CIB TG 16, *Sustainable Construction*, Tampa, Florida, USA, November 6–9, 1994.

AN ENVIRONMENTAL CODE OF PRACTICE FOR BUILDINGS AND THEIR SERVICES

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ABSTRACT

BSRIA's Environmental Code of Practice for Buildings and their Services[1] aims to reduce the environmental impact of buildings at all stages of their lifecycle. The Code is intended to be a working document for acquiring, designing, refurbishing and ultimately disposing of buildings in an environmentally sound way and for minimising the environmental impact of buildings in use. This paper describes the work undertaken to produce the Code of Practice and research presently underway to improve feedback from building projects.

The Code was produced following a period of pilot implementation and consultation. It provides a systematic means of navigation through the environmental aspects of a building project from concept to demolition. Increasingly the success of a modern building necessitates a multi-disciplinary approach. The Code creates the basis of a common language with which to address environmental concerns for all those involved in determining the type and level of a building's services, increasingly everyone. It is therefore of interest and value to clients, architects, quantity surveyors, asset managers and building owner operators.

Alongside a strategy, those involved also need direction as to the most cost effective means of alleviating the environmental impact of buildings and information on how good ideas in principle work in practice. Research presently underway is aiming to produce this information through constructive feedback from buildings with environmentally friendly features. This will lead to publication of a number of case studies on the cost, environmental and qualitative implications of implementing the recommendations in the Code of Practice. It is intended that the case studies will provide the basis of a methodology to assist in promoting environmentally-effective and cost-effective design, management and disposal strategies.

The demolition process is of particular interest as it provides invaluable information to feedforward into the design process. This paper includes a case study of building decommissioning, demolition and recycling of components.

1.0 BSRIA

This research was undertaken at BSRIA, the UK's Research and Information Association for the building services industry. The Association is non-profit distributing and sets as its objectives to be the research arm of large and small building services organisations across the whole range of building services activities. BSRIA presently has about 800 company members.

Consideration of the indoor, local and global impact of the built environment is a core element of BSRIA's activities. Indoor climate modelling, sick building syndrome, water economy, noise, legionalla, energy efficiency and emissions are all areas in which BSRIA has undertaken research and produced reports or publications. In 1990 BSRIA turned its attention to environmental issues more robustly in response to increased interest from the membership. The change at BSRIA was typical of changes happening as a result of public concern and consequent pressure from consumers, investors and voters. Research was initiated to promote more environmentally aware practice in building services provision.

2.0 IMPACT OF THE BUILT ENVIRONMENT

2.1 Artificial Environments

Buildings are enclosures created almost exclusively with the aim of providing an improved environment for people and activities. People in the developed nations spend the greatest part of our lives within these artificial indoor environments and should expect them to enhance our well-being, be functional, joyous and healthy. However, building designers, owners and users also have a responsibility to protect, and where possible enhance, the local environment outside the building. Concern now extends further as we realise the impact on a global scale of the industrial, energy and transportation infrastructures which support our buildings.

2.2 Environmental Implications

The resouce implications of the built environment in the UK are enormous. Around 52% of delivered energy in the U.K. is building related[2]. Non-industrial water consumption accounts for around 60% of delivered public water supplies[3]. In addition there are resource requirements of construction, the associated manufacturing energy and transport demands of the materials used, an area of enormous research interest. Buildings generally last a long time and badly designed buildings inflict unnecessarily high demands on the environment. If they are demolished prematurely they represent a wasteful use of capital resources and embodied energy.

The building industry can also contribute to a more sustainable environment in terms of affordability, quality of life and employment creation beyond its immediate role of shelter provision. In many ways an environmental approach is more of a philosophy than a set of rules and hurdles. It is important to give due regard to the extent of the indoor, local and global impacts of buildings and facilitate improved habits in those who use them but this ultimately extends beyond the design, installation and management of building services. An environmental approach needs to become part of personal, professional and company ethics, affecting everything an organisation and the individuals within it do and the decisions they make.

2.3 Green Buildings

Buildings are not exempt from the growing market for 'green' products and the development of environmental labelling. Increasingly they will be required to satisfy a number of criteria applied to other 'green' products, including that they should not:-

- Endanger the health of the occupants or any other parties;

- Cause unnecessary damage to the natural environment or consume a disproportionate amount of energy during construction, use or disposal;

- Cause unnecessary waste due to short life, poor design, or less than ideal construction and manufacturing procedures;

- Use materials from threatened species or environments.

Conversely they should:-

- enhance living, working and leisure environments;

- consume minimum energy over their life cycle;

- generate minimum waste over their life cycle;

- use renewable resources wherever possible.

Clearly the issue is one which encompasses the whole of the building life cycle which increasingly involves redevelopment, conceptual design, design, construction, maintenance and ultimately demolition and disposal.

3.0 TARGET AUDIENCE

Procurers, design professionals, contractors, suppliers and operators all face particular obstacles. All have different priorities and need different kinds of advice and reference information. All can contribute in an important way to reducing the environmental impact of a building.

The procurer, by establishing the right priorities, in order to seek the right kind of building in the right place, with the maximum positive, and minimum negative, environmental effects, and with the greatest benefits for users and non-users. Also, by clearly instructing the design team with regard to the requirements of the users by being prepared to move away from the syndrome of lowest price and by supporting, as far as possible, design selection and plant procurement on the basis of life cycle costs and environmental impact.

The design team, by responding to - challenging and influencing if necessary - the procurer's requirements in order to produce the best result. Designers must think through issues leading to overdesign and inefficiencies, pay attention to detail and give forethought to maintenance, commissioning and manageability, and the needs and well-being of the user. There is a need to integrate the architecture, structure and services strategies and to establish system selection on the basis of life cycle costs and environmental impact.

The professional institutions, by actively promoting a wider interpretation of building services that hardware provision and enabling fee structures to be established accordingly. Also by recognising the crucial importance of feedback information at all stages to the overall evolution of the building design process.

Contractors, manufacturers and suppliers, by meeting the requirements in an environmentally sound way and by minimising any wastage, pollution, hazards and risks associated with their products, services and working practices. Also, by supporting occupiers with better training, information and support.

The owner and occupier, by managing the building in an environmentally sound way and making improvements where practicable and by recognising and pursuing quality.

4.0 DEVELOPMENT OF THE CODE

With the support of government and industry BSRIA has written an Environmental Code of Practice in two phases.

4.1 Objectives

The project was always ambitious.

> It aimed to provide a strategy to **reduce the waste streams through buildings** and it was felt that addressing the services strategy was crucial to meeting this objective.
>
> Environmental issues cut across, not only geographical, but also professional boundaries and create conflicts of interest. So in order to fully address environmental issues it was necessary to produce a document which would **create the foundation of a common language** for all those involved in the building industry.
>
> What was also required was a means to **encourage continual improvement** consistent with the increasing adoption of environmental management systems.
>
> It was important that that the document **provided questions as a basis for discussion** not answers that people could back into as lowest common denominators.

4.2 PHASE 1: Draft Code of Practice

A Draft Code of Practice was structured around the life cycle starting with design team selection, client briefing through material selection and eventually to demolition and recycling of materials. For convenience and compatibility the sections followed the sequence of a new building, from inception through to ultimate demolition and disposal. However, this was for convenience of presentation only, as users of the Code may be involved in a range of activities. The sequence is recognisably more of a life-cycle than a linear process and the structure of the Code allows for a starting point at any stage. It encourages a review of design to date if environmental issues have not previously been included.

4.3 PHASE II - Pilot Study

A Pilot implementation project took place in 1992/3 which tested the application of the Draft Code. The recommendations which it contained were compared and contrasted with procedures in building design and use with host projects. It was intended that the pilot phase assist in reducing the environmental impact of the projects and processes under scrutiny and highlight areas for improvement in the Draft Code.

Consistent with the objective of creating a common language the pilot scheme involved the interest and active participation of a number of organisations with projects which ranged across the building life cycle from building inception to demolition and disposal of materials. Projects included domestic, public and private sector buildings and involved national and local government, representatives of the energy utilities, building owner/operators, a manufacturer of building services equipment, a services consultancy, a developer, an investment company, architects and clients.

4.4 Code of Practice

The Code consists of a series of recommendations at each stage in the building lifecycle along with supplementary information. The inclusion of recommendations in the later sections does not indicate that they should not, or could not, have been considered at an earlier stage but serve to enable the user to break into the cycle at an appropriate point and make a positive contribution.

In addition to the Recommendations each part also has an information section under a series of icon headings.

<u>Legislation</u>: Rules one must observe today.

<u>Guidance</u>: Where one can look to see examples of Good, Better and Best Practice.

<u>Rules of Thumb</u>: Easy to use design factors to achieve Good Practice and to check if one is achieving it.

<u>Pitfalls</u>: Where things all too often go wrong.

<u>New Ground</u>: Things to watch for when new ideas are being applied.

<u>Discussion Points</u>: Unresolved issues. Perhaps areas where further research is required.

The Code also includes cartoons and anecdotes, partly as light relief and partly because some issues are best addressed obliquely.

The redraft of the Code in 1994 took account of the comment received from the pilot studies and from the wider industry. One significant change was to make the Code compatible with the UK's contract procedures. Navigation through the Code is assisted by indicating some common methods of procurement. It is intended that the Draft Code remain as the generic for possible adaptation for building industries in other countries.

The most important decisions affecting the impact of a building are taken at the earliest stage in building conception and design. However, occupation and feedback in use are crucial both to environmental management and to feeding essential information into the design process to encourage innovation. The dismantling and disposal stages of the lifecycle provide invaluable information to feedforward into the design process. Use of the Code at any stage can help to reverse a vicious circle of progressive decline and generate a virtuous circle of continuous improvement.

5.0 PHASE III - Evaluation

All of those concerned to reduce the environmental impact of buildings need to be able to identify the most financially and environmentally effective measures which they can implement in a given situation. This is consistent with good design practice and with the increasing role of environmental management of building assets. A major barrier to improvement is the dearth of feedback information from building projects. This is especially important where the new generation of environmentally sensitive buildings is concerned, as there is very little fully substantiated guidance which can be used by practitioners.

Following the production of strategic guidance, in the Code of Practice, it was appropriate to encourage the adoption of best practice by analysing the environmental, financial, and qualitative costs and benefits of environmental options which have been taken in building projects. A portfolio of case study projects has been compiled which covers the entire building life-cycle. At this stage the study is essentially a scoping exercise, with all the limitations that this introduces, and one which is by necessity progressing on the basis of specific case-studies. It is expected that it will be some time before the research will produce a methodology for use in decision making but in the short term the information generated will be clear about assumptions made, identify generic issues, encourage environmental considerations, disentangle conflicts of interest and prevent decision paralysis.

5.1 Dismantling Case Study

This case study concerns a nine-storey office block which was demolished using a competitive bid, achieved over 90% recycling of the demolition waste and made a considerable financial saving on landfill costs. A total of over 4000 tonnes of material was sent for recycling. Where established markets for the materials were not present, for example with sanitaryware and roller blinds, buyers were actively sought. The study aimed to identify the actual financial, environmental and qualitative benefits achieved. The diversion of materials away from landfill has obvious environmental benefits and alleviates the problem of diminishing landfill capacity, but also saved the contractor around £40,000 in landfill costs. However, other environmental issues have also to be taken into account when considering recycling.

It is now generally accepted that recycling presents a good environmental option although anecdotal evidence can highlight questionable practices. The resource inputs may be significant. There is little information available to verify whether recycling is justifiable in specific instances, nor is there information on the strategic issues and discontinuities which might make recycling more or less environmentally benign. Important issues worthy of consideration are the health and safety implications of reclamation and recycling versus raw material extraction; the resource (energy, water and chemical) requirements for reclaiming, transport and re-processing; fitness for purpose, legislation, conservation of habitat and amenity from reduced raw material extraction, processing and transport of raw materials; conservation of landfill capacity.

5.1.1 Tendering

Environmental considerations were not high on the list of priorities. Cost along with safety and lack of disruption were of prime importance as a replacement building had already been constructed and occupied adjacent to the building to be removed. Pre-qualification of contractors was undertaken on the basis of reputation, company size, and in-house availability of suitable plant and personnel. A site visit at short notice to pre-qualified bidders was also used to assess submissions. Five contractors were supplied with the demolition brief which mentioned recycling. Two preferred bids were very similar in price, but differed in their methodology. One proposed demolition into the basement of the building, and the other suggested floor by floor dismantling. The timescale for the latter slightly exceeded the former but anticipated a complimentary revenue from the sale of the retrieved materials to offset extra labour costs.

5.1.2 Materials

Concrete

A total of 3561 tonnes of concrete were reclaimed from the demolition project, and were transported to a concrete recycling plant approximately 25 km away. Assuming a transport energy conversion figure of 4.5 MJ/tonne/km[4], this represents 288.4 GJ extra energy used than if the concrete had been landfilled at a site 7km away. Although the embodied energy values of reinforced concrete and crushed rock aggregate are known (2.03 and 0.5 GJ/tonne respectively[5]), it is presently impossible to determine the energy saving in producing aggregate from concrete as further research is needed into the energy consumption of recycling operations. Had the concrete been landfilled, 1600 GJ of energy would have been needed to produce the aggregate which could have been obtained from crushing the concrete. This figure is offset by the energy requirement of recycling, which remains unknown, but it should also be remembered that almost a further 300 GJ of energy were expended in transport to the recycling plant. An extra benefit of recycling the concrete is that the iron reinforcing bars are reclaimed as scrap.

Extraction of virgin aggregate to meet present demand is becoming increasingly problematic, and is environmentally destructive if carried out by quarrying on land or by sea-dredging. Some of the environmental problems associated with aggregate production on land are also present with concrete crushing: excessive noise, dust, transport requirements and visual intrusions. However, quarrying for aggregate also leads to loss of land, habitats, subsidence, damage to aquifers and release of methane, along with much greater and long-lasting social effects due to traffic generation and the proximity to workings.

Ferrous scrap

There is always a demand for scrap metal, and it is unlikely that this material would be landfilled. The demolition produced 236 tonnes of ferrous scrap, all of which was processed at a scrap yard approximately 30km away from the demolition site. 24.4 GJ of transport energy was utilised in recycling. The energy required to produce steel from scrap is half of that required to produce it from ore[6], 16 GJ/tonne, giving an energy saving in this case of 3776 GJ. 32 GJ/tonne is given for the embodied energy of iron and steel and assumed here to represent the production of steel from ore). In reality savings will be less as 46% of the total consumption of ferrous metals in the UK is from scrap[7].

Non-Ferrous Scrap

There is an established infrastructure and constant demand for non-ferrous scrap metals such as aluminium, copper, lead, tin and zinc. The two major metals recovered from the demolition were aluminium and copper, making a total of 40 tonnes. The majority of this was aluminium from the facing of the building, although there is no breakdown of the relative weights of each metal. Scrap aluminium provided 28% of total UK consumption in 1990, and scrap copper provided 47%[7]. If landfilled, copper and aluminium are toxic to plants, birds, insects and microorganisms. The energy required to produce aluminium from scrap is only 4% of that required to produce it from ore[6]. The embodied energy of aluminium is 235 GJ/tonne, giving a figure of 9.4 GJ/tonne for aluminium produced from scrap. The embodied energy of copper is 70.2 GJ/tonne. The non-ferrous scrap was transported 140 km, using an extra 24 GJ of energy. One of the major energy-saving benefits of the demolition was that non-ferrous and ferrous scrap was separated on site. Had this not happened, it is likely that the scrap would have first been sent to the scrap yard, sorted out there, and then the non-ferrous fraction sent on either to landfill or, more likely, to a reclamation site. Energy is also used to operate the magnet in this sorting process.

Glass

In 1990, 21% of UK glass consumption came from recycled glass[7]. Recycling glass (using cullet) reduces the need for the production of the raw materials, mainly silica, which go into glass and the production of which gives rise to the same environmental problems associated with aggregate production, discussed above. In the demolition project, a total of 72 tonnes of glass was sent to a cullet recycling plant, 300 km away. The extra transport energy consumed in this operation amounted to 94.9 GJ. The embodied energy of sheet glass is 18.6 GJ/tonne, meaning that 1339.2 GJ net energy was saved through not having to produce new glass from virgin materials (assuming that no glass was lost in the recycling operation). Again, the energy consumption of the recycling operation is unknown. There have been recent doubts over the economic benefits of glass recycling, due to the increased amount of recycled cullet which necessitates higher production standards and simultaneous significant reductions in the cost of virgin materials. In the UK there has been a 25% drop in raw material requirements because of increased production of soda ash in the USA. Glass collected from local authority bottle banks gives a surplus of green glass, and there is a need for much more clear glass, a demand which could easily be met by increased recycling of glass from construction waste[8].

6.0 CONCLUSIONS

The research described aims to assist clients, designers and contractors to make decisions which will best enhance the environmental integrity of future buildings designs. The Code of Practice provides strategic guidance and the feedback case studies aim to assist all involved to identify where best to focus attention to produce genuine environmental improvement. The information will also be of use to policy makers who may wish to identify where best to target policy to facilitate improvement and innovation.

The energy costs and CO_2 implications of recycling are of increasing concern. The justification for recycling some materials is questionable, particularly when this involves significant transport, re-processing and perhaps additional chemicals. The case study cited indicates that recycling was justified in terms of reclaimed materials and embodied CO_2 and the savings in both extraction and landfill. In addition the project made a considerable financial saving on landfill costs.

Assessing the financial and environmental costs and benefits associated with individual buildings, components or features is complex and involves making a lot of assumptions. Ultimately the results of research need to be subject to sensitivity analysis. However building professionals are increasingly required to make decisions on environmental grounds and wish to know how to make cost-effective rather than tokenist improvements. Rather than succumb to decision paralysis when confronted with the enormity of the task this research has taken the form of a scoping study to identify the need for vastly improved feedback information from completed projects and to start to float some important issues.

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