COMELY GREEN PLACE

SUSTAINABLE HOUSING PROJECT

SUSTAINABLE MATERIAL SPECIFICATION

WREN
&
BELL
STRUCTURAL CIVIL AND
ENVIRONMENTAL CONSULTANTS

CONTENTS

1. INTRODUCTION

The Comely Green Place Sustainable Housing Project will be the first major sustainable housing project in Scotland to define a better way of building the kind of houses that people want to live in. The programme is based around the building of a number of blocks of traditional timber-frame flats, much the same as those being built all over the country on a daily basis. The difference is that Comely Green Place will be built to have the lowest practicable environmental impact throughout the lifetime of the development.

This document sets out the specifications required for each of the main construction materials to be used in the project. The method used to decide on the final specification is outlined below.

In essence, the method includes three main considerations:

- the environmental performance of each material (in terms of production, operation and recycling / disposal),
- the cost of the material compared to the standard material that would normally be used,
- the operational performance of the material (taking into account the extended design life of the building).

These considerations are not taken in isolation but compared against each other for each option so that, for example, the increased cost of a material would be acceptable if it was matched by improved environmental and operational performance. Similarly, a significant increase in the cost of a particular material compared to the standard might not be acceptable if it was felt that the same amount of money spent elsewhere would have a greater environmental or operational benefit.

Environmental and operational benefits were also compared against each other for each option. A material might be particularly durable, for example but be unacceptable in environmental terms, or conversely it could be felt that the adverse environmental impacts of a particular material were outweighed by its operational benefits.

Although every effort has been made to take into account the latest information from life cycle assessments and report findings, these decisions will eventually be based on a subjective judgement. One of the main aims of the Comely Green Place Sustainable Housing Project is to encourage future sustainable development by clearly stating what decisions have been made and on what basis. This will allow future developers to judge the best sustainable option for them, based on their own subjective impressions of comparative environmental impacts and on the up-to-date information of the day. To this end, this document contains information on those materials which were not selected, as well as those which were and seeks to explain the decision-making process behind the specification.

An adaptation of the Dutch "Environmental Preference Method" has been used to set this specification. This method compares materials and products currently on the market and ranks them according to their environmental impact. It considers environmental impacts throughout the whole lifecycle of a material, including the extraction, production, building, occupational and recycling phases. Thus, for example, a higher environmental impact during construction could be justified by improved performance throughout the life of the building.

This method has been adapted to include local availability and economic viability. It has also been revised to take into account the extended design life of this development and the requirements of the relevant building regulations.

The main sustainability issues considered in the assessment are:

- shortage of raw materials
- ecological damage caused by the extraction of raw materials
- energy consumption at all stages (including transport)
- water consumption and pollution
- harmful atmospheric emissions, such as those leading to ozone depletion
- global warming and acid rain (CO_2, NO_x and SO_2 production)
- material performance, durability, repairability and re-usability
- waste generation and efficiency of production
- human health issues

Format of the Specification

For each of the materials listed below the original sustainability criteria are given, followed by a discussion of the issues which arose during the design and research stages of the programme. Finally, the preferred option is given, with a summary of the justification for its use in terms of environmental, economic and operational criteria.

Additional: Energy Savings

Cunninghams (FM) Limited have carried out the following calculations on the basis of the standard and sustainable specifications. Several assumptions have been made regarding occupancy rates etc., so the figures should be regarded only as a guide. However, they provide a useful measure of the savings made in terms of energy costs by building to the sustainable specification.

Normal Specification (with concrete ground floor and conventional gas boiler)			
Floor	Ground	First / Second	Third
Hot Water (KWh/yr)	4750	4750	4750
Heating (KWh/yr)	8437	7616	7837
Boiler Efficiency	1.47	1.47	1.47
Cost (p/KWh)	1.6	1.6	1.6
Cost (£/yr)	£310	£290	£295

Sustainable Specification (with timber floor and condensing boiler)			
Floor	Ground	First / Second	Third
Hot Water (KWh/yr)	4750	4750	4750
Heating (KWh/yr)	6712	6016	6274
Boiler Efficiency	1.17	1.17	1.17
Cost (p/KWh)	1.6	1.6	1.6
Cost (£/yr)	£215	£205	£210

This gives approximate savings for the development as follows:

Annual Energy Cost Savings from Sustainable Specification (not including electricity savings)			
	Ground	First / Second	Third
Saving (%)	30.6	29.3	28.8
Saving (£/flat/yr)	£95	£85	£85

Total saving for development (£/yr)	£8,300

These figures are indicative only but provide a useful indicator of the purely financial benefits of adopting the sustainable specification in terms of energy savings. They do not take into account any of the other benefits.

2. SUSTAINABLE SPECIFICATIONS FOR PRINCIPAL MATERIALS

2.1 Demolition and Site Infill

- ☑ all waste material generated during on-site demolition should be used as fill material on-site
- ☑ additional inert construction waste may be imported to the site if further fill material is required

- ☒ disposal of demolition and construction waste to landfill should be minimised

Discussion

The Comely Green Place site, although contaminated, does not present significant issues in terms of toxicity to construction workers, inhabitants or flora, or hazard to the building fabric. This situation allows all the above points to be observed. The only exception is the disposal of a limited amount of fly-tipped waste which has been deposited on the site. This material is of variable, and sometimes unknown composition, so it will have to be disposed of to an appropriate landfill facility.

Final Specification

The nature of the site allows minimal use of landfill, with the exception of some small quantities of fly-tipped material.

2.2 Foundations

- ☑ piled construction to minimise the quantity of concrete used
- ☑ floor construction will be timber wherever possible, otherwise the same principles of high recycled material content and low mass will be applied in the use of any concrete required

Note: although a high recycled content in the concrete is desirable from an environmental point of view, this must be balanced against the importance of quality in the foundations. Given the extended design life of the development, it would be a false economy in both financial and sustainable terms to compromise the quality of the foundations for a relatively meagre environmental saving.

Discussion

The final specification for the floor construction depends on a number of factors. Although a timber floor is preferable in terms of sustainability and insulation, it can present problems in terms of moisture resistance, a requirement for additional piling and the floor levels of the development (since the original drawings are based on the basic specification with a concrete floor).

Piled foundations make the most efficient use of this high embodied-energy material. The foundations will therefore be piled and the concrete used will contain the maximum practicable level of Ground Granulated Blastfurnace Slag (GGBS) concrete, which is a by-product of the steel industry. A decision was made not to use recycled aggregate in the

foundations, as the consistency of the material could not be guaranteed. Because of the extended design life requirement of the development and the fundamental importance of sound foundations, the best option appears to be the use of virgin aggregate and GGBS-rich cement in a piled construction.

On top of these piles will be laid a timber floor. This is the best environmental option, as well as providing enhanced insulation, leading to improved energy efficiency of the building. The concrete floor in the standard specification causes difficulties in terms of insulation and materials / energy efficiency.

Final Specification

Piled foundations and ground beams constructed from a high-GGBS content concrete (but without recycled aggregate) will be overlaid with a suspended timber ground floor, constructed from local sustainably-produced timber, treated with boron (see 2.3).

2.3 Timber Frame Structure

- ☑ timber will be sourced from sustainably managed local forests
- ☑ the timber supplier shall be accredited to the "Wood Mark" sustainable forestry standard maintained by the Forest Stewardship Council.
- ☑ untreated timber will be used wherever possible
- ☑ where treatment is required to provide protection from insect and fungal attack, borate treatment will be used
- ☑ wood treatment will be carried out in accordance with current best environmental practice at local mills

- ☒ quaternary ammonium compounds, zinc soaps, azoles, CCB, ACF, CCA, improsol (BF) or creosote will not be used

Discussion

All aspects of the above specification will be observed.

Final Specification

By negotiation with the timber frame manufacturer, timber to be supplied from FSC-accredited Scottish forests and boron treated where treatment is required. The timber frame for the sustainable specification is to be of 140mm stud construction to allow for the increased thickness of insulation. However, blown cellulose insulation (see 2.5) is to be installed in-situ after the frame has been erected, so the timber frame is to be specified without insulation.

2.4 External Wall

- ☑ rendered blockwork construction
- ☑ within the requirements of the structural design, the external wall blocks will have a high recycled content, maximising use of recycled aggregate, blast furnace slag or pulverised fuel ash from local power stations.
- ☑ locally produced mineral render

- ☑ batch produced render to maximise quality and consistency and minimise wastage on site
- ☑ external wall sheathing will be oriented strand board (OSB) to maximise structural strength while minimising the use of resources and generation of formaldehyde.

Discussion

Several block suppliers were identified which manufactured blocks with recycled contents of around 80-90%. These had a variety of densities and reputations, so an existing block supplier has been specified, as the quality of their blocks is known and the composition is comparable to the best of the competition.

The design includes some facing blocks for detailing around windows etc. These should be made of concrete with a specified high recycled content or manufactured synthetic stone, which causes less depletion of natural resources than natural stone.

OSB has been specified for the wall sheathing as it represents the best available material in terms of operational performance, as well as having the lowest environmental impact and an acceptable price. OSB contains a lower proportion of resin than other fibreboard products which increases its strength as well as reducing the potential for formaldehyde off-gassing.

Final Specification

Blocks have been sourced from Russell Concrete Products of Twechar, one of Hart Builders' existing suppliers, which are confirmed as having 85% recycled content and are produced locally. Facing blocks should be made of synthetic stone or high recycled content concrete.

External wall sheeting will be oriented strand board manufactured to comply with BS EN 300 and certified to have a total extractable formaldehyde content of less than 0.005%.

2.5 Insulation

- ☑ cellulose (e.g. WarmCel) will be used in conjunction with 140mm stud to provide insulation
- ☑ cellulose will also be used as loft insulation
- ☑ insulation on piping will be mineral wool

Discussion

Blown cellulose insulation performs at least as well as the traditional glass fibre insulation; its thermal resistance is about the same and it does not have the same problems with compacting during installation. Its embodied energy and environmental impact are considerably lower than any alternative, so it has been chosen for insulation in the walls, ground floor and roof-space.

Final Specification

Cellulose insulation to be used in walls, ground floor and roof-spaces.

2.6 Roof Covering

- ☑ high recycled content (50% minimum) clay or concrete roof tiles
- ☑ flashings will be polyethylene, ethylene-propylene diene or polyisobutene
- ☑ barge and soffit boards and dry verge components will be high density polyethylene, cement fibre or timber.

- ☒ metal or quarried slates will not be used because of the high energy requirements, environmental degradation and poor efficiency of their production
- ☒ flashings will not contain lead or zinc

Discussion

Great difficulty was experienced in sourcing a roofing material with a high recycled content. Redland make a Cambrian slate from 65% slate quarry waste and similar products are also available from other manufacturers with varting percentages of recycled material (e.g. Marley Monarch, 35%). No clay or concrete materials could be sourced with a significant recycled content. On the basis of the materials identified, Redland Cambrian would appear to be the most sustainable material.

Roof valleys should be constructed using Harcon GRP products. These are a replacement for lead valleys that have a considerably lower embodied energy and environmental impact, comparable service life (they are guaranteed for sixty years) are quicker to install, less prone to vandalism and theft and are also cheaper.

Any items which are required to protrude through the roof should not be sealed with lead but should use one of the proprietary replacement products such as Nuralite (a blend of mineral wool, polyester and bituminous materials).

The environmental argument against the use of PVC is real but has in our opinion been exaggerated by special interest groups. It is possible that PVC would be the preferred option in areas where longevity and durability are important.

Final Specification

Redland Cambrian processed slates (or equivalent) should be used for the roofing material. Roof valleys should use the Harcon GRP system and Nuralite should be used in favour of lead or similar materials.

PVC is permissible where no reasonable alternative material can be identified which has a similar performance in terms of environmental, operational and financial considerations.

2.7 Windows and Glazing

- ☑ window frames will be constructed from sustainable durable wood, treated with local borate implants at the joints if required
- ☑ argon filled low emissivity (LE) double glazing, minimum 14mm cavity (this specification is based on figures supplied by Pilkington; it is possible that an alternative supplier would specify a slightly different configuration to obtain the optimum balance between insulation, price and practicality)

- ☑ dry glazing installation
- ☑ external window sills will be of high recycled content prefabricated concrete or manufactured stone

Discussion

The sustainable specification detailed above was originally based on the best compromise between performance, environmental impact and cost. It is possible, for example, to install triple-glazed windows with untreated beech frames, which would perform better and have a lower overall environmental impact. However, the cost would make it impractical and no future projects could then afford to follow this specification. Consequently, the above specification was felt to represent the best solution.

Final Specification

All aspects of the above specification will be observed.

2.8 Internal Non-Load Bearing partitions and Floors

- ☑ locally, sustainably produced timber partitions will be used
- ☑ flue gas gypsum plasterboard to be used for internal partition boards.
- ☑ chipboard flooring will have a certified formaldehyde content in accordance with the current regulations BS EN 312

Discussion

The optimal material for internal partitions would appear to be flue gas gypsum plasterboard. This is 100% recycled and has a minimal environmental impact. External sheeting should be ply and flooring should be made of chipboard.

These materials provide the required structural characteristics for the above uses and are acceptable from a financial standpoint. The only negative aspect of their use is the potential for formaldehyde off-gassing and its implications in "sick building syndrome". Specification of certified chipboard manufactured in accordance with BS EN312 should ensure that this is minimised.

Final Specification

internal walls flue gas gypsum plasterboard and floors BS EN 312 certified chipboard.

2.9 Solid Stair Cores

- ☑ reinforced concrete stairs with a high recycled material content
- ☑ high recycled content blockwork walls

Discussion

For reasons of fire safety and durability, the railings and balustrades cannot be made of timber. These must therefore be made of metal. Given this specification, there was a further decision to be made which came down to a choice between steel and aluminium. Fittings are

readily available in either material and the environmental impact of aluminium is probably slightly lower than those of steel. However, the quantity of steel required to do the same job is significantly less and the quality of product available in aluminium is not considered to be adequate. Therefore, steel balustrades have been specified.

Final Specification

High recycled content to be specified in stair concrete and wall construction. Balustrades and railings to be made of steel for reasons of fire safety and durability.

2.10 Doors and Finishing Joinerwork

- ☑ external doors will be locally produced from certified local sustainable durable wood.
- ☑ where treatment is required, this will be done by localised borate implants
- ☑ internal door frames will be produced from locally produced certified sustainable wood
- ☑ internal doors will be of honeycomb construction with hardboard skins

Discussion

In the standard specification, door frames, skirting boards and other finishing joinerwork would typically be made from medium density fibreboard (MDF). A comparison of this material with natural, sustainably produced timber is difficult. MDF has the advantage of using a greater proportion of the timber material, since about 80% of a tree can be shredded for fibreboard production, compared with about 50% that is useful for solid-sawn lumber. This means that fewer trees are required to do the same job.

However, the MDF production process has the disadvantage of using phenolic resins in an energy-intensive process to bind the fibres. These resins are a product of the petrochemical industry and therefore carry a significant burden of embodied energy, as well as being non-sustainable. However, MDF is easier to work with and has greater consistency than natural wood, leading to reduced losses on site. It also has the advantage of requiring less paint to achieve the desired quality of finish.

On balance, a judgement was made that the environmental, operational and financial benefits of using MDF materials outweighed the costs, so MDF is included in the final sustainable specification.

Final Specification

MDF to be added to the above specification for door frames and other internal finishing joinerwork.

2.11 Plasterboard

- ☑ flue gas gypsum plasterboard will be used

- ☒ mineral wool board or phosphogypsum will not be used

Discussion

British Gypsum are the main suppliers of plasterboard in the UK. They were contacted regarding the composition of their products and confirmed that mined gypsum was no longer used; all plasterboard is now manufactured from flue gas gypsum.

Final Specification

The standard plasterboard is manufactured with flue gas gypsum, so this material will be acceptable.

2.12 Electric Fittings and Cables

☑ polypropylene cable insulation should be used if a supplier can be found

Discussion

Electrical installations are likely to be contracted out to a mechanical and electrical contractor and specifications will be included in the contract in line with the environmental objectives of the project. Background research undertaken for this development has indicated that PVC-free wiring may be very difficult and expensive to obtain. The environmental impacts of PVC production have recently received media attention as part of a special interest group campaign. Although there are issues associated with this material, they are not as serious as has been suggested and should be assessed on the basis of what factual and unbiased information is available.

For ease of installation, maintenance and replacement, electrical installation will, where possible, be restricted to the internal walls. This will avoid the need to put electrical conduit in the external wall insulation.

Final Specification

PP insulation should be used if possible. The requirement for conduit should be minimised by locating electrical installations on internal walls.

2.13 Plumbing

☑ polypropylene (PP) or polyethylene (PE) pipes should be used if available
☑ pipes should be mechanically connected, not bonded, to facilitate repair and recycling
☑ external sewers should be made of vitrified clay or high density polyethylene
☑ gutters will be made from high density polyethylene or polyester

Discussion

HDPE was identified as the best material in terms of environmental impact. However, in economic terms it is some three times the price of PVC and there are questions regarding its stability in UV light. In addition, HDPE must be joined using a thermal welding process, which is more labour intensive than mechanical connectors and makes repair and recycling more difficult.

Having researched the alternatives to PVC and examined in some detail the arguments for and against the material, it is considered that PVC represents the best option in terms of environmental, operational and financial performance. Much of the environmental argument against the material is somewhat exaggerated, to say the least and given the differences in financial and operational performance between PVC and other materials, it is considered that PVC represented the best overall material in this application.

Final Specification

PVC to be used for internal plumbing and external guttering, external sewers will be made of vitrified clay, waste pipes (which may experience high temperatures) should be made of ABS. All pipes should be mechanically connected for ease of repair and recycling.

2.14 Sanitary Fittings

☑ WC suites will have an adjustable flush volume, up to a maximum of 6 litres
☑ taps and shower-heads will be water-saving designs

Discussion

The above specification was regarded as acceptable on environmental, operational and financial grounds.

Final Specification

The above specification is to be observed.

2.15 Heating

☑ space and water heating will be by gas-fired condensing boilers

☒ electricity should not be used for internal heating, water heating or cooking

Note: Combination boilers have not been specified because of potential problems related to the poor water supply pressure in the area.

Discussion

A great deal of consideration has gone into the specification of the heating system, from Combined Heat and Power (CHP), through Community Heating to simple electrical heating. Each had pros and cons for all three criteria, particularly when taking into account the mix of ownership types across the development. Larger schemes such as community heating had a small advantage in terms of energy efficiency but presented legal and practical difficulties in supplying heat to housing association, shared ownership and private apartments alike. Also, the specification of gas cookers in the standard specification means that the gas supply infrastructure is already in place, so that a hot water pipe system would represent a far greater additional cost than extending the gas line to individual boilers.
CHP was considered and some preliminary calculations undertaken to assess its feasibility. These calculations showed that, while there was an environmental advantage to using such a system, there was no financial advantage. This was mainly because the patterns of demand

for hot water and energy in such a development do not match the supply from a CHP plant, so much of the energy efficiency gain is effectively wasted. The disadvantages in terms of noise and emissions of operating a CHP plant in an enclosed site also outweighed the small advantages.

With the specification of increased insulation in the development, heat loss through ventilation becomes a more significant issue. Additional consideration was given to a number of methods of reducing this loss, including a system which would collect warm, moist air from bathrooms and kitchens, pass it through a heat exchanger and de-humidifier and return it into the stairwell. Although such a system would save a considerable amount of energy, it presents difficulties in terms of noise and fire safety.

In the end, a balance was achieved with the specification of individual gas-fired condensing boilers, together with individual heat-exchanging ventilation fans. As well as being more efficient, these boilers can be smaller than those required for the standard specification because of the improved insulation and reduced ventilation losses of the sustainable specification.

Final Specification

Individual gas-fired condensing boilers to be installed in each flat, with heat exchanging ventilation fans in kitchens and bathrooms.

2.16 Paintwork

- ☑ interior paintwork will use water-based acrylic paint on wooden surfaces and mineral paint on walls
- ☑ exterior paintwork will use high-solids alkyd paint

Discussion

The above specification was regarded as acceptable on environmental, operational and financial grounds.

Final Specification

The above specification to be observed.

2.17 Electrical Goods

- ☑ electrical goods will be selected on the basis of their lifetime environmental performance as described by the EC Eco-Labelling Scheme.
- ☑ lighting will be fitted with compact fluorescent light bulbs
- ☑ external lighting will be energy efficient and should be a design that will minimise light pollution

- ☒ electrical goods with a score lower than “B” will not be used

Discussion

The above specification was regarded as acceptable on environmental, operational and financial grounds.

Final Specification

The above specification to be observed.

2.18 Kitchen Fittings

- ☑ for economic reasons, kitchen fittings will most likely be made from chipboard and fibreboard. This material should be certified to have a formaldehyde content in accordance with the current European regulation BS EN 312.

Discussion

The above specification was regarded as acceptable on environmental, operational and financial grounds.

Final Specification

The above specification to be observed.

2.19 Recycling Facilities

- ☑ segregated recycling facilities will be provided for paper and glass, with textiles and plastics possibly being added at a later date
- ☑ City of Edinburgh Council Department of Cleansing has approved these facilities and will provide uplift
- ☑ during construction, waste minimisation techniques will be applied to reduce waste generation and waste will be segregated into clean rubble, general chemical waste, timber, metal, synthetics and others

Discussion

The above specification was regarded as acceptable on environmental, operational and financial grounds.

Final Specification

The above specification to be observed.

2.20 Road Surfacing and Footpaths

- ☑ the use of recycled stone sets from Comely Green Crescent is the preferred option
- ☑ alternatively, a block paving system with a high recycled content should be used
- ☑ consideration should be given to porous materials, which help to even out peaks in stormwater flow

☑ asphalt should be avoided wherever possible but may be required in adopted roads.

Discussion

It is considered unlikely that sufficient stone sets will be available to accomplish the preferred option. If this is the case then they should be used as much as possible and high recycled content concrete paviors used elsewhere. Recycled paviors are available but variation in colour and standard may make them unacceptable aesthetically.

Adopted roads are likely to be required to be made of asphalt.

Final Specification

Adopted roads are likely to be required to be built to the relevant specification. However, where possible, re-used materials such as stone sets should be used and high recycled content materials specified where re-used materials are not available in sufficient quantities.