connected to the network's district heating supply. Inside, the ventilation and heating systems are linked together.

Each apartment has been fitted with a controlled ventilation unit with heat recovery. This ensures healthy living by changing the air regularly, while reducing energy costs through the heat recovery system.

Apartments are heated by concrete cooling. A radiant heating system is integrated into the top concrete layer and finished concrete shell of the ceilings and walls in the ground and firstfloor apartments, cooling the concrete core so that the building can be used as an active reservoir. The key feature of this is that the heating pipes can be integrated into the ceiling components while still in the factory.

Another advantage is the high level of prefabrication. There is no need for a floor finish, as the heating pipes are integrated while in the factory, and the concrete surface serves as a floor finish. The low supply temperatures (via a combination of a heat pump and connection to the "Wilhelmsburg Central Integrated Energy Network" local heating) ensure a consistent heat supply and a pleasant room climate. As the temperature is maintained at the same level, less energy is needed than for regular increments, so there is a self-regulatory effect. The temperature differences between the ceilings and the floor or room space vary only by about 3-4ºC from a room temperature of 21ºC. Another advantage over conventional air supply and heating systems is that the concrete cooling removes the need for additional electrical heating, with the result that the building is heated using only renewable sources.

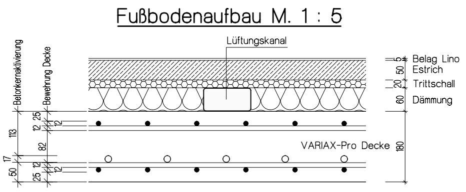


Fig. 20: Floor structure heated by concrete cooling (not to scale)

For cooling, cold water flows through the system, allowing the mitigation of undesirable spikes in ambient temperature due to use or concentrated sunlight. This smooth temperature profile ensures a constant pleasant temperature inside the building.

# B.4 Planning Process

A two-stage competition was launched in mid-2009, for which Fusi & Ammann Architekten created a concept that interprets the "town-house" as a flexible loft apartment building that can be adapted to the living situation and wishes of its residents. From the very beginning, the project, conceived as a modular construction with a high level of prefabrication, was developed in conjunction with the team partner and contractor SchwörerHaus KG and its partners.

The building showcases the combined skills of the SchwörerHaus Group, which manufactures its own prefabricated building products and components in other sectors – this project has seen the company take a new holistic approach. The basic loft unit as a prefabricated module with a square ground plan, made up of prefabricated elements such as wet rooms, finished ducts, prestressed concrete and wood ceilings, composite concrete and wood ceilings, load-bearing exposed concrete walls, and highly insulated wooden board façade elements, formed the basis for the design, while also informing the production parameters: choice of materials and material qualities, transport loads, size of production lines, and joint pressure points. The foundation work (auger piles, support frame, and floor) and the individual components of the interior structure were the only parts to be fully built on site.

Fig. 21: Elevation: from the competition

Fig. 22: Building site, summer 2012

When the competition design was reviewed, the original concept of a T-shaped building with flexible ground plans, constructed according to a modular system with a high level of wooden components and prefabrication, was retained. Some changes were, however, made to the project details, and these were reflected in the construction work, which was completed in late 2012.

The envisioned two or three storey building was given another floor. The loft concept featuring modules from 45 square metres that could be joined up vertically or horizontally remained unchanged. All building components had a high degree of prefabrication and were simply assembled at the building site. Ceilings were made of pre-stressed concrete with an inbuilt heating system, and were fitted into the other building components. The outer walls were produced as two-part wood and concrete boards in the form of large panels that could be fitted together and pulled apart, with windows and building services components already in place.

The ceiling construction was originally envisaged as becoming lighter towards the top – first concrete, then wood and concrete composite ceilings, then lightweight wooden ceilings. This was not implemented – not due to any technical problems, but because of fire protection requirements. This meant that only concrete ceilings could be used. The two different heating systems that were to be included for demonstration purposes were reduced to only one: all-over concrete

Fig. 23: Installation of prefabricated components, summer 2012

Fig. 24: Installation of wet room

cooling was incorporated, instead of combining this with the air supply and heating system.

Due to the high level of prefabrication in the building components and the vast experience of the investor SchwörerHaus KG in the field of prefabrication, the building construction phase was very short – the erection of the shell construction and the façades took only six weeks.

# B.5 Assessment

This project sees the prefabricated building reinterpreted as a townhouse that brings innovative construction methods to a multistorey building together with low levels of total construction costs and sustainability issues. As such, it is a pioneering building that acts as a showcase within the IBA, and demonstrates a vast range of design, spatial and technical solutions and configurations for forward-looking urban living.

"Case Study #1" takes an extremely fresh approach to its materials, of which it features countless innovative combinations in the outer walls and ceiling structures, made possible by the degree of prefabrication: reinforcement in the factory ensured that the assembly was quick and problem-free, as assistance was not required, and the division of the supporting structure from the thermal insulating shell permitted various façade systems with different levels of insulation.

As the building contractor, system producer, and architect formed a team as early as the competition stage, and the team went over the project intensively at that point, it was possible to deliver a design that could be executed with as few conceptual changes as possible, both in terms of the technology used and the expenditure required.

Unfortunately, the decision was made not to go through with the concept of different ceiling systems, due to difficulties in acquiring the correct permits. In this case the building contractor, who is not a project manager or property developer in the normal sense, tried to reach a compromi-

Fig. 25: Case Study #1, April 2013

Fig. 26: Wet room (type 1)

se solution too quickly, without checking which permits apply to wooden ceiling structures by seeking advice or opening discussions with the building authorities.

Thanks to the project's conceptual approach, which focused on a new type of building in combination with high-quality prefabricated elements, it has succeeded in meeting the targets and goals set out in the competition, and will serve as a good model for future projects.

- This is the type of building that can be set in a green meadow, constructed as a block or linear structure, or inserted into a vacant lot, and can comprise from one to seven storeys.

- An interior concept that allows for different apartment sizes and types (apartment over one floor, maisonette) and also the possibility of retaining the open layout of the lofts or dividing them into individual rooms.

- Prefabrication ensures the optimal use of resources (energy and material flows) and high-quality execution, combined with a sustainable, recyclable material concept. The two-part nature of the building's shell also allows its energy profile to be upgraded in due course through the prefabricated components and by changing the outer components of the insulated wooden board elements. The separation of the primary and

Fig. 27: Staggered storey, April 2013

secondary structures allows variable design elements to be used in the secondary part, so that the building type, conceived on the basis of previous design requirements, can be adapted to its surroundings. The two-shell structure incorporates a robust insulating layer, which can include environmentally friendly materials when applied to subsequent projects.

Industrial mass production allowed the on-site building phase to be significantly shortened, so that construction work could be carried out almost regardless of the weather. "Case Study #1" was one of the few IBA buildings to be completed without any delays, as it eliminated the execution period, and drying and scaffolding time. Thanks to industrial prefabrication and the unchanged quality standards, plus great price stability, uncertainties surrounding the build, such as additional costs due to weather and material price increases, could be kept to a minimum.

The selling price of € 2,700 per square metre lies well below the Hamburg average. In view of the high quality of the materials and the low running costs due to a high energy standard and the adaptability of the ground plans, the model has clearly been successful as a high-calibre construction. The modular construction system and materials used make it possible to transfer the concept to almost any other urban context. At present another project based on "Case Study #1", which was originally designed for the IBA Hamburg, is being constructed by SchwörerHaus in southern Germany, illustrating the exemplary nature of this type of building.

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