Creating the models

The basic model for the selected housing blocks is established with reference to both published and historical quantity data obtained from DLS Management's database of projects. Sub-elements and specific material components are extrapolated from this data to generate the complete material mass model.[2] Upon completion of the building material mapping, the individual material quantities can then be separated and converted into their physical masses by using published and accepted conversion factors.

The material masses included within the models are based on generic building designs. In the case of the housing authority blocks, this is a standard specification, whilst the private sector version is a typical representation of the building design most commonly adopted. The material masses within the models include standard foundations design allowances and building services installations for each of the building types. In the case of foundation design, whilst ground conditions vary, as a result of both the building location and loading, it has been possible to produce what can be regarded as a 'typical foundation design'. This type of design is considered to be applicable for a significant proportion of housing blocks constructed in Hong Kong.

The models are also expanded to include repair and refurbishment regimes for each of the studied building types over their respective notional lives. The major 'cost in use' materials and refurbishment cycles have been identified, using historical records available from DLS databases. This approach allows the generation of a realistic life-cycle model. Each of these individual material groupings are then further analysed to create detailed repair and maintenance 'mass' models suitable for application to the housing block types. In the case of refurbishment, typical churn rates[3] for the different blocks have been considered. Importantly, the residential profile is different, with the housing authority blocks being public rental housing, whilst the private sector blocks are split between owner-occupier and rental units on a ratio of 75 : 25. For the purposes of this study, the rental profile, in terms of refurbishment rates, of the private and housing authority blocks are considered to be comparable, whilst the owner-occupier churn factors are different and reflect the longer gaps between refurbishment. It is worth noting that in Hong Kong the churn rate within residential blocks in the private sector is generally high, when compared with other countries.

The resulting collation of all the material masses identified at the construction, repair and maintenance stages form the total material life-cycle mass for the different housing block types. This presents for the first time a true material-usage full-term life profile for a residential building in Hong Kong and is the most in-depth analysis available. Having developed this whole-life mass profile for one block type, results can be benchmarked against different residential buildings on a floor area basis. This mass profile forms the underlying source of the calculation of the energy, environmental and waste models for the different blocks.

The development of the waste model, although primarily driven by the mass model, requires the inclusion and assessment of the quantities of materials 'wasted' at each stage of the construction and maintenance process. The identification of which materials are currently recyclable and which materials could potentially be recycled is another factor influencing the format of the waste model. Generally, the construction waste quantities are derived from established and accepted allowances used in the construction industry (Architectural Services Department, 1982). Recycled materials are identified from information already published in the public domain, supplied by manufacturers and extracted from related reports and studies, information that is considered adequate for the current model.

The development of the energy and CO_2 models for the different materials is established using conversion factors derived from recognized international sources and then applied to the mass values for each stage of the building's life. Creating an operational energy consumption and CO_2 emissions 'profile' for each building type has been achieved by resorting to recorded data already in the public realm. The utility organizations within Hong Kong have published some general data on this issue, but some adjustment is required to make allowance for the different resident lifestyle profiles between the public and private sector residential blocks.

The final segment of the model is the cost element, which is derived from benchmarked construction costs for the selected building types and then broken down to the different building elements, and then further to material categories wherever possible. The repair and maintenance models are also costed using data sourced from past DLS projects and these have been included as typical snap-shots of the whole-life expenditure