The Revival of the Albatross

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ABSTRACT: The Navy-building named 'The Albatross' is a landmark in the north of Holland nearby the sea. The building, currently used as housing for navy officers, will be transformed into an office building. The initial design of the building is well-suited for this change. The ambition in this project (part of the European REVIVAL consortium) is to develop a high performance, sustainable renovated and healthy building in an uncomplicated and low-tech way. The building should become an architectural highlight in the surroundings. Specialty of this project is the life-cycle-assessment-guided design process and the minimization of the extra costs. Chosen energy efficient measures in the preliminary design phase are: extra insulation, second skin, passive cooling, natural ventilation, heat pump, photovoltaic, and much more. After realisation the indoor climate and energy use will be monitored.

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1. INTRODUCTION

This paper focuses on the concept for the sustainable renovation of a remarkable building in the north of Holland; 'The Albatross' (Figure 1).

The building is owned by the Royal Dutch Navy, who is planning to renovate this building from the seventies. The ambition in this project is to develop a sustainable and healthy building in an uncomplicated and low-tech way. In order to do so, the project is part of a European consortium, named REVIVAL. In March 2004 the preliminary design phase was finished successfully.

2. OBJECTIVES

2.1 REVIVAL objectives

REVIVAL stands for Retrofitting for Environmental Viability Improvement of Valued Architectural Landmarks.

The global objective of the REVIVAL consortium is to show that tertiary buildings from the post-war pre-energy consciousness era, can be refurbished economically, with improvements in energy performance that lead to lower life-cycle CO_2 emissions than the original building, or an equivalent new building. Thus refurbishment would make a significant contribution towards the EU policy of meeting the Kyoto protocol.

Specific objectives include:

- The development of energy saving techniques appropriate to the construction type and use type of the demonstration buildings, involving new products and innovative procedures. A further objective is to recognize the social implications both for the occupants of the buildings, and the potential for employment.
- A standard procedure for life cycle-evaluation of CO_2 emissions, applied to single buildings, and to dynamic populations of buildings (CO_2 budgeting) to enable building owners to form policies and priorities.
- To revise and produce a new Design Guide to present the techniques and the conclusions.

Figure 1: 'The Albatross'

2.2 Building objectives

Objectives related to the building itself are:

- 30% reduction in energy demand compared with current new building regulations with 30% energy supply from renewable sources or 50% reduction in overall energy use.
- any over-cost of eco-refurbishment to be minimized
- internal conditions satisfying all new-build criteria
- high overall environmental assessment achieved

3. THE EXISTING BUILDING

3.1 The Albatross

The building named 'The Albatross' (Figure 2), a landmark in the north of Holland nearby the sea (Den Helder), consists out of an high-rise block (7 identical layers, ± 4400 m²) and a lower part with meeting rooms (1 layer, 1800 m²).

The existing building, dating from 1972, façade orientation east-west, is equipped with single glazing in aluminium frames, no insulation, inefficient artificial lighting, heating by radiators (gas furnace) and a mechanical ventilation system (supply & exhaust).

The building is currently used as housing for navy-officers and will be transformed into an office building.

Figure 2: 'The Albatross'

4. LIFE CYCLE ANALYSES

4.1 Life Cycle Analyses: 'Eco Quantum'

In order to find the right balance between quality and environmental impact, life-cycle analyses (LCA) has been applied in the design process. In this project the calculation tool 'Eco Quantum' was used. W/E consultants developed this LCA-tool specific for the building sector. The input of an Eco Quantum calculation consists out of quantified building materials and predicted energy- and water use. Every given building material in the Eco Quantum database has got its own environmental profile regarding to the construction-, maintenance- and demolition phase. The calculation tool first generates environmental in- and outputs out of the quantified building data. The second step is the translation into environmental impacts. The third step is the classification and normalisation of the results into four different scores (sources, emissions, energy-use and waste) and finally one single indicator: the 'EQ-score'.

Eco Quantum gives the possibility to define the environmental impact of different scenarios for the future of a building. The input for the calculations consists besides the use of materials, energy and water also out of the expected life-span of the renovated or new building(-elements). Each building scenario can have its own life-span. Reference for the scenarios is the existing building and its existing use of energy, water and materials.

4.2 Scenarios for The Albatross

The scenarios for the future of the building are described as follows:

- 'Consolidate' (10 years)

The existing glazing and aluminium frames have a very high U-value (6.2 W/m²K) and are therefore the weakest element in the thermal building envelope. A very effective measure to reduce the energy-use and -costs is improving the thermal quality of the glazing and its aluminium frames. The 'consolidate'- scenario realizes a lower U-value (3.3 W/m²K) of the glazing by placing extra glazing panels in front of the existing glazing on the inside of the building. Thermal comfort will increase because of the decreasing cold draft from the window panes. No other measures are foreseen. The expected lifespan is set on 10 years.

- 'Upgrade' (25 years)

The upgrade scenario focuses on improving the thermal quality of the building envelope and the efficiency of the existing installations. The quality of the indoor climate improves considerably. The existing interior (separation-walls, ceilings, toilets, etc.) is maintained. The upgraded building meets the demands for the operative building legislations and has an expected lifespan of 25 years. Therefore the following measures are taken;

- new glazing and aluminium frames with thermal barrier (U = 2.2 W/m²K)
- insulation of the existing opaque building skin elements (U = 0.3 - 0.4 W/m²K). The new façade consists out of insulation-foam and tiles.
- air tightness = 0.5 dm³/s m²
- heat recovery system for ventilation-air (efficiency = 95 %)
- heating: condensing gas boiler, efficiency = 90%
- lighting capacity = 9 W/m²

- 'Strip' (40 years)

Stripping the building means dismantling the building by demolishing the existing façade, the interior and the installations. Only the bearing concrete structure remains. The 'skeleton' is then refurbished with new elements, that are focused on an energy performance that is 30% better than the operative building legislations ask for. The expected lifespan is set on 40 years. The following new elements are added to the 'skeleton';

- new glazing and wooden frames (U = 1.8 W/m²K)
- second skin glazing façade (pre-heating efficiency for supply ventilation-air = 10 %)

- insulation of the existing opaque building skin elements (U = 0.3 - 0.4 W/m²K). The new façade consists out of insulation-foam and tiles.
- air tightness = 0.2 dm³/s m²
- ventilation: natural supply by grills in the façade, mechanical exhaust
- heating: combination of a heat pump (source; groundwater) and local heat delivery with low temperature (T< 55 °) floor heating.
- cooling: passive, by night ventilation and use of thermal mass
- lighting capacity = 8 W/m², daylight sensors and occupancy detectors
- new interior; 'metal stud' and glazing for separation walls

- 'New' (40 years)

The new scenario is a copy of the strip scenario, except for the bearing concrete structure. Building a new office requires also a new 'skeleton'. Because the use of 'fresh' concrete, 20% rubble is added.

4.3 LCA results

Figure 3 shows the total environmental performance of the scenario's ('EQ-score') as a percentage of the reference. In general one can see that the impact of energy use is the biggest and the impact of water use is the smallest. The existing office building is taken as the reference and scores 100%. The 'consolidate' scenario performs not well enough (85%). The 'upgrade' scenario scores best (48%).The 'strip' scenario scores also pretty well (56%). One can also see that renovating the building following the scenarios 'upgrade' or 'strip' performs environmentally better than to build new. This is mainly because of the re-use of the bearing construction in these scenarios and so saving the waste and materials when building a new one.

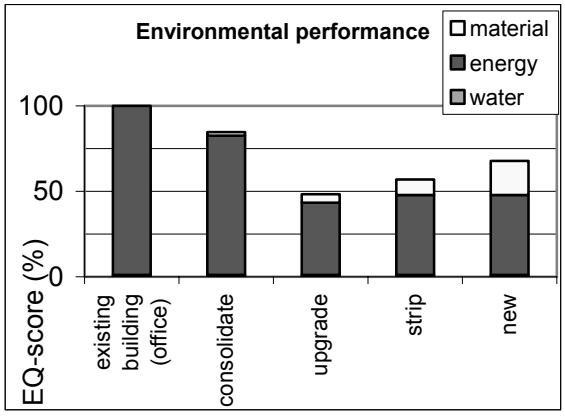

Figure 3: environmental impact of building scenarios

The reason that 'strip' scores little worse in energy performance then 'upgrade' is also because of the embedded energy in materials. When using less material, the score will be better. The scenario 'upgrade' scores best in materials performance. The challenge for the preliminary design was to combine elements from both the scenarios 'upgrade' and 'strip'. The strategy became to use as many existing building elements as possible from the scenario 'upgrade' and to achieve the energy performance from the scenario 'strip'. This leads to the best achievable environmental performance for this project.

In order to check the sensitivity of the influence of the life span on the scenarios, each scenario has been calculated with four life spans (5, 10, 25 and 40 years). Figure 4 presents the results of these calculations. The results of the preliminary design has been added. One can see that the scenarios 'upgrade' and 'strip' switch in priority when the life span gets longer. One could say that the longer the expected life span is, the more materials can be added. As the life span asked for by the client is 40 years, the preliminary design performs best.

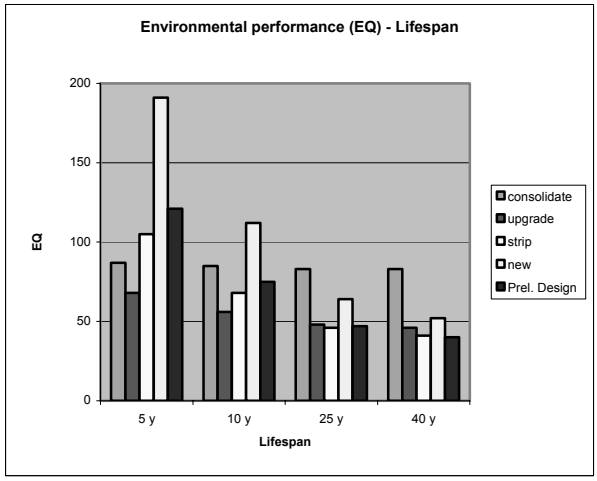

Figure 4: environmental performance and lifespan

5. ENERGY CONCEPT

5.1 The facade

In order to find a low-tech energy concept that uses few new materials and performs well on energy the design team focused on the façade. In this project the design team concluded that the façade gives the most possibilities to make use of passive energy.

Important element in the list of demands is the presence of openable windows in each room.

In order to optimize the façade design, four concepts were studied on:

- 'Low-E (ref)'

A standard (reference) façade in this project consists of Low-E glazing in wooden or thermal insulated aluminium frames. Opaque elements in de façade are well insulated (U-value ≤ 0,3 W/m²K).

- 'curtain/low-E'

The existing building can be seen as 'an invitation' for a second skin. Therefore the principle of this variant is adding a transparent second skin to the existing building on the east and west façade. The skin consists of a permeable (plastic) curtain. The main façade is upgraded like the standard façade

principle described above (low-E). The second skin can be used as an 'rain & wind coat', shading-device and exhaust or supply for ventilation.

- 'single/Low-E'

Instead of a permeable curtain in this concept a single pane glazing is added to the building as second skin. The existing façade is replaced by a well insulated façade consisting of Low-E glazing in wooden or thermal insulated aluminium frames and well insulated opaque elements (U-value ≤ 0,3 W/m²K). Ventilation air is supplied via the space between the two skins. Adjustable grilles/windows in both skins for adequate winter or summer ventilation.

-'single/single'

In this variant the existing façade maintains with the existing single glazing and aluminium frames. Opaque elements and thermal bridges will be insulated. A single pane glazing is added as second skin. Ventilation as in the 'single/Low-E'-concept.

5.2 Thermal performance

For all façade variants calculations have been made in order to determine the thermal performance. To this end a model of a single office room has been analyzed with the building simulation programme TSBI3 of the Danish Building Research Institute. Heat demand as well as comfort indices have been determined.

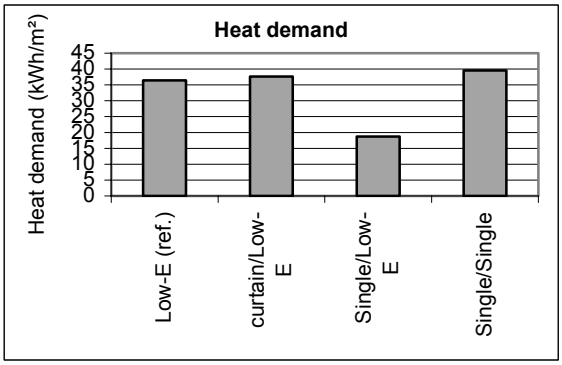

Figure 5: calculated heat demand (single office room)

Figure 5 illustrates that the heat demand of the Low-E, the curtain/Low-E and the single/single façades are practically identical. The heat demand of the single/Low-E façade is about half the heat demand of the other concepts. Remarkable is that the single/single façade equals the Low-E (ref) façade. The solar heat captured in the air cavity and the heat recovery of the transmission loss through the existing façade by means of the air supply via the air cavity levels the extra heat losses of the double single pane construction.

CONCLUSION

The calculations proved that maintaining the existing façade and adding a single pane performed as well as a reference façade. A single/Low-E façade performs better, but uses a lot more building materials and costs a lot more. So the design team chose the 'strip scenario' with the single/single façade variant for the preliminary design. The total environmental performance is now optimized.