Upgrading of post-war Row Houses in The Netherlands on the area of usable area and thermal resistance

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ABSTRACT: About 21 percent of the total of 6.5 millions dwellings in The Netherlands are row houses from the period after the Second World War (1946-1976). These post-war row houses don't match up with present-day demands. The main goal is to upgrade these dwellings resulting in a larger usable area combined with more comfort and convenience and giving a better energy performance.

The first goal is to develop a unit that can be placed at the front or at the back of a row house while the occupant stays in his dwelling. This unit contains, if wanted, a kitchen or (for the second floor) a bathroom. The occupant can choose for one, two or three units on top of each other. Choosing three units means a new roof (with solar collector and photovoltaic solar cells) which connects the third unit and the old roof.

The second goal is to upgrade the thermal resistance of the complete dwelling with limited inconvenience for the occupant. Further, attention will be paid to day lighting, acoustic insulation and other problems.

With this design project outdated houses can be recycled into modern, comfortable, spacious low energy sustainable buildings

Conference Topic: 6 Recycled architecture
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1. INTRODUCTION

About 42 percent of the total of 6.5 millions dwellings in The Netherlands are row houses. From these row houses, almost 51 percent are from the period after the Second World War (1946-1965), this means almost 1.4 million dwellings. These post-war row houses don't match up with present-day demands. In this paper, a possible solution will be presented to recycle outdated houses.

2. JUDGEMENT OF THE OCCUPANTS

2.1 Introduction

In a research [1] preformed in Eindhoven by 'Stichting Interface', the judgement of the occupants on their dwellings is reviewed. In this research, the occupants had to judge a list of aspects of their dwelling. The outcome of the research is presented in the document 'Dynamiek, waardering en woonvoorkeur'. From this research, several conclusions can be drawn. In this paper, only the most important conclusions will be mentioned.

2.2 Outcome of the research

The first aspect the occupants had to judge, was the size of the different inner and outer spaces. The storage area was judged the worst, followed by the bathroom, balcony (if present) and kitchen.

The second aspect is the suitability of the different spaces. Just like the size, the worst suitability was that of the storage area. This was again followed by the bathroom, kitchen and balcony (if present).

Looking at the technical condition, the occupants mentioned the acoustic insulation, the thermal insulation, the degree of finish of the interior, the draft and the present condition of the exterior as the worst aspects.

Finally, the facilities of the dwelling were judged. The occupants were the least satisfied with the safety aspects, followed by the facilities of the bathroom and kitchen.

The solutions presented in this paper, will give an answer to most of the mentioned negatively judged aspects. Of course, not all the mentioned problems can be solved within this solution.

3. CHARACTERISTICS POST-WAR ROW HOUSES

3.1 Introduction

The post-war row houses in The Netherlands can be divided into two main forms: a house with a though living room and a house with the living room overlooking the garden. Although there are two different types, the construction of both types are mostly the same, the difference lies within the floor plan of the ground floor. Only the row house with a through living room shall be clarified here, because this it the type that is used in most cases for post-war row houses.
3.2 A row house with a through living room

In this type of row house (Fig. 1) the ground floor contains a living room from façade to façade. Next to the living room the kitchen, toilet, entrance and stairs are located. The width of this type is around six metres and wider. With a smaller width, the living room becomes too narrow and the other type is preferable.

The kitchen is mostly around 6 square meters and contains only a sink, stove, a few cupboards and room for a refrigerator.

The bathroom is even smaller, about 2 square meters. Most of the times the bathroom contains only a shower and, if lucky, a washing bowl.

Figure 1: Plan of the ground floor of a house with a through living room.

3.4 General characteristics and construction post-war row houses

The post-war row houses have four rooms, no cellar, an attic that can be walked on, one or two toilets and a shower. The usable area varies from about 80 to 130 square meters.

These houses have in general both front and back garden. The length of the front garden varies from about 2.5 up to 6 meters or more. The depth of the back garden varies from 6 up to 9 meters. In general a garden shed is located in the back garden.

Mostly, the post-war row house have a pitched roof, although houses with a flat roof exist. In general the pitched roof is shared by the whole row of houses and the ridge runs parallel to the facades.

The dwelling has a cavity wall of brickwork without insulation. The roof is covered with roof tiles above a air cavity and wooden roof boarding. The dwelling has wooden or concrete floors and a crawl space. The party wall is stony.

The dwelling is connected to the energy and natural gas lines. The dwelling has a individual central heating boiler and geyser or a combination boiler. The boiler has in general increased efficiency. The ventilation is always natural.

4. PROBLEMS TO BE SOLVED

4.1 Introduction

The problems that came forward from the research can be divided into several parts. First you can look at the acoustics in the dwelling. The second part is the façade and the thermal insulation of this façade. The next part is the extra space and facilities that are needed. A (eventual) problem coming forward from the creation of extra space is the day lighting. That will be the last part of this chapter.

4.2 Acoustics

According to the research, one of the problems in row houses is the lack of acoustic insulation. Research is preformed on the solutions for the acoustic problems in this type of house.

The noise pollution in (row) houses can be divided into three different parts: noise pollution of adjoining dwellings, noise pollution of the own dwelling and noise pollution of the surrounding area. The different types of pollution have got different solutions, therefore the three forms will be discussed here separately.

4.2.1 Noise pollution of adjoining dwellings

Most of the noise pollution is caused by adjoining dwellings. The party wall is most of the times massive and made of concrete, brickwork or sand lime blocks, so impact sound can travel through it without problems. (fig. 2)

Figure 2: Different types of party walls, from worst (left) to best sound insulation

The best solution for the party wall is to replace a massive wall with a cavity wall without cavity ties, but in existing buildings this is of course not possible. Therefore another solution must be used. The best solution is to place a flexible facing wall before the party wall. A facing wall can be made easily from a wooden framework. Another option is to use a system that is specially made for this problem. Several systems from several manufacturers can be used. Not only the party wall must be finished off with sound insulation, also the adjoining interior walls must be taken into account. These walls can pass the sound on to the dwelling if they are connected with the party wall. A solution is to cover these walls also with sound insulation. Another solution is to disconnect these walls, so the sound can not travel through these walls.
Finally, attention must be paid to the roof and foundation. Just like the party wall, sound can travel through the roof and through the foundation.

Although all these solutions work properly, there will always be a little noise pollution left. The best solution for sound pollution of the adjoining dwellings is to reach a solution together with the neighbours.

4.2.2 Noise pollution of the own dwelling

This part can be divided into two separate sections: floors and ceilings with poor sound insulation and sounds from installations within the dwelling.

Several solutions are usable to upgrade the sound insulation of floor and ceiling. Some solutions are very easy (softboard panels and carpeting) to use and some are more difficult to use (suspended acoustic ceiling).

Sounds from installations and other objects in the own dwelling can be solved near the installation or object. There are different solutions for different problems, most of the time easy to do.

4.2.3 Noise pollution of the surrounding area

Most of the post war housing estates are relatively quietly situated with a lot of trees and shrubs, dead end streets and big gardens. Noise pollution of the surrounding dwelling in these areas is minimal.

Sometimes a large road or a railroad is situated near these housing estates. In this case upgrading the sound insulation of these facades can be useful.

The existing facade shall be upgraded (see next chapter) thermally. By using heavy mineral wool and a plaster layer, the sound insulation will also be upgraded.

4.2.4 Conclusion acoustics

Although several measures can be taken to restrict noise levels, there will always be sound pollution in these dwellings. It is obvious that sound pollution from the adjoining dwellings is the most annoying form of sound pollution. But many occupants will change their tolerance boundary when their dwelling is provided with sound insulation and they are more quickly to complain. So the problem also exist afterwards.

Because one of the main objectives of this project is to limit inconvenience for the occupant to a minimum, the sound insulation will only be placed if the occupant will endure inconvenience during a longer period of time and after the occupants of adjoining dwellings have consulted each other to reach a solution.

4.3 Upgrading the façade

The existing facade must be upgraded to increase thermal insulation of these walls. Because the facade exist of closed (brickwork wall) and open (windows, doors) parts, these two types are treated differently.

Finally, the present condition of the exterior of the facade shall be discussed, because this was a important issue according to [1].

4.3.1 Thermal insulation of the façade

To insulate a cavity wall, there are three possibilities: insulation in the cavity, insulation on the inside of the façade and insulation on the outside of the façade (external wall insulation).

Insulation in the cavity is not a good option because the cavity is only 50 mm wide and with this, the coefficient of thermal conductivity won’t even reach 2.0, not even enough to match up with present day demands (according to the Building Decree: R ≥ 2.5 m²K/W). Insulation in the cavity can also lead to damp problems.

Insulation on the inside is not a good option either. There are several negative aspects that can be taken into account. First the decrease in usable area in the dwelling. Secondly the inconvenience for the occupant can be mentioned. Looking from a technical point of view, the risk of condensation, mould formation near thermal bridges and the loss of thermal storage in the walls must be mentioned. Altogether reasons enough to dismiss this option.

External wall insulation is the third possible option. An advantage of this option is the lack of loss of usable area and the little inconvenience of this method. Thermal bridges are avoided as the whole exterior is being wrapped. A disadvantage is the loss of a brickwork exterior.

All methods have advantages and disadvantages, but external wall insulation outweigh the other two choices. Because the little inconvenience of this method and the good technical features, this is the best choice. A layer of 150 mm will be used to reach a coefficient of thermal conductivity of around 4.0 m²K/W (depending on the type of insulation).

4.3.2 Replacing the windows

Not only the closed façade must be upgraded, but also the windows and doors. Because of the age of the old frames, it is best to fit new frames. This is also better to make a good connection with the external wall insulation. To limit the inconvenience to the occupants, a system is designed to replace the windows and doors (see fig. 3)

First a wooden frame with Plexiglas or transparent tarpaulin will be attached to the inside of the old frame. Then all moving parts and the glass will be removed. A new, specially altered, frame will be attached to the old frame. Windows and moving parts are placed and then the Plexiglas or tarpaulin can be removed. Finally, a new window ledge will be created. Then the outside of the walls can be fitted with the thermal insulation.
4.3.3 Appearance of the façade

Because of the use of external wall insulation, special attention must be paid to the appearance of the façade. External wall insulation can be finished with a wet or a dry system. Several different finishes like waffle slabs, slates and profiled metal plates can be used when using a dry system. When using a wet system the finish used most is a plaster coat. Because of the fondness of the Dutch people for brickwork and other stony materials, the wet system with a plaster coat will be used. To resemble the brickwork, a special plaster coat can be used from the firm ‘BSP Sierpleister’ [2]. This firm uses several colours of plaster and a brickwork pattern to resemble brickwork (fig. 4).

Figure 4: Example of plaster with a brickwork pattern from the firm ‘BSP Sierpleister’

4.4 Extra space and facilities

The units placed in front of the dwelling, provides not only more usable area, but also more comfort and modern equipment because of the kitchen and bathroom that can be placed in the unit. In this section, the design will be clarified.

4.4.1 The construction of the unit

The construction of the unit has to be light weight so the units can use part of the existing foundation and can be exported by truck in one part. Further, the construction has to be rigid, so the interior of the unit won’t be damaged during transport.

A steel bearing structure is chosen, which consist of U-beams (UNP 200), steel frame profiles (100mm) and a layer of lightweight concrete for the floor, columns of steel square hollow steel (100*100mm) and steel frame profiles (90mm) between box bears (100*100mm) to support the ceiling (see fig 5). All the floor parts are welded together as well as all the parts of the ceiling to make a rigid construction. The columns connect the floor and ceiling with a fixed-end connection.

Figure 5: Bearing structure (isometry)

The non-bearing walls are placed between the steel columns and are made of steel frames, insulation, plasterboard and plaster( see fig. 6).

Figure 6: Construction wall (horizontal section)

The plaster coat of the wall is applied after the units are placed. This is because of the chance of damage during transport and so that the plaster layer of the unit can be attached to that of the dwelling. The floor construction has several studs on the side of the dwelling for the transmission of force to the existing foundation.

4.4.2 The foundation of the unit

A problem with placing new buildings close to existing buildings is the impact of the new foundation and its making process (vibrations) on the existing buildings. The units will be placed very close to the existing buildings.

Although the mass of three units together is (in comparison) not much, it is to much to completely use the foundation of the existing dwellings by cantilever, also because the weight has to be distributed evenly over the foundation. To accomplish this, a whole new construction has to be mounted to the dwelling, so this is not an option.
The best solution is to use on the side of the existing building the foundation of this building and to place the units on the other side on a new foundation. Because large parts of the existing façade will be removed and because of the light weight of the units, the existing foundation is strong enough to carry the units partly as well. By using steel tube piles for the new foundation the vibrations and noise can be restricted to a minimum.

4.4.3 Connection between existing building and units
A connection must be made between the units and the dwelling.

The ground floor connection is made by attaching a frame to both the unit and the dwelling. On top of these frames a boarding with finishing can be placed. The seams must be filled with a rubber. (fig. 7)

The walls of dwelling and unit are connected with a simple covering of the connection. To prevent airborne sound pollution from the neighbours and draft, rubber is used to make an airtight connection (fig. 8).

For the other connection (ceiling) a similar construction can be used.

4.4.4 The roof for the connection between building and units
If the occupant chooses to place three units in front of his dwelling, a new roof is needed to connect the units and the old roof. The new roof is placed from the ridge to the top of the third unit. In this way only more useable area is created, because the part of the old roof under the new roof can be removed, leaving an area with a comfortable height. In the new roof, a solar collector is placed to meet in the occupants needs of warm water. The construction of the new roof is in steel frame.

4.4.5 The kitchen in the unit
The unit can be fitted with a kitchen and/or bathroom.

A kitchen needs a smart design to be comfortable to work in. In the past the several parts (stove, sink, cupboards, refrigerator and so on) were placed in a almost random order. This prevents people to work efficiently. In the past century, much research has been done to make a efficient design for the kitchen. One of the first was Christine Frederick [3]. She designed the principle of the 'Continuous Kitchen' The different parts were placed so that the user could work as efficient as possible. (see fig.9) The idea came from an assembly line as found in factories.

Figure 9: A non-efficient (left) and a efficient  (right) kitchen with a route for preparing a meal (A) and a route for cleaning up after a meal (B), designed by Frederick

Present day the concept of a ‘working triangle’ is often used to design a kitchen. On the corners of this triangle you find the sink, stove and refrigerator. These are the most frequently used objects in the kitchen. To create a good working environment, the distance between the three points must be around 6 meters in total.

Using both the concept of the ‘Continuous Kitchen’ and that of the ‘working triangle’ and a schedule of requirements made by the ‘VAC’, the Dutch Women Advisory Committee [4], a kitchen design is made (fig. 10)

Figure 10: The floor plan for the kitchen with the different zones
In this kitchen there are four working zones: preparation, cooking, serving out and clearing up. The layout has been chosen so that the different steps can be taken in a fluent motion (see fig. 11).

Not only the arrangement is important, but also the height of the working surfaces. This height is different for different activities but also for different persons. This must also be taken into account in the design.

4.4.6 The bathroom

The bathroom is less depending on a good design to be comfortable. This is because in a bathroom the occupant most of the time uses only one aspect of the bathroom simultaneous (just the toilet, just the washbowl). More important is enough usable space near the different objects in the bathroom. And of course more luxury and room then the bathroom already in the dwelling (with just a shower and, if lucky, a washbowl).

Several demands for the bathroom are named in the schedule of requirements made for this bathroom. According to this schedule of requirements, more then one floor plan can be designed.

4.5 Day lighting

One problem that had to be taken into account, was day lighting in the dwelling. Normally, the depth of row houses is about 7.5 meters. Now, the depth increases with almost 3 meters to about 10.3 meters.

4.5.1 Requirements according to the Building Decree

To satisfy the requirements of the Building Decree, the dwelling must have a equivalent daylight width of 0.5 m² per room and at least 10% equivalent daylight width of the total surface area. The ground floor (living room and kitchen) has a total of 4.9m² equivalent daylight width and a total surface area of 36.3m², so this suffices.

4.5.2 Average daylight factor

This factor gives information about the amount of daylight in the dwelling. If it is above 1% it is (just) sufficient. A factor between 2 and 5% is more preferable. The average daylight factor was calculated and is in this case 2.7%.

4.5.3 Daylight simulator

A scale model from the ground floor with unit is produced on a scale of 1:20. This model was put in a day light simulator to simulate normal day light conditions. (see fig. 11).

Figure 11: Daylight in the scale model living room without (left) and with unit

Measurements were taken on several places in the scale model to determine daylight factors. The lowest measurement is 2.7%, this is in the dining area. On all the other locations, the daylight factor is higher.

4.5.4 Outcomes

Although the amount of daylight in the dwelling decreases a lot, it still suffices according to Building Decree and other measurements. No further measures have to be taken.

5. VISION ON PARTNERSHIP

A great advantage of this unit with a kitchen a already installed in the unit, is that there is no moment that the occupant doesn’t have access to a kitchen. When reinstalling a new kitchen, you usually are without kitchen facilities for sometimes more than 4 weeks..

To deliver a complete unit with kitchen, it is necessary that a kitchen manufacturer and a unit manufacturer work together to accomplish this.

Just like with the Senseo from Philips and Douwe Egberts, the joint sales effort of a unit builder like De Meeuw and a kitchen manufacturer like Bruynzeel must result in a product which holds the best of the two separate manufacturers.

6. CONCLUSION

Fact is that the post-war houses don’t meet up with present day demands. Fact is that to demolish all these dwellings and to build other dwellings who do meet up with the demand is a unreal and wrong answer to the problems. Not only will demolishing mean destruction of capital, but demolishing does also exert a great pressure on the environment.

By using this concept, the existing dwellings will be transformed into modern, comfortable and spacious buildings

Another important outcome is that the upgraded dwelling is a low energy dwelling, with sufficient thermal resistance in its façade and with (the possibility of) a solar collector.

The solution given in this paper for the post-war row houses is just one solution. It is not said that other solutions are not an option, but by accepting the problem and giving a solution, a start has been made.

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REFERENCES