EVALUATING THE IMPACT OF AN ENHANCED ENERGY PERFORMANCE STANDARD ON LOAD-BEARING MASONRY DOMESTIC CONSTRUCTION

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Interim Report Number 4 – Construction Process

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Executive summary

1. This interim report reports on the early stages of the construction process at Stamford Brook. Since house construction began in July 2004, the two developers have succeeded in their attempts to construct low-energy low-carbon airtight homes in mainstream speculative housing that meet the energy standard proposed by Leeds Metropolitan University research team (EPS08) and the wider environmental standard (EPS) set by the development team (the developers, the National Trust and Leeds Met). As explained in Deliverable 2: Design Process, EPS08 is an estimate of the standard thought to be regulatory in a 2008 revision of Approved Document Part L and, as such, is still a more demanding target than the current proposals for 2005.

2. Cooperation between the Leeds Metropolitan University team and the developers has been excellent. The construction team (site management, sub-contractors, operatives, clerk-of-works, buying, technical, external consultants, etc) have shown enthusiasm while maintaining a high build standard.

3. The Leeds Metropolitan University team has put a significant effort into supporting the developers throughout the design and construction processes. A direct result of this has been that rich insight has been gained into a wide range of issues raised by the energy aspects of the EPS standard. The action research approach adopted at the outset of the project has been highly successful.

4. A number of practical problems have been encountered through the construction process. These include problems at the floor-wall junction, eaves details, window details and airtightness in room-in-the-roof dwellings. These have in the main been addressed jointly by the developers and the Leeds Metropolitan University team and in almost all cases, satisfactory solutions have been developed.

5. Initial airtightness results are excellent. The decision to use parging to provide an air barrier in walls independent of the dry-lining has worked well, delivering air permeabilities down to 1.75 m/h @ 50 Pa. The success of parging is due in no small part to the conceptual clarity that it provides – the parging layer is the primary air barrier. A full report on airtightness will be presented in Deliverable 5.

6. The double glazed windows fitted at Stamford Brook meet the EPS requirement of U = 1.3 W/m^2K and DWER=70 at the BFRC standard size (The actual scale used in the DWER has changed since EPS08 was written, see www.bfrc.org). However, in practice, the windows are significantly smaller than this and the frame fractions significantly higher than originally expected. This will increase the actual U values of the windows and reduce solar gain and visible light transmission. The windows are fitted from inside the dwelling and have vertical trickle vents and warm edge technology and see Figures 6 and 7, respectively. The use of warm edge (Thermix) reduces the impact of window size on U value.

7. The extra-over cost of building to the energy standard is in the region of £3000, reducing expected emissions of CO_2 for a typical 100 m^2 semi-detached house by approaching one tonne per annum. Running Cost savings are expected to be of the order of £80 per annum, giving a crude payback time of the order of 40 years – not including the social cost of carbon or recent increases in the price of delivered energy. Inclusion of these factors is likely to mean that the package of additional energy saving measures will be broadly cost effective.

8. Tangible outputs from the project so far include: a complete set of Stamford Brook Working Details for masonry dwellings that have minimal thermal bridging through the junctions; construction and individual trade specs; a product and materials schedule; KPIs; site staff training scheme; sales team training scheme; informative housebuyer packs; documented ethical procedure for involving home owners in a research project; and a wealth of publicity through local involvement, regional and national seminars, conferences, trade journals and the press.

The construction process: introduction

Report outline:

9. This Deliverable (no. 4: The Construction Process) is an interim report that deals with the construction phase at Stamford Brook and follows on from Deliverable 2: The Design Process. All judgements and evaluations in this report are preliminary and, in some cases, may be revised before the final report.

10. Although infrastructure work on site began in January 2004, the first house foundations were not dug until July 2004. The spine road into the site was constructed first, from the A56 (Manchester Road in Altrincham) into the site. Road works included the creation of a major new road junction and a new traffic light system. This spine road is shown in Figure 1 – it cuts between existing properties (college and an office block near the horizon) and playing fields (centre of picture) before reaching the built-up area of Stamford Brook (lower third of picture), a distance of approximately 500 metres. From there, other site roads were completed before house construction began.

Figure 1: Aerial view of Stamford Brook site

11. At the time of writing (June 2005) Redrow have a small number of house completions with about eight houses and flats now occupied and with a decorated viewing unit. Bryant are shortly to make their first completions and have four show houses completed.

Programme

12. Several factors meant that the actual progress on site does not match the work items originally listed in the deliverable schedule for the PII project. There was a five month delay in site infrastructure start. Investors reserved many of the first houses released for sale, rendering those houses unsuitable/problematic for intensive monitoring. Waiting for home owner/occupiers will mean a further delay to the start of the monitoring period. It is intended to have all ten dwellings in the monitoring phase by summer 05 in order to acquire a whole heating season's worth of data. During house construction, the developers continued to adjust their build programmes to allow for training, additional EPS requirements, etc. In addition, the planned sequence of build was altered to respond to customer demand for house types not part of the initial development parcels. For example, there was a large demand for detached properties, which were not originally scheduled to start until 2006. As recently as Jan 05, one developer revised the build schedule and pushed back the hand-over date of dwellings already started by up to 11 weeks. However, the Leeds Met research team has been able to accommodate these changes.

Costs

Cost brief

13. A brief was written by the research team for the Trust's QS in July 2004. A copy is included in Appendix 1. The key outputs identified in that brief were:

- Key Output 1: Estimates of increase in whole building construction costs, averaged over the whole of phase 1 of the development, comparing actual out-turn with the same estate built to ADL 2002 standards and to the draft ADL05;
- Key Output 2: a break-down of the above, by element;
- Key Output 3: an analysis of the development of a checklist of key elemental costs, from the outset of the project to final out-turn.

Cost report

14. The report by the Trust's QS on costs in included in Appendix 2. The main points are:

- The average construction cost increase is 9 % compared to the Developers' standard construction 2002 compliant construction cost.
- The top three contributors to the cost increase are 38% for windows and doors, 27% for walls and 15% for non-energy sustainability features at the level of the individual dwelling (water and waste minimisation and low impact materials).
- The main airtightness measure, parging, cost just over £400 per unit, adding around 0.9% to costs.
- Dynamic effects on cost are apparent in a number of areas. The clearest cases are the wall ties, where the costs fell by a factor of 5 and loft insulation, where the extra-over cost fell to approximately £16 per unit. The development of an improved specification, reducing the number of ties from 8 to 4 per m^2, was an important factor in reducing costs for wall ties. The reason for the low loft insulation cost is the currently low price for waste-derived cellulose insulation (Warmcel).

15. One of the objectives in the Environmental Performance Standard (EPS) was to source materials and products locally, wherever possible. This was not done in the case of plastic wall ties and windows and doors. Together these items accounted for around 46% of the total cost increase. There appears to be only one European provider of plastic wall ties for wide masonry cavity walls.

16. Only a small number of suppliers were able to offer the required window specification (softwood timber frames, soft coat, argon-filled low emissivity glazing and warm edge technology[*]). Of these, Rationel, who mass produce windows in Denmark to a very similar specification to that required by the EPS, was a clear leader on price. Comparison of the prices offered by Rationel and a specialist, small-volume, UK manufacturer, suggests that the ability to mass produce windows and doors has a larger impact on prices than the technical specification.

17. The PQS made considerable efforts to determine the extent to which the out-turn costs for Stamford Brook were "realistic". Issues still under discussion include the scaffolding requirements of installing the windows. In general, the out-turn costs are within a few percent of the estimates of "realistic" costs made by the PQS.

18. It nevertheless appears likely that, in specific areas, further work will result in further reductions in costs. An obvious example is external doors, where the reported extra cost is in excess of £600 per unit. In 2001, the second author bought a steel faced, polyurethane core door with magnetic draughtstripping, in Canada, at retail for approximately £200. Volume discount might halve this. This appears technically to be at least as good as the doors installed at Stamford Brook.

[*] It was ironic that after going to some lengths to source windows with warm edge technology for the houses at Stamford Brook, it was discovered that warm edge was fitted as standard in the windows at the site office.

19. A second area is the nature of the heating system required by dwellings as well insulated and airtight as those at Stamford Brook. Work done for ODPM in 2004 (R.J. Lowe, 2004), based on analysis undertaken by F&A (M. Lowe 2004), showed the following costs for wet central heating systems:

Capital cost offsets from reduction in capacity of wet central heating system	supplied (£/kW)	supplied & fixed (£/kW)
Reduction in radiator size but not number; assume 1 kW/m^2 of radiator	72	n/a
Omission of radiator; 1 no. 1 m^2 (1kW nominal) radiator	173	263
Reduction in boiler rating; per kW	22	n/a

20. The greatest reductions in cost would be achieved by omitting, rather than resizing radiators. The research team thought this may ultimately be possible in the case of bedrooms in two storey dwellings, but neither Redrow nor Taylor Woodrow have been prepared to take this step at Stamford Brook due to the perception of the customer and the resultant impact on sales. More work could be done in this area.

EPS08 compared with ADL2005

21. As explained in the 'costs' section, the 'extra-over cost' was defined as the difference between the actual cost of building Stamford Brook houses to the Environmental Performance Standard (EPS08) minus the cost that the developers would normally expect by building their 'typical' house to the regulations current at the time. In the early pre-contractual stages of the project, the current regulations were initially ADL1995 and latterly ADL2002. As the project entered the design stage, the next expected revision was assumed to be in 2008. Even though that was unexpectedly brought forward to 2005, this next major revision still seemed far into the future. However, during the construction phase in early 2005, it became clear that this revision was imminent and yet it was unclear how the developers would achieve ADL2005 (their 'typical' build on their other sites). As this would be their new baseline for calculating extra over costs for Stamford Brook, this uncertainty is currently being addressed by the developers. The research team produced a working paper (see Appendix 3) showing what were thought to be the main differences between EPS08 and ADL2005. The conclusions were:

a) The work described in this paper suggests that the Stamford Brook dwellings will exceed the requirements of ADL05. The margin between predicted CO_2 emissions for space and water heating and ventilation and the ADL05 Target Carbon Emission Rate is in the region of 4-8%.

b) The intention of the Stamford Brook Partnership has been that each phase of the development would be built to energy and CO_2 performance targets that were significantly ahead of the requirements of prevailing national standards. As this paper makes clear, the introduction of a new Part L based on the targets published in the consultation document will narrow the performance margin in all dwelling types.

c) An indication of the level of performance that may be required in the next revision of Part L is given in the latest Part L Consultation Document (ODPM 2004), under the heading Future thinking for parts L1 and L2. This suggests that the 2010 revision of Part L will reduce CO_2 emission targets for space and water heating in new dwellings by a further 20-30%. Any revision of EPS08 would need to be set at something like this level if the project is to retain its national significance as a pathfinder for energy performance standards in mass housing. This would require consideration of technologies - including active solar water heating, heat pumps and district heating - that have not been on the agenda for Stamford Brook so far.

d) The proposed new Part L will also change the structure within which performance standards are expressed. The effects of this change are to resolve the conflict between the elemental and carbon rating approaches and to provide a framework that incentivises a much wider range of technologies than hitherto. This structural change will need to be reflected in any future revision of EPS08.

e) One of the most important unknowns in all of the above is the gap between predicted and actual performance. The care spent on the construction of the dwellings, together with pressurisation testing and energy monitoring should ensure that actual performance at Stamford Brook comes reasonably close to predicted and, therefore, that the estate performs better than the industry average in this respect. But lack of empirical data on energy performance for new housing will make this assertion difficult or impossible to confirm.

22. The requirement for condensing boilers (bottom of Band B) came into effect in April 2005 and the extra-over cost of the EPS was adjusted accordingly.

Crossover of design and construction phases

Stamford Brook Working Details

23. The most important document that bridged the design process and the construction process was a set of robust standard details that were designed specifically for the Stamford Brook project. The Stamford Brook Working Details were updated in April 2004 just prior to site start and given new EPS numbers which cross-reference the relevant details from the National Specifications, while allowing space for additional bespoke detailing (column VAR). The accompanying register also indicated which details should be included within each of the trade specifications given to the subcontractors as part of the contract documentation. The details were drawn by Dave Poole of Taylor Woodrow Developments with support from the research team. As the details continued to develop throughout the construction phase, additional support was given by the site management team, subcontractors operatives and clerk-of-works. The latest set of Stamford Brook Working Details is included in Appendix 4.

Contract documentation

24. Specifications were provided to Subcontractors with the tender documents: The main items of documentation were the construction spec, materials schedule, trade specs and Stamford Brook Working Details. These were required the sub-contractors and suppliers to examine and cross reference the information to fully understand what was required to meet the standard.

Construction Specification

25. Construction Specification for Load-bearing Masonry Houses at Stamford Brook, latest version 16, 19th May 2005.

Trade Specifications

26. Theses were individual trade specifications, largely based on existing Group Trade Specs, amended in line with EPS requirements.

Product and Material Schedule

27. Product and material schedule, latest version 10, 6th December 2004.

Project issues checklist

28. A project issues checklist was devised in Autumn 2004. Everyone involved on site was encouraged to add issues to the checklist which was then circulated by the project managers each week for comment. The checklist was a very successful tool in the early months of construction and helped to communicate buildability issues and solutions to all staff involved. The checklist has now largely been replaced by fortnightly site meetings attended by a core of site management members and subcontractors as applicable.

Key Performance Indicators

29. A table of key performance indicators (KPIs) is being developed to analyse the impacts of enhanced energy standard on the developers' own performance indicators and quality standards. A copy of the latest version is shown in Appendix 5.

Construction team

Site set up

30. Each developer had a Project Manager, one of whom was based permanently on site. Each has senior site managers, site managers and assistant site managers. Different suppliers and subcontractors were used by each developer with the notable exceptions of the bricklaying sub-contractors, ventilation system suppliers and the window supplier. The Trust employs a clerk-of-works who visits weekly and attends site meetings. Although unusual for a speculative builder, the use of a clerk-of-works here has proved very successful for as well as checking compliance with the EPS, he has provided the builders with an advice service for the additional EPS requirements and given the research team useful practical guidance on many construction issues.

Site operatives training programme

31. One of the major successes of the project so far has been the site training programme for site staff, delivered by the research team. Sessions were held with groups of site staff (site management, sub-contractors, operatives) which tried to provide the knowledge and skills necessary for building low-carbon, airtight dwellings in the mass-build speculative housing industry. (It was acknowledged that training of this kind would be not be readily available nationally until post-2008.) The research project was introduced and a background to sustainable building methods given. Thermal bridging was explained and illustrative examples given of how to reduce bridging using Stamford Brook Working Details as examples. The main part of the training was devoted to achieving dwelling airtightness. The main messages were: “Do a pen-on-section test to design the air barrier”; “Be clear about where the air barrier is”; “Seal the air barrier if punctured or incomplete”. Feedback from operatives and subcontractors indicate that the sessions were interesting and useful. A copy of the Powerpoint presentation is shown in Appendix 6, along with a certificate that was given to every attendee. The certificate also contains a brief summary of the important points from the presentation.

32. It was stressed at the beginning that the training is a two-way exchange of information and the research team now regularly chat with people on site who have their own ideas on how to improve buildability or reduce cost. All these ideas are folded back into the training programme, which is still developing.

Research team role on site

33. The research team spent one or two days a week on site, from September 2004 onwards. The team worked closely with site staff, photographing construction details and noting points made in conversation. This action research approach worked well, feeding knowledge gained back into the design and construction processes, see Figure 2. This two-way exchange of information benefited both the developers and the research team. This way, the team was regarded as an assistant to the process and did not have a supervisory role. A strong site presence also reinforced the feeling that the research team wanted to hear everyone’s ideas and comments.

Figure 2: Research team discussing buildability issues with subcontractors.

Construction phase – site observations

Foundation construction

34. The earliest indication that the transition from 'design phase' to 'construction phase' was not going to be as smooth as hoped was in the construction of the foundations. The original foundation design (strip footing) was altered suddenly and unexpectedly in the summer of 2004. Poor ground conditions encountered in Phase I meant that a different foundation solution had to be found. One developer chose pile and ring-beam and the other chose vibro-compacted stone. The research team did not have a site presence up to this point and was only made aware of the changes when a Project Manager expressed concern that there did not seem to be room to fit perimeter insulation around the ringbeam on the pile foundation. The other developer was experimenting with under-raft insulation as a way of coping with insulation and thermal bridging requirements. Both solutions were developed independently from the research team and the original 'design team', with one developer using an external consultant to assist in the design of pile details. Once the foundations were out of the ground, the research team suspected that both designs were not as thermally efficient as the strip footing detail. An exploratory calculation using Therm confirmed this and showed that each foundation solution now suffered from thermal bridging significant enough to make the floor exceed the limiting U value requirement with certain perimeter to area ratios (EPS08 still has limiting U values for elements, e.g., floor U value limit = 0.26 W/m^2K).

35. It could have been possible to use the pile foundation design as is and simply build additional brick courses to give room for the required insulation but the floor levels could not be altered as they would not match the rest of the site infrastructure and drainage runs. A large number of piles had already been driven and it was only when the ring beams were fitted that the discrepancy was noticed. A full study was then undertaken.

36. The engineering company that provided the pile details was not part of the 'design team' and were not made aware of the EPS requirements. Their solution did, of course, meet the structural and thermal performance requirements current at the time (2002). However, once the EPS requirement was explained at subsequent meetings, the engineer understood immediately and was quickly able to provide revised detailed drawings. Although there was some misunderstanding between the developer and the engineer, it could be argued that, if the EPS were regulation, the engineer would have known anyway about the requirements.

37. Together, the research team and the site team made further design iterations to improve the performance and buildability of the pile and ring beam foundation. Rigid urethane sheets had to be cut precisely and chamfered to fit the ring beams already in place as they had sloping sections rather than square. This was difficult for the groundworkers even using two thicknesses of board (40mm and 60mm) to make up the 100mm thickness required. In the revised detail, there was sufficient room to insert whole 100m sheets without chamfering, see Figure 3. Two layers of coursing blocks had to be removed and replaced with aerated block at the edge of the insulation to reduce thermal bridging, see lighter coloured blocks, Figure 3. The clerk-of-works has since reported that the revised detail has proven easy to build in all subsequent plots and no additional site supervision is necessary.

Figure 3: Insulation problems around ringbeam foundation.

38. Together, the research team and the site team also made further design iterations to improve the performance and buildability of the raft. Improvements included losing the cavity concrete fill at low level; losing under-raft insulation in favour of underslab insulation; losing perimeter insulation and simplifying the casting of the raft itself. The increase in underslab insulation from 85mm to 100mm to help with masonry coursing was a further benefit to the thermal performance. A report is included in Appendix 7.

39. On reflection, it might have been better for the design team to have provided a robust detail design for all types of foundation likely to be needed before construction began and so avoid last-minute confusion and hasty redesign but at least now there are three details (strip, pile, raft) that have very low psi values. A full report is given in Appendix 8.

Wall ties

40. The wall cavities are 142mm wide and are retro fully-filled with mineral fibre insulation. The two masonry leaves are connected with plastic wall ties to minimise point thermal bridging. Bricklayers reported no real problems building the very wide cavities apart from the greater risk of dropping a tool or a brick down them. Having said that, retrieval was easier. On one occasion, a falling tool managed to snap a number of plastic wall ties as the ties are much more brittle than the more-familiar metal ones. One bricklayer thought a wide cavity had the advantage of being able to manoeuvre the trowel in the cavity to scoop protruding mortar from the joints. Another saw the advantage of being able to knock snots from wall ties using a long batten more easily – although, due to their brittleness, one or two ties were snapped in this process. Figure 4 shows the width of the cavity, the plastic wall ties and in-fill between I-beam floor joists.

Figure 4: Masonry wall construction showing plastic wall ties.

41. During construction of the first dwellings, most bricklayers found it difficult to correctly course the brickwork using the plastic wall ties. The tie itself is less than 10mm in diameter but has four nodules at the ends to help the mechanical fixture in the mortar bed. Unfortunately, the width at the nodules was exactly the width of the bed – 10mm - leaving no tolerance in mortar bed size. This problem was most noticeable on one kind of hand-made brick where individual bricks varied in size considerably, some several millimetres more than the standard 65mm. Fortunately, this problem disappeared on its own as the brick was unexpectedly discontinued by the manufacturer after only a few dwellings had been built. The replacement brick suffered less from problems of dimensional stability.

42. The tie used at Stamford Brook is manufactured in Denmark. No UK manufacturer of a suitable plastic wall tie has yet been sourced. It is suggested that UK manufacturers consider this potential gap in the market and investigate what cavity widths are likely to be used by builders in the near future (and post-ADL2005).

Cavity trays

43. Pre-formed semi-rigid cavity trays were used in the first dwellings built but there were problems with the taped-on stop-ends detaching from the tray. This was because the trays were designed for ‘normal’ cavity widths. The wider 142mm cavities at Stamford Brook meant that the tray had to be forced into position at a different angle from that intended, causing tension on the stop ends which came away. The solution the bricklayers came up with was actually cheaper: to use DPM cut to length on the scaffold and turned up at the ends to make a stop-end. Later, bricklayers were said to prefer this method as they thought the rigid system ‘fiddly’ and difficult to stick the components together in damp conditions. They also found it easier to have one roll of DPM on the scaffold that could be used for all heads, rather than having to return to the compound to collect individual, dedicated components. Additionally, it was extremely difficult to fit a triangular piece of mineral wool underneath the rigid system, whereas the DPM has more flexibility. This was a good example of allowing a solution to develop using action research.

Intermediate floor joists

44. The construction method of I beams first floors was raised in April 2004. One developer chose to use joist hangers and one preferred to build in joists at both ends.

45. The built-in joist was favoured by one developer as they believed it improved health and safety. Various methods of achieving a good airtight seal at the joist/blockwork interface were examined. Web stiffener blocks are inserted at the ends of the I-beams when building-in, which provides the necessary structural integrity for the beams. (Stiffeners are not required with joist hangers that restrain lateral movement of the top flange, as used by the other developer.) The stiffeners also simplified the profile from an ‘I’ section into a rectangular section which was easier to seal around with mortar and/or silicone. The blocks were ordered as ‘factory fit’ to circumvent site fixing. However, some stiffener blocks did not fit as well as expected and had gaps between the top of the block and the top flange as large as 25mm on some beams. This required additional silicone sealing on site. The joiner found it easier to seal the blocks in the compound rather than on the scaffold.

46. Some design team members were concerned that the build-in method would require good workmanship and additional site supervision. However, once these issues were raised with bricklayers in the training sessions, good workmanship around joists became the standard with no particular additional site inspection necessary. In fact, a high standard of blockwork throughout the site was the norm, with fully-filled perpends and pointed blockwork providing a continuous substrate for the parging coat. It should be added that the bricklayers responded easily to the enhanced standards and many said that they welcomed the fact that so many people on site and from the industry were taking such an interest in their workmanship.

47. The discussion of workmanship and sealing around wood joists re-opened the case for using pre-cast concrete floor slabs in house construction which are thought to provide a robust method of achieving airtightness at the junction of the floor and blockwork. Concrete slabs are currently used in apartments, for acoustic reasons. The ends of the cores of these slabs are routinely filled with mortar as construction progresses to aid with airtightness, see Figure 5. It is hoped to reconsider concrete intermediate floors in houses in later phases, although one developer has already stated that it is almost certain they would not use this method of construction.

Figure 5: Concrete floor slabs.

48. The idea of using a proprietary plastic joist seal product was discussed. This method was eventually dismissed by the design team as it seemed a step away from the basic principles of minimum material usage and the fact that additional skills were required rather than less. One of the drawbacks was the fact that it was necessary to cut a slit in the joist seal product to thread an (additional) restraint strap through to the blockwork. It was felt that the product, for all its claimed airtightness benefits, was adding complexity into workmanship, adding cost, and involving additional tools thereby increasing the health and safety risk.

Windposts

49. The consultant structural engineer recommended installing windposts in several buildings. While the developer had anticipated installing windposts in the multi-storey apartments, their use in one smaller dwelling type (a detached flat above four garages) was unexpected as several of these units have been built on other sites without the windpost requirement. As this information arrived late in the design process (October 2004), it was feared that the introduction of this detail might adversely affect thermal bridging through the wall and hence, carbon rating. Site management asked the research team what effect the posts would have on thermal performance. The report (contained in Appendix 9) shows that the effect is actually minimal because the post itself is located mainly in the internal leaf, not in the insulation layer. Also, the length of the junction is small compared to other junctions.

Window formers

50. Lengthy discussions were held during the design stage on how to close the cavity at jambs and sills. The developers preferred method was to use PVC cavity closers but the Trust wanted non-uPVC as stipulated in the EPS. Temporary timber profiles were suggested. The problem with this approach was that many such profiles would be needed for the different sized windows and that they could only be re-used a small number of times before they ended their useful life. This went against the principle of minimal materials use.

51. The ideal solution appeared to be a permanent former which gives an accurate size for bricklayers to work to; provides a resilient fixing for the frame; provides a DPC; creates a stop for the blown insulation, gives a structure to apply parging onto; and gives support to the plasterboard. The Trust allowed the use of PVC formers on the first two parcels (approx 53 dwellings) on the understanding that, as no suitable alternative was available at that moment, all efforts would be made to encourage a more sustainable product to be developed or sourced. No substitute for PVC has been so far been found.

52. One unfortunate breakdown in communication between the research team and the buyer caused problems with the insulation in the window formers. The former that was discussed previously in design meetings had a slab of insulation attached to one side to assist in providing insulation between the masonry leaves at the reveal. Since the cavity would be fully-filled by retro-blown mineral fibre at a later date, it was suggested that the insulation on the side of the former was redundant and could be omitted if that made the product cheaper to obtain. When the buyer later wanted clarification on whether the former needed to be insulated or not, the research team replied

no, meaning no slab fixed to the side, the buyer took that to mean no insulation inside the hollow section of the former. Although this was nobody's fault, it created a lot of disruption on site. It was not noticed that the hollow section was un-insulated until many formers had been fitted. The builders tried hand-filling with mineral fibre and sprayed urethane foam with varying levels of success. Formers in the compound yet to be fitted were easier to deal with. All formers delivered to site are now factory insulated.

Reveal blocks

53. When an order was placed for the reveal blocks, it was discovered that the proposed 65mm block could only be obtained as a 'special' (custom-sized masonry block) and that only the 75mm standard blocks were in stock and available at short notice. The research team had assumed that the developers would order the specials well in advance and that the large scale of Stamford Brook would allow bulk-buying, thereby avoiding any extra-over cost. The research team were asked what difference this made to thermal performance. Therm was use to calculate a psi value for the revised reveal detail and these results were input to the Domestic Performance Calculator to see the effect on whole wall U value. On this occasion, it made a small difference changing the whole wall U value by 0.002 W/m^2K. It was decided to issue a new, revised detail rather than sourcing specials, in light of this small effect on thermal performance.

54. This difference in psi value, though small, was one of a number of tiny adjustments from the original and agreed design and it was feared that more changes might become apparent as the construction phase progressed. It is intended to perform a study to examine all the as-built details again to measure the cumulative effect on thermal performance. The research team thought that this process of 'settling in' would still allow the EPS requirements to be achieved as some details appeared to perform better than originally designed (for example, the floor construction).

Windows

55. The double glazed windows fitted at Stamford Brook meet the EPS requirement of U = 1.3W/m^2K and DWER=70. (The actual scale used in the DWER has changed since EPS08 was written, see www.bfrc.org). The windows are fitted from inside the dwelling and have vertical trickle vents and warm edge technology and see Figures 6 and 7, respectively.

Figure 6: Timber, high-performance, double-glazed windows.

Figure 7: Windows showing part-open trickle vent and warm edge spacers.

56. As expected, timber windows of such a high specification are more expensive than the lower spec (ADL2002) uPVC ones routinely fitted at other sites. It soon became apparent that the extra-over cost of windows and doors is approximately half the total extra-over cost for each house to meet EPS08. Inevitably, other suppliers were asked to quote for later parcels. One alternative supplier/fitter appeared more cost effective but demanded a prohibitively large number of dwellings be available for each site visit (20 plots). This obviously did not fit in with the site build programme. This supplier did opt for 'BM TRADA Q Mark", a certification scheme approved by BFRC (British Fenestration Rating Council) which includes security, safety, weather, operation, strength and durability as well as the thermal performance aspect. Other suppliers are currently quoting but when the fitting, storage and incidental costs are included, the current supplier is still the cheapest.

57. Another company that quoted manufactures an almost identical style and specification window (frame fraction, argon-fill, low-e, warm edge, etc) but could not understand why the performance of their units did remotely match that of the windows already fitted at Stamford Brook. It seems that they estimated the performance of their own range of windows in-house, using a different procedure to the European Standard. When it was recommended they obtain a rating from BFRC (British Fenestration Rating Council), they admitted they had not heard of the service. When it was suggested that they could also try to comply with the Stamford Brook EPS08 requirement via the DWER route (Domestic Window Energy Rating), they had not heard of that either. This indicates that other manufacturers may not be claiming the window energy performance that they deserve and, equally worrying, it is possible that some are falsely claiming higher performance.

Doors

58. While the doors perform well thermally, with a U value of $1.0W/m^2K$, there was a substantial extra-over cost associated with them. This, together with a general dislike of the style of the door, led the developers to propose their standard spec metal-faced door which has a U value of $0.55W/m^2K$. This choice is still being decided at the time of writing.

Roof trusses (cold roof)

59. A revised eaves detail was issued (7-10-04) which showed reduced insulation in the eaves void. When the first trusses were delivered to site and fixed, the research team noticed that the truss design was not as shown on the drawing, reducing further the amount of insulation in the eaves void. These two factors meant that the as-built eaves was very different, thermally, from the original drawing upon which the carbon rating of the dwellings was based. In some house types, this meant

that the U value of the roof exceeded its limiting value (EPS08 still has limiting U values for elements, e.g., roof junction limit = 0.19 W/m^{2}K). A report was made and sent to the developers, see Appendix 10.

60. The birdsmouth of the truss was intended to overhang the wallplate by 50mm thereby creating more space for insulation in the eaves void. This overhang had not been allowed for in the actual trusses delivered to site and the birdsmouth was positioned on the wall plate corner, as is traditional. The research team has been unable to find out where this communication breakdown occurred, although it is interesting to note that the same problem occurred with each developer and their respective suppliers. The truss manufacturer may have assumed the birdsmouth would sit as normal and did not check with the Stamford Brook Working Details. It may be that these detail drawings were not given to the manufacturer at all. The technical drawing departments remembered discussing the overhang feature, although on the drawings it was not highlighted or made clear to the supplier (an omission now rectified). In any event, it seemed to show that any departure from traditional or normal methods of construction do need to be clearly flagged-up to all parties involved, from the moment of conception, through the design iterations, and through the placing of orders to subcontractors/suppliers. The construction team itself should also be made aware but, in this case, they had no control over the process and had no choice but to fit the components as they were delivered to site.

61. Plywood boards are inserted between trusses at eaves level to allow a controlled amount of sag in the roof membrane for ventilation. This further narrows the gap between wallplate and the underside of roof at the point where thermal bridging through the eaves is most critical. The clerk-of-works was concerned that this gap, if small enough, may restrict the placing of the Warmcel roof insulation into the eaves void when it is blown in at a later date.

62. Once the truss overhang problem was identified, the developers gave instruction to the supplier that all future trusses should have the overhang. In fact, one developer increased the overhang to 100mm to reduce thermal bridging further. Unfortunately, this still left a number of dwellings with this problem as there are trusses already on site and a number under construction at the factory.

Attic trusses (room-in-the-roof)

63. Early designs of the room-in-the-roof insulation showed I-beam construction fully in-filled with cellulose insulation. A cheaper alternative was found to be an attic truss system. Each truss arrives on site in two parts and is joined on site at the ridge. With these trusses, vertical members form the upstand about 1 metre from the eaves. The width of the raking members is smaller than that of the I-beams and so urethane insulation (λ= 0.022 W/mK) was suggested to provide the same U value as the I-beam with cellulose insulation (λ= 0.038 W/mK). The design, when issued, showed cellulose insulation horizontally along the joists from eaves to upstand, mineral fibre quilt vertically up behind the upstand and urethane in the remainder of the roof. The research team had assumed the urethane insulation would go from eaves to ridge as it seemed easier, cheaper and quicker to build and only required one type of roof insulation material. There was some discussion over the two approaches, with one developer reluctant to use the all-urethane method but eventually they agreed to fit all-urethane. However, when it came to fit the insulation, the urethane sheets had to be cut to fit which involved some waste and a significant labour component, especially in the rake between the eaves and he upstand where lengths of (4” x 1”) wind bracing had been fitted on the underside of the trusses.

64. When the air pressure tests were done on the first houses completed, the room-in-the-roof house types were significantly leakier than the cold roof types. Investigations revealed that the main leakage routes were in the roof, in the area between the wallplate and the roof upstand. Several design ideas were discussed to address the issue but it was the site manager who developed a simple but effective way of installing a DPM to bridge the gap between the masonry and roof ceiling airtight layers. A DPM is laid on the edge of the upper floor, overhanging the plate and extending into the room-in-the-roof by some 2 meters. The attic trusses are then placed on top of the DPM and fixed. The DPM is stapled to the back of the plate to provide an airtight seal with the masonry airtight layer. Before the plasterboarding operation, the excess DPM is turned up the upstand and fixed to the roof airtight layer. This was another action research example where the research team and site team worked together to develop a workable solution. The DPM can be seen underneath the trusses in Figure 8.

Figure 8: Room-in-the-roof attic trusses showing DPM (blue) air barrier.

Counter battens

65. Duplication of effort in the design process was avoided by one developer taking responsibility for creating Stamford Brook Working Details for both developers (based on mutual discussions at design meetings). This worked very well for most of the details being adopted by both developers but one interesting divergence of opinion occurred with the roof covering. In the room-in-the-roof house types, rigid urethane was (eventually) chosen to fully fill the void between ceiling and tiling battens. The original detail showed a breathable membrane between the tile battens and the insulation/trusses. The other developer was not confident with this solution as they traditionally fitted counter-battens before fitting tile battens to allow a ventilation space under the tiles. The response was a revised drawing showing 25mm less insulation below the batten-line to allow a void for the membrane to sag and provide the ventilation space. This revised solution provoked heated discussion on the pros and cons of counter-battening but, as the matter lay outside the EPS, the research team was not directly involved. The outcome is that one developer now uses counter-battens (and 150mm insulation) and the other does not (with 125mm insulation).

Wall cavity insulation

66. The decision to use retro-blown mineral fibre cavity wall fill (rather than built-in batts) came from the desire to reduce mason labour on site and improve buildability by filling the entire cavity in one dedicated operation. However, several other issues were raised during construction, concerning completeness of cavity and sequencing of build operations.

67. On one occasion, the side lights of a bay window were the wrong size when delivered to site. The shell of the house was completed during the time it took for replacements to arrive, meaning that the wall cavity insulation, parging and plasterboarding had been done while the bay window reveal was left open to the elements. A similar problem occurred with utility meter boxes. The boxes are taken out of the wall during wiring-up, allowing the loose cavity fill to fall out around the opening. Mineral fibre was later pushed into the cavity in each case but it is unsure how much blown fill was lost and how much settlement had occurred leaving gaps near the eaves. This effect was less noticeable using yellow wool, rather than white wool which was easily dislodged by wind.

68. It was suggested that the builders drill and install cavity wall insulation and then fill the drill holes with mortar before the parging operation. That way, any badly filled or missed drill holes could be covered by the parging. Some instances occurred where this was done out of sequence and the drill holes were made through the parging layer, see Figure 9. This is considered a high risk strategy, as some mortar plugs were later found to be missing, leaving a 25mm diameter air leakage path straight into the cavity. These sequencing problems may have occurred as the wall insulation installer is not based on site and has to be booked in advance.

Figure 9: Parging showing insulation drill holes filled with mortar.

Gable insulation

69. Building Control were concerned about installing cavity blown insulation in gables and how, if the top of the cavity is closed, how does the air escape to provide a fully filled cavity. Current Robust Details recommends EITHER to continue insulation up to the top of the gable OR take the insulation to 250mm above the ceiling tie and insert a cavity tray above the insulation. This may be more practical with built-in cavity batts. The retro-blown insulation installers state that insulation is forced 500mm vertically from the point of entry (hence the spacing of 500mm between drill holes) and so suggested drilling holes as close to ceiling level as possible so that the insulation would rise approximately 400mm into the gable cavity above plate level. (There are strong physical grounds for expecting the installers' rules of thumb for the travel distance of blown cavity insulant, which were developed for cavities of 50-65 mm, to be conservative for wider cavities.)

70. Calculations by the research team showed that 250-400mm of insulation above plate has little impact on the gable psi value and that at least 1000mm is needed, although taking the insulation all the way up to the verge would be better still. With a gable height of 2.7m this is not such a large area (1.7 x 5.2 / 2 = 4.4m^2) for a Derwent house type gable and so might be cheaper and easier than putting in a cavity tray.

71. However, there remained the impracticalities of drilling and installing wall insulation from inside the loft as a firm access platform and lighting would be needed.

72. Another aspect to emerge from these discussions was the lack of a combination detail for eaves and window head. The technical director supplied these details which would be a useful (and necessary) addition to the 2002 Robust Details catalogue.

Parging coat

73. The parging layer continues up to, and around, the floor joists, see Figure 10. However, there are still occasions when small areas are missed, such as behind the decking and joist struts (fitted at chamber – well before the plastering operation).

74. If a staircase is positioned on an external or party wall, there is a large area of blockwork behind the stringer that is difficult to seal after the staircase is fitted. The research team were making suggestions along the lines of applying sealant between the stringer and the wall. However, each developer independently thought of a way to deal with this problem by parging the area first before fitting the staircase, see Figure 11. The first dwellings to be parged this way were done with mortar as the plastering subcontractor was not yet on site. The plasterer now routinely parges the stair area in advance of the fitting of the stairs.

Figure 10: Parging around I-beams.

Figure 11: Parging wall before fitting stairs.

Air barrier in upper ceiling

75. The parging layer as an air barrier was an easy concept to grasp. It was more difficult to consider the upper ceiling plasterboard as the air barrier to the roof. The parging was clearly visible and operatives were aware that once service penetrations had been made, the airtight layer had to be made good. Although the electricians routinely seal around individual lighting cables, other air leakage paths through the roof were more complex and less easily understood. The main problem was that metal studding was chosen rather than timber studding for the upper floor partitions.

76. In the metal studwork head-piece there are holes pre-drilled at 250mm centres which are used to allow the electrician's lighting cables through. These same holes provide a direct path into the roof space for any air inside the stud cavity, see Figure 12. Air can enter this cavity through electrical boxes for sockets and light switches and underneath skirting boards. Several options were discussed. Head-pieces without holes are not available commercially and even if they were, the electrician then has the problem of drilling his own holes where needed. Rubber covers (like grommets) were considered to cover all remaining holes but the additional labour would be substantial and the task of checking that all holes were filled would also be difficult as they would be difficult to see. The solution was to place a timber head-piece in position first before the metal head-piece. The timber used is not structural so is of small section. Even with this additional timber,

the metal stud system is still preferred to timber studding as the narrow section allows greater room sizes.

Figure 12: Metal studwork showing potential air leakage paths through pre-cut service access holes in head plate.

Plasterboard

77. Although the parging layer reduced the air leakage through the blockwork substantially, there was still a need for good workmanship from the plasterboarder to avoid the plasterboard cavity being used as a conduit for air to escape from inside, through the structure and to outside. To avoid this there is a requirement to provide continuous ribbons of bonding around each wall perimeter and around all electrical boxes. Some plasterers interviewed instinctively thought that the parging would be enough on its own. They also said that, the more bonding is placed on a wall, the more difficult it is to push the board into position. Unfortunately, this blind faith in parging meant that continuous ribbons were not provided in all cases. Having said that, the houses still met the air pressure test requirement on completion so it is difficult to say what difference continuous ribbons make to overall house airtightness. It is pleasing to report that good workmanship is being found, as seen in the freshly plasterboarded wall in Figure 13 whose damp patches reveal the correct application of bonding underneath.

Figure 13: Platserboarding showing continuous ribbons of bonding at perimeter and around electrical boxes.

Cellulose roof insulation

78. The installation of the cellulose roof insulation was easier than expected. The fitter was given a demonstration by the supplier in the first dwelling that was insulated. A vehicle-mounted pump moves insulation fibres down a supply pipe that is long enough to extend right into the loft. Here, the fitter can direct the nozzle and is able fill around the truss members and right into the eaves without leaving voids, see Figure 14. The fitter remarked that this method is far easier than lifting rolls of mineral wool into the loft and spending time laying and cutting the quilt. With the thickness required (250mm) that would have involved fitting a layer between the joists and then a cross-laid layer with the arduous task of cutting the quilt around the truss members. The fitter also found the airborne particles less irritating than mineral or glass fibre.

Figure 14: Cellulose roof insulation fitted closely around truss members.

Ventilation system

79. The proposal was to use a Dutch MEV unit in the first dwellings while Vent Axia researched and developed their own version. They decided against the constant volume approach and are developing a controller with an infinitely variable dc motor. The unit will be the 'Multispeed' MEV and should be available before summer 2005. However, a recent (January 2005) development is that Vent Axia is now unable to source the proposed Dutch unit due to subcontractor contractual difficulties. For the first dwellings another unit will be fitted until the Multispeed is available. Then, the standard units already fitted will be upgraded. As the old model has the same chassis as the Multispeed, the upgrade is a simple circuit board insertion.

80. Ridge vents were the design choice for the ventilation ducting terminals but it was found that their size interrupted the aesthetics of the ridge line. Ridge vents were also undesirable for health and safety reasons as additional scaffolding in the loft space was required to connect the ducting. Tile vents were then used as shown in Figure 15 (two terminals shown, one per house for MEV).

Figure 15: Roof tile terminals for the ventilation ducting.

Heating system

81. Traditional gas-fired wet central heating systems are fitted. One developer chose to use a vented system with a feed and expansion tank in the loft space despite the risk of additional air leakage penetrations through the upper ceiling and the difficulty of insulating the tank and associated pipework. There is also the problem of creating a platform for the tank and an access platform for maintenance and cleaning. Such a platform is necessary because the insulation is 250mm deep and so, it is not possible to stand directly on the joists. The other developer opted for a pressurised system which is contained within the heated envelope of the dwelling. Interestingly, each developer believed their system to be the cheaper alternative. The two systems are shown in Figures 16 and 17, respectively.

Figure 16: Unvented system. Feed and expansion tank in loft space showing platform and additional insulation required.

Figure 17: Vented system. Pressure vessels in heated envelope of building.

Unexpected airtightness issues

82. An unforeseen consequence of building airtight dwellings was the effect on drying out times of the structure. Humidity levels were found to be very high in some rooms during construction. However, on investigation, it was noticed that the trickle vents were all closed, fire doors to rooms were shut and the ventilation system was not powered up in these instances. Particular care is now taken to ventilate all rooms during construction.

83. An allied problem occurred with the interior decoration during some damp winter months. Coats of paint were still wet the following day, delaying the application of further coats. Water-based undercoat and gloss paints are used (to comply with the EPS requirement for no VOCs) and were found to be slower-drying than oil-based paints which added to the problem. Again, adequate ventilation is needed during this trade. One developer tried using mobile industrial heaters but this did not reduce moisture content of the air due to the airtight nature of the dwellings. Ventilation is needed to remove the mass of water from the building.

84. An interesting side-effect of improved airtightness has been on the efficacy of self-closing fire doors. The current trend towards the construction of more three-storey dwellings and apartments in the UK has also meant an increase in the number of self-closing fire doors fitted. It has been noted that some self-closing doors at Stamford Brook are having difficulty closing fully due to the airtightness of some of the rooms. Joiners on site have reported this problem on other airtight buildings on other sites. The remedy has been to fit two or even three closers to enable the doors to close fully.

85. The fitting of cat-flaps was an unexpected issue arising from the airtightness requirement. A flap could also affect the U value of the door. It was generally felt that if cat-flaps are fitted, this is done after completion and, therefore, after the air pressure test. This is one example of home owner changes to the property that could affect the intended the energy performance. Restrictive covenants were suggested and are still being debated. Manufacturers could be encouraged to provide products which maintain the airtightness standards. Another suggestion was to use a tube through the wall designed to comply with the airtightness standard, put in every house when constructed and sealed but with the option for cat owners to open it up. As the first homeowners moved in, the issue was still unresolved and it is now up to the occupier to decide.

Sales and home occupancy phase

Sales

Sales staff training

86. The research team held training sessions for sales staff to guide them through the additional environmental and energy saving features and benefits of the dwellings so they would be in a position to confidently inform customers. One initial session was held before site start using a Powerpoint presentation, similar to that used in the site staff training sessions, see Figure 18. Since then, sessions have been frequent and informal, with sales concerns and customer comments feeding into the training process.

Figure 18: Sales team training session given by Catherine Prasad (NT) and David Roberts (LeedsMet).

Sales Specification

87. The sales specification was based on the existing Group Sales Specifications dated 21 October 2003, amended in line with EPS requirements.

Homeowner packs

88. In the areas of environmental and energy issues, the research team has led the writing of the Home Buyer Information Pack A4. A copy of the bullet list given to homebuyers is included in Appendix 11.

Home owners

Ethics and information to homeowners

89. As the intensive and extensive monitoring involves speaking to the general public and working in some of their homes, a rigorous set of ethics documents was produced by the research team that makes it clear how the research will be undertaken and states the procedures for dealing with confidential information.

90. The home owners will initially be asked by the sales department if they are interested in taking part in the University research project. If they are, they will be asked to sign an 'Initial Contact

Agreement' which will give the research team permission to contact them by letter. Once they are happy to proceed, they will be given a copy of the 'Information to Householders' and will sign a 'Householders Agreement'. Householders are free to withdraw at anytime without let or hinderance. They are also supplied with a 'Researcher Contact List' with names, addresses and photographs of the research team, see Appendix 12.

Update Report on Monitoring

91. The research team has accepted delivery of ten sets of intensive monitoring kit and a weather station.

92. The weather station has been set up on site and air temperature, humidity, wind speed, wind direction and solar gain data are being transmitted from the site in Altrincham and successfully received at the University in Leeds via a mobile phone modem.

93. One set of monitors has been installed in a viewing unit (unfurnished showhome) to allow operator familiarity and experience of installation.

Update Report on Post-Construction Testing

94. Several houses have already been air pressure tested on completion. Tests have shown that two storey dwellings with a trussed cold roof have achieved results of between 1.8 and 4.8 m/h @ 50Pa, all within the 5 m/h target set by the EPS. Room-in-the-roof houses were slightly leakier at around 6-7 m/h @ 50 Pa thought due to problems of maintaining continuity of the airtight layer between the masonry and the roof.

95. It was hoped to conduct co-heating tests on one house from each developer during the winter months of 2004/05 but, due to house completions falling outside this period, these tests are now rescheduled for Autumn 2005. The test is most effectively done when there is a distinct difference in air temperature inside (25^0) and outside (average below 15^0). A summer test would mean using prohibitively higher indoor temperatures to rise above ambient. A full report of the pressure testing and co-heating tests will form Deliverable 5: Post Construction Testing and Envelope Performance.

Dissemination

Part L conference

96. Two members of the research team presented the Stamford Brook project at the Part L Conference in London in October 2004, which was also attended by Phil Hope. As construction on site had just started, the talk focused on of design issues and predicted energy and environmental performance. This was received favorably and so the research team was asked to present again in March 2005. This time, the talk was supported by the project managers of the two developers who showcased their experiences at Stamford Brook from a developer point of view.

RENEW seminar

97. The project was shortlisted to appear at the RENEW seminar held 10-11-04. A joint presentation was made by the Trust's co-ordinator, a technical director from one developer, a planning consultant and a member of the research team. As well as the sustainability of the project, the panel of judges was particularly interested in how the project partners acquired expertise from within and from external sources and the sharing of that knowledge, again, internally and on a regional and national level. Another area where the project scored highly was the engagement of all sectors, particularly in the Trust's liaison with the community.

John Prescott's Sustainable Communities Summit

98. The team was chosen as one of five projects to be showcased at the Sustainable Communities Summit on 31-01-05. There were two aspects to the showcase. A short film was made at Stamford Brook which will be looped at the Summit in the demonstration area. The film features the research team pressure testing dwellings and taking part in site training. The second aspect was that a site tour, forming one of the fringe events. Coach parties of visitors were taken to site and shown various stages of construction. The research team provided demonstrations of pressure testing and the long term monitoring sensors and loggers as well as leading parties of visitors around the site.

Other dissemination

99. Dissemination is ongoing and includes papers in BSERT (Building Services Engineering Research & Technology) and in Structural Survey; conference papers at the SB05 (Sustainable Building) conference in Japan; conference papers at COBRA in Leeds. Other dissemination includes national and local press and being chosen as a case study in the Government's Sustainable Buildings Task Group following correspondence with Sir John Harman.

Conclusions

100. This interim report reports on the early stages of the construction process at Stamford Brook. Since house construction began in July 2004, the two developers have succeeded in their attempts to construct low-energy low-carbon airtight homes in mainstream speculative housing that meet the energy standard proposed by Leeds Metropolitan University research team (EPS08) and the wider environmental standard set by the National Trust (EPS). As explained in Deliverable 2: Design Process, EPS08 is an estimate of the standard thought to be regulatory in a 2008 revision of Approved Document Part L and, as such, is still a more demanding target than the current proposals for 2005.

101. Cooperation between the Leeds Metropolitan University team and the developers has been excellent. The construction team (site management, sub-contractors, operatives, clerk-of-works, buying, technical, external consultants, etc) have shown enthusiasm while maintaining a high build standard.

102. The Leeds Metropolitan University team has put a significant effort into supporting the developers throughout the design and construction processes. A direct result of this has been that rich insight has been gained into a wide range of issues raised by the energy aspects of the EPS standard. The action research approach adopted at the outset of the project has been highly successful.

103. A number of practical problems have been encountered through the construction process. These include problems at the floor-wall junction, eaves details, window details and airtightness in room-in-the-roof dwellings. These have in the main been addressed jointly by the developers and the Leeds Metropolitan University team and in almost all cases, satisfactory solutions have been developed.

104. Initial airtightness results are excellent. The decision to use parging to provide an air barrier in walls independent of the dry-lining has worked well, delivering air permeabilities down to 1.75 m/h @ 50 Pa. The success of parging is due in no small part to the conceptual clarity that it provides – the parging layer is the primary air barrier. A full report on airtightness will be presented in Deliverable 5.

105. The extra-over cost of building to the energy standard (not the wider environmental standard) is in the region of £3000, reducing expected emissions of CO_2 for a typical 100 m^2 semi-detached house by approaching one tonne per annum. Running Cost savings are expected to be of the order of £80 per annum, giving a crude payback time of the order of 40 years – not including the social cost of carbon or recent increases in the price of delivered energy. Inclusion of these factors is likely to mean that the package of additional energy saving measures will be broadly cost effective.

106. Tangible outputs from the project so far include: a complete set of Stamford Brook Working Details for masonry dwellings that have minimal thermal bridging through the junctions; construction and individual trade specs; a product and materials schedule; KPIs; site staff training scheme; sales team training scheme; informative housebuyer packs; documented ethical procedure for involving home owners in a research project; and a wealth of publicity through local involvement, regional and national seminars, conferences, trade journals and the press.

Acknowledgements

107. The Stamford Brook project is funded/resourced by the Department for Communities and Local Government (under Partners In Innovation project - CI 39/3/663), the National Trust (land owners) and the developers (Redrow Homes and Bryant Homes) with contributions from The National House Building Council, the Concrete Block Association, Vent-Axia, and Construction Skills. The contribution from all partners is gratefully acknowledged.

108. The research is led by the Buildings and Sustainability Group in the Centre for the Built Environment at Leeds Metropolitan University in collaboration with the Bartlett School of Graduate Studies at University College London.

Appendix 1: Stamford cost brief

Stamford Brook Costing brief

Bob Lowe & David Roberts, July 2004

Summary

The purpose of this paper is to outline what LeedsMet requires from Maria Andersson Consulting to be able to complete the costing exercise for Stamford Brook. The costing exercise should address both the costs arising from LeedsMet's EPS08 and the costs arising from the Trust's wider Sustainability Brief.

The key outputs from the exercise should be:

Key Output 1: a break-down of a checklist of key elemental costs,

Key Output 2: histories of the above from the outset of the project to final out-turn;

Key Output 3: Estimates of increase in total, whole building construction costs averaged over the whole of phase 1 of the development, comparing (provisional) actual out-turn with the same estate built to ADL 2002 standards and to the draft ADL05.

Detailed description of outputs

Key output 1 should contain:

- bar charts showing the out-turn cost rates (£/m^2, £/kW or other appropriate units) for the main elements of envelope, airtightness, heating system and ventilation system under EPS08 and the Sustainability Brief (as-built) and estimates of the out-turn under ADL02 and ADL05.
- contributions to these totals from the main elements of envelope U value, airtightness, heating system and ventilation system and key elements of the Sustainability Brief;
- pie charts showing the magnitude of total out-turn construction costs under the Sustainability Brief and EPS08 and estimates of the out-turn under ADL02 and ADL05

This will enable us to produce statements of the form:

"y% of the overall increase was accounted for by extra wall costs. z% was accounted for by more expensive windows."

and

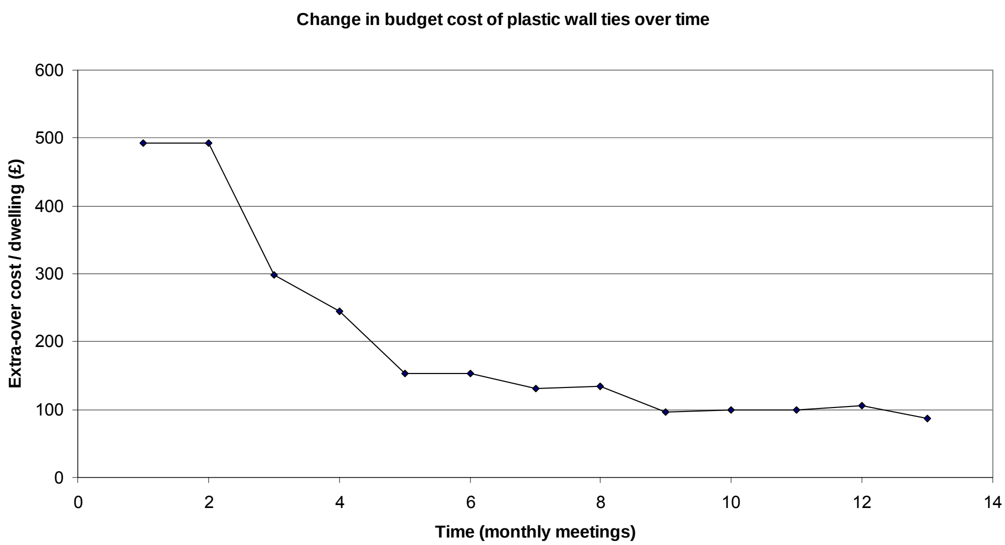
"The better insulated walls used at Stamford Brook cost £x per m^2. Walls complying with ADL02 would have cost £y per m^2. The increase is z%."

Costs for opaque elements should be broken down under headings:

- additional cost of insulant
- additional construction costs.

Key output 2 should enable us to produce time series graphs (an example shown below) showing the development of costs since the beginning of 2001. Points at the end of the curve will be actual rather than budget costs.

The time series graphs would need to be accompanied by explanations of sudden or large changes, or trends (e.g. quotation from new supplier, revised method of calculating e/o…).



Key Output 3 should enable us to provide statements of the form:

“The total Sustainability Brief at Stamford Brook resulted in an x% increase in construction costs.”

“The application of EPS08 at Stamford Brook resulted in a y% increase in construction costs.”

These statements would need to be qualified by a statement of how overheads, profit and tax had been accounted for. Costs associated with the learning curve itself – the work done by the developers to define costs and construction techniques for EPS08 and the wider brief - should be separated out. Also separate out house design amendment and development costs.

Q. Is it possible/sensible to separate out costs of each builder where different and reasons why there are differences?

Q. Is it possible to separate out e/o costs for det/semi/mid house variants?

.

Appendix 2: Cost report

THE NATIONAL TRUST

STAMFORD BROOK

COST ANALYSIS REPORT

DRAFT

February 2005 - Maria Andersson

Contents

Section 1 - Executive Summary

This cost analysis report encapsulates recent work undertaken on behalf of the National Trust in relation to the extra over costs attributable to the incorporation of the Environmental Performance Standard (EPS) specification for the development at Stamford Brook.

Incorporation of the agreed EPS for the first 79 properties, now under construction, by the Developers (Taylor Woodrow and Redrow Homes), results in and extra over construction cost of in the order of £4,150 per property, based on a property with a gross internal floor area of 89.8m2.

The extra over cost represents on average a 9 % increase when compared to the Developers standard construction cost.

Around a quarter of the extra over cost attributable to EPS compliance relates to the external wall construction for compliance with the energy standards set for the Stamford Brook development. The largest single proportion of the extra over cost, representing in excess of a third of the total at 38% is, however, attributable to the window and door specification.

Around 15 % of the extra over cost relates to sustainability in general, such as for example limiting the use of PVC products and minimising water usage.

The extra over costs attributable to EPS compliance have reduced gradually since the early stages of the Stamford Brook development. For example the use of recycled cellulose roof insulation initially attracted considerable additional costs, whereas it is now comparable with the Developers standard products.

As construction works have now commenced, following competitive tendering of work packages, this cost analysis report is the first that allows actual extra over costs associated with EPS compliance to be established.

This report breaks down the extra over costs elementally and also analyses the development of cost during the pre-construction development, design and specification period.

The report concludes by recommending that further work is undertaken in conjunction with the Developers to ensure that the elements of construction that attract extra over costs for EPS compliance are acknowledged by the supply chain as becoming part of the standard construction in the future and thus attracting the same purchase discounts.

Section 2 - Introduction

Following a considerable review of sustainable and environmentally friendly construction methods and materials the first 79 properties are now being constructed at Stamford Brook.

This report outlines the current extra over costs associated with compliance with the Environmental Performance Standards (EPS) set for the Stamford Brook development as agreed between the National Trust and the Developers (Taylor Woodrow and Redrow Homes).

After outlining the background to the cost analysis for Stamford Brook, in section 3 of the report, the report, in section 4, outlines the basis for the reporting of costs.

Section 5 of the report illustrates a breakdown of the key elemental costs affected by EPS and details increases in the overall capital construction cost. Average costs are analysed for the 79 properties, as well as individually for the two Developers (Taylor Woodrow and Redrow Homes).

Section 6 of the report details the comparable iteration of like for like cost estimates during the design and development period, particularly over the last two years prior to construction commencement.

Finally, section 7 provides a brief conclusion and recommendation for further actions.

Section 3 - Background

The National Trust first sought external advice on costs in relation to sustainable initiatives for the Stamford Brook development in the year 2000.

Early cost studies looked generally at sustainable initiatives such as water saving appliances, super-insulation, plasterwork, I-beam construction and rainwater collection. These studies included wider sustainability initiatives such as grey water recycling, solar panels etc., which, as a result of budgetary constraints, were not included in the final agreed list of Environmental Performance Standards (EPS) items for the first areas of construction.

As the EPS requirements and the development proposals were developed there was a need to undertake further cost and value studies in 2002/3, as notwithstanding the fact that an "open book" approach had been agreed with the Developers, the National Trust needed to be able to demonstrate "value for money" to justify the Trust's contribution to the extra over costs associated with EPS compliance.

For a period of two years from October 2002 until October 2004 regular (approximately monthly) EPS meetings were held. This allowed costs to be reviewed following receipt of revised quotations and agreement of construction details, and decisions to be taken as to the final inclusion of EPS related design and specification items within the first areas of construction work. In order to provide as true a reflection of actual costs as possible all quotations and estimates were converted pro-rata to apply to the total of 710 properties proposed for the Stamford Brook development.

The Developers, Taylor Woodrow and Redrow Homes, obtained sub-contract tenders for the first areas of work (79 properties) during the third quarter of 2004 and have now commenced construction.

Section 5 below details the current extra over costs for achieving the EPS, split into a series of EPS headings that have been in use by the National Trust, the Developers and the external consultants over the last two years.

The EPS used as the basis for this report covers the following main areas:

minimisation of energy use and greenhouse gas emissions;

minimisation of water use;

minimisation of waste; and

general environmental standards.

This report illustrates the extra over cost associated with compliance with the EPS and covers both the "Dwelling Energy Standard" as written by Leeds Metropolitan University and the National Trust's "Sustainability Brief".

The "Dwelling Energy Standards" proposes prototype performance standards for Part F and Part L of the current Building Regulations (ADL2002) and has requirements for fabric U values, thermal bridging, airtightness and ventilation provisions for the properties, all in excess of ADL2002. The main aim being to lower carbon dioxide emissions from the properties constructed.

The EPS elements that relate to the "Dwelling Energy Standards" can be summarised as follows.

High performance timber double-glazed windows.

Plastic wall ties between masonry leaves to minimise thermal bridging.

Parging layer on external walls to provide airtightness.

The National Trust's "Sustainability Brief" includes requirements for the increased use of environmentally friendly materials, reduction in domestic water use and a reduction in construction waste.

The costs detailed in this report have been worked out in detail for 79 properties, representing the first areas of work, namely Area 6 for Taylor Woodrow (28 No. properties) and Areas 3 and 4 for Redrow Homes (51 No. properties).

The property mix for the first areas of work has been confirmed as follows.

Developer	Property type	Area (m2)	No. properties
Taylor Woodrow	Chatsworth	71.3	4
	Calder	75.2	2
	Doniford	90.4	3
	Hamborough	90.9	2
	Raglan	92.7	4
	G- Type	135.7	1
	Apartment 1	67.6	1
	Apartment 2, 3, 6, 7, 10	67.6	5
	Apartment 4, 8	67.6	2
	Apartment 5	67.6	1
	Apartment 9	67.6	1
	Apartment 11, 12	67.6	2
		Total:	28
Redrow Homes	Foss	144.3	2
	Derwent	124.4	14
	Whittle / Eleveden		(2 blocks)
	4 apartments per block		8
	Whittle	57.7	
	Eleveden	47.7	
	Fern	63.2	3
	Sunart	98.7	6
	Devoke	83.7	6
	Wye	105.44	6
	Ardleigh	63.6	2
	Fyne	105.6	2

	Fyne 1	92.1	1
	Llanberis	88.4	1
		Total:	51

Based on the number of properties included within the first areas of construction the average size of property for Taylor Woodrow is 78.8 m2 and for Redrow Homes is 95.8 m2.

Taylor Woodrow and Redrow Homes have both confirmed that the property mix for Areas 3, 4 and 6 is fairly representative for the remainder of the development, although the actual property types and sizes will vary.

Section 4 – Cost Reporting

This section explains the basis for the cost reporting and analysis under the headings of cost; wastage; partners in innovation; exclusions; and developer baselines.

Cost

The costs reported within this report relate to the current Building Regulations (ADL2002) and do not at this stage make any allowances for the proposed 2005 Building Regulations (ADL2005).

ADL2005 is currently going through the consultation period and the actual standard that will be required to be complied with by the end of 2005 is still unclear. It is known, however, that ADL2002 and ADL2005 will no longer be directly comparable. ADL2005 will relate to the whole house carbon target, as opposed to individual element. This leaves each builder to select the best combination of construction elements and renewables to meet the carbon target. As a result a number of different combinations may be selected, resulting in widely differing costs.

In addition all costs are current day capital costs (January 2005) and are exclusive of preliminaries, overheads / profit and VAT.

Although the Stamford Brook development of some 710 properties would lend itself to bulk purchase of the majority of construction components, thus reducing costs (including extra over costs associated with EPS compliance) the Developers were reluctant to embrace this principle, preferring instead to place orders individually for each area of work One reason for this is that their national purchase agreements allow them the same discount on small quantities as on large orders thus shielding them from the economies of scale that would normally be expected.

It should, however, be noted that the Developers appear, in some instances, to have accepted, at face value, extra over costs associated with EPS compliance, as put forward by the sub-contractors and suppliers. Although the costs illustrated within this report are in line with current market prices, developers who develop properties on the scale that Taylor Woodrow and Redrow Homes do, generally receive considerable trade discounts from the suppliers and sub-contractors. A good example of this is the lintels where Taylor Woodrow gets a discount of some 76% and Redrow Homes some 74%. Clearly this is an extreme example but illustrates the flexibility within the market.

It is felt that only limited efforts have been made by the developers in terms of obtaining competitive quotes for some of the extra over cost for EPS compliance. Typical examples include the LSOH cabling and the Geberit soil and waste pipes where “cover prices” have been included as the response from the sub-contractors and suppliers has been relatively poor. Other examples include pure extra over items such as rainwater butts, compost bins etc. It is acknowledged, however, that some extra over cost are stated as provisional at this stage and will be firmed up once construction and installation of the relevant element is underway.

In view of the above, if more effort were to be spent on trying to reduce extra over cost associated with EPS compliance, a saving of around 10% per property ought to be achievable, even if the extra over cost associated with the windows and the mechanical extract ventilation remains as existing, as a result of existing contractual arrangement. This is a key factor in further EPS cost reduction, in that the developers are reliant on national bulk discounts even when placing relatively small orders for “normal” materials. To fully ensure equivalent benefits for EPS elements there needs to be a “buy in” from the Developers to achieve their national discounts on these new items and products.

Additional market research should also ensure that all products are obtained from a competitive market. At present the Refus plastic wall ties and the Rationel high performance windows and doors are obtained from Danish manufacturers with no competition as no equivalent products have, as yet, been sourced within the UK or elsewhere in Europe.

In addition consideration should be given to the joint purchasing power of Taylor Woodrow and Redrow Homes for the Stamford Brook development, which after all is a joint venture between the National Trust and the two Developers. This alone ought to reduce the extra over cost associated with pure extra over EPS items such as compost bins, flow regulators, rainwater butts etc.

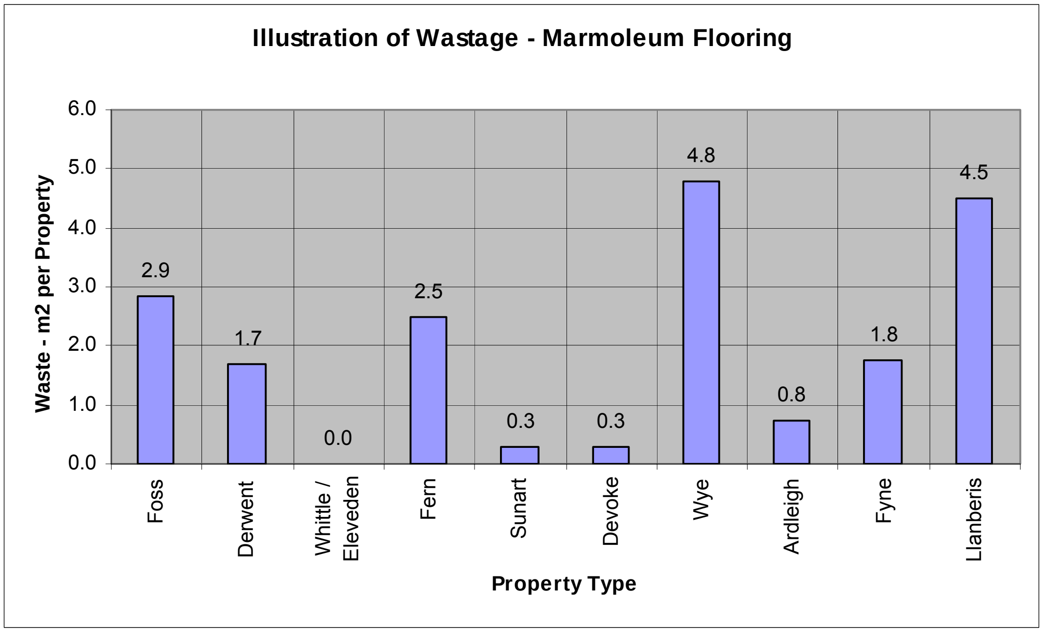
It is accepted that the extra over costs associated with EPS compliance may be disproportionately high for the first areas of work as the sub-contractors are likely to price the "risk" involved with constructing properties that are different to the norm and still incorporates relatively new technology.

The Developers, in conjunction with the National Trust and Leeds Metropolitan University have, however, held a number of information and training session with the sub-contractors both pre and post tendering which has helped to explain the aims and objectives of the project as well as the potential for further work (i.e. 710 properties).

Subject to full "buy in" from the Developers and as technology improves and works progress, in time for tendering of future areas of work, it is anticipated that the extra over cost associated with EPS compliance will proportionally reduce.

Wastage

As wastage is a key issue in terms of EPS compliance the use of marmoleum flooring within the kitchen areas to Redrow Homes properties should be reviewed for future areas of work. At present the marmoleum flooring is only available in large sheets resulting in considerable wastage (on average 1.6 m2 per property) as illustrated by the table below. In addition to the concern about wastage of material, there is also a considerable additional cost associated with this. Even if the product is retained, on average, some £56 per property, which is a pure extra over wastage cost, could be saved by reducing the wastage to a more acceptable level.



Partners in Innovation Trials

A small number of separate trials, such as MVHR, "room in the roof" and wet plastered properties, are being made as part of the Stamford Brook development. These are not reflected within this report, as the number of properties involved is considered too small to provide a true reflection of costs.

Exclusions

Additional costs are being claimed by the Developers for a small numbers of items that have not previously been identified as having extra over costs to achieve EPS compliance.

The items, identified below, have not been included as part of the cost analysis as the principle of their inclusion has not been accepted by the National Trust.

Clay drainage

The inclusion of clay drainage (as opposed to PVC) to the properties has been discussed with the Developers for some time. The drainage supplier, Hepworth, has confirmed that there should be no cost difference between the two products and agreement to proceed was given by the National Trust on this basis.

Following tendering of the first areas Redrow Homes has obtained quotations from the relevant sub-contractors indicating an average additional cost of £456 per property for the provision of clay drainage.

Discussions with Hepworth and the sub-contractors are continuing.

Scaffold adaptations

The Developers are claiming additional scaffolding costs as a result of the type of window used at Stamford Brook, in that the windows will be fitted from the outside, as opposed to the inside, thus requiring the scaffolding to be adapted.

The extra over cost claimed by Taylor Woodrow amounts to £150 per property (£83 apartments). Redrow Homes' additional cost amounts to £138 per property.

No additional costs have been included within this report as this item is considered a construction process issue to be resolved by the Developers rather than an EPS issue.

Developer baselines

As you would expect with two large national Developers the cost baseline from which the EPS related extra over costs are added differs slightly. There are two main differences worth noting, namely the boilers and kitchen floor coverings.

For the water and space heating Taylor Woodrow already use condensing boilers as standard, in contrast to Redrow Homes conventional boilers.

For the kitchen floors Taylor Woodrow use tiles in contrast to Redrow Homes PVC flooring.

As a result additional costs are incurred for the condensing boilers and the marmoleum flooring. For ease of referencing this cost has been averaged out over the total number of properties (refer to section 5 below).

With the exception of the above the other differences in costs between the two Developers are related to the actual property types, sizes and designs adopted for the Stamford Brook development.

Section 5 - Cost Breakdown

This section explains the content of the EPS items and outlines the EPS extra over costs under three main sections. The average cost for all 79 properties included within the first areas of development are analysed first, followed by the average costs for Taylor Woodrow and Redrow Homes respectively.

EPS Items

For ease of referencing and continuity the following EPS cost headings have been used when analysing the costs.

Dwelling Energy Standards

External wall

Wall design – cavity / insulation

Plastic wall ties

Internal finishing - parging

Windows and doors

Roof insulation

Roof insulation

Loft access

Ground floor insulation

Heating and ventilation

Space and water heating – condensing boiler

Mechanical extract ventilation

Sustainability Brief

Water minimisation

Low volume flush WC

Flow regulators

Rainwater butts

Waste minimisation

Garden compost bins

Kitchen top pail

Waste segregation

Products / Materials

Non PVC products (LSOH cables and marmoleum kitchen floors and Geberit soil and waste pipes)

Low VOC paint

A brief description of each EPS heading is given below.

External wall

The wall design incorporates a wider than normal cavity that can accommodate greater levels of insulation to maximise the thermal benefits. The insulation for the fully filled cavity is a retro-blown mineral fibre insulation.

To minimise thermal bridging an alternative to the standard steel wall ties was sought. The chosen Refus wall tie is a Danish product, made of plastic.

Parging to provide and airtight layer was accepted as an alternative method to wet plastering (which was not favoured by the Developers, mainly as a result of the additional drying time involved).

Windows and doors

In addition to the high performance double-glazed timber windows the design of the window and door openings has been carefully considered to maximise solar gain and minimise thermal bridging.

The U values achieved by the Rationel windows and doors are considerably in excess of those achieved by standard windows.

Roof

The insulation for the cold roofs is blown recycled cellulose. To meet the air tightness requirements a specialist loft access hatch is required.

Ground floor insulation

The design for the ground floor includes a ground-bearing in-situ reinforced concrete slab with expanded polystyrene insulation.

Heating and ventilation

A wet central heating system with a condensing boiler and hot water storage was incorporated at an early stage together with mechanical extract ventilation in order to ensure that adequate ventilation was provided to the properties.

Water minimisation

Low volume flush WC's (4.5 litres or below), the inclusion of flow regulators for taps and the provision of rainwater butts are incorporated to minimise water use.

Waste minimisation

As appropriate, each property will be provided with a garden compost bin and a kitchen top pail for organic waste. In addition the kitchen design incorporates a waste segregation unit. Properties will also be served by Trafford Borough Council's waste and recycling scheme.

Products / materials

The National Trust would have preferred to prohibit the use of PVC products, however, many building components are currently unavailable in forms other that PVC. As a result the use of PVC products has been limited and substituted wherever possible. Examples include low smoke and fume cabling (LSOH), Geberit soil and waste pipes and non-PVC marmoleum flooring.

All paint for the Stamford Brook development will have a low volatile organic chemical (VOC) content.

It should be noted that a number of items specifically listed within the EPS have been confirmed by the Developers to have no cost implication. This demonstrates that the benefits associated with developing sustainably are starting to filter through the supply chain. Specific items include the following.

Efficient showerheads

Minimisation of construction waste

Use of timber from sustainable sources

Use of zero ozone depletion products

Use of low formaldehyde chipboard, mdf etc.

Re-use and re-cycling of materials wherever possible

Use of local source for heavy aggregates wherever possible

Limited use of high energy embodied materials

Use of 20% re-cycled aggregate for foundations

Use of timber products rather that PVC wherever possible

The table below summarises the inclusion / build-up to the EPS costs.

EPS Item	Inclusion / Build-up
External wall	
Wall design – cavity / insulation	Increased width cavity, full cavity insulation, additional lintels and associated insulation and addition of cavity closer
Plastic wall ties	Alternative wall ties
Internal finishing – parging	Addition of parging coat
Windows and doors	Alternative windows and doors and method of fixing
Roof	
Roof insulation	Not applicable (refer to section 6 below)
Loft access	Alternative loft access
Ground floor insulation	Not applicable (refer to section 6 below)
Heating and ventilation	
Space and water heating – condensing boiler	Alternative boiler (Redrow Homes only)
Mechanical extract ventilation	Addition of mechanical extract ventilation
Water minimisation	
Low volume flush WC	Alternative WC
Flow regulators	Addition of flow regulators to taps
Rainwater butts	Addition of rainwater butts
Waste minimisation	
Garden compost bins	Addition of garden compost bin
Kitchen top pail	Addition of kitchen top pail

Waste segregation	Addition of waste segregation unit within kitchen
Products / materials	
LSOH cables	Alternative cables
Kitchen floor	Alternative flooring material (Redrow Homes only)
Geberit soil and waste	Alternative soil and waste pipes
Low VOC paint	Alternative paint

Average Cost Breakdown

The table below illustrates the combined average extra over cost attributable to each of the EPS cost headings for the first parcels, as submitted by the Developers. A second cost column has been included listing realistically expected cost i.e. the costs that are recommended for agreement between the National Trust and the Developers for the first 79 properties. Where there is a difference between the costs submitted by the Developers and those recommended for agreement substantiating details, to back up the extra over costs, remain to be submitted by the Developers. As appropriate costs have also been indicated as provisional i.e. to be agreed at a later date once all the information is available.

Based on the information available to date the second column of cost illustrates realistic costs that could be expected for the first 79 properties.

It should be noted that a number of costs have already been considerably reduced (in agreement with the Developers) as the original costs submitted could not be substantiated or justified. This is already accounted for within the Developers costs below. Typical examples include the parging, the external wall construction and the loft access.

EPS Item	Developers - Cost per property (£)	Realistically Expected - Cost per property (£)	Difference (£)
External wall			
Wall design – cavity / insulation	608	569	39
Plastic wall ties	84	84	-
Internal finishing – parging	424	343	81
Windows and doors	1,584	1,575	9
Roof			
Roof insulation	0	0	-
Loft access	16	16	-
Ground floor insulation	0	0	-
Heating and ventilation			
Space and water heating – boiler *	129	129	-
Mechanical extract ventilation Provisional	698	698	-
Water minimisation			
Low volume flush WC	74	10	64
Flow regulators Provisional	74	48	26
Rainwater butts **	36	36	-
Waste minimisation			
Garden compost bins	10	10	-
Kitchen top pail	2	2	-
Waste segregation	62	62	-

Products / materials			
LSOH cables Provisional	106	106	-
Kitchen floor *	76	76	-
Geberit soil and waste Provisional	145	145	-
Low VOC paint Provisional	37	37	-
Total:	4,152	3,933	219

* The actual cost for the condensing boiler and marmoleum flooring is £200 and £118 per property respectively (applicable to Redrow Homes properties only).

** The cost attributable to the rainwater butts assumes that one rainwater butt is provided for each property with the exception of the apartments. This is, however, unlikely to be achievable and as such the overall cost attributable to water butts will eventually be reduced.

The items noted as provisional have been listed below for clarity.

Mechanical extract ventilation - The fixing cost allowance for the mechanical extract ventilation has been included at £300 per property on the advice of Vent-Axia.

Flow regulators - The extra over cost included by Taylor Woodrow is a provisional allowance, awaiting quotations. The cost included by Redrow Homes is based upon a quotation, however, this is considered excessive. Alternative quotations are being sought and as such the extra over cost is included as provisional.

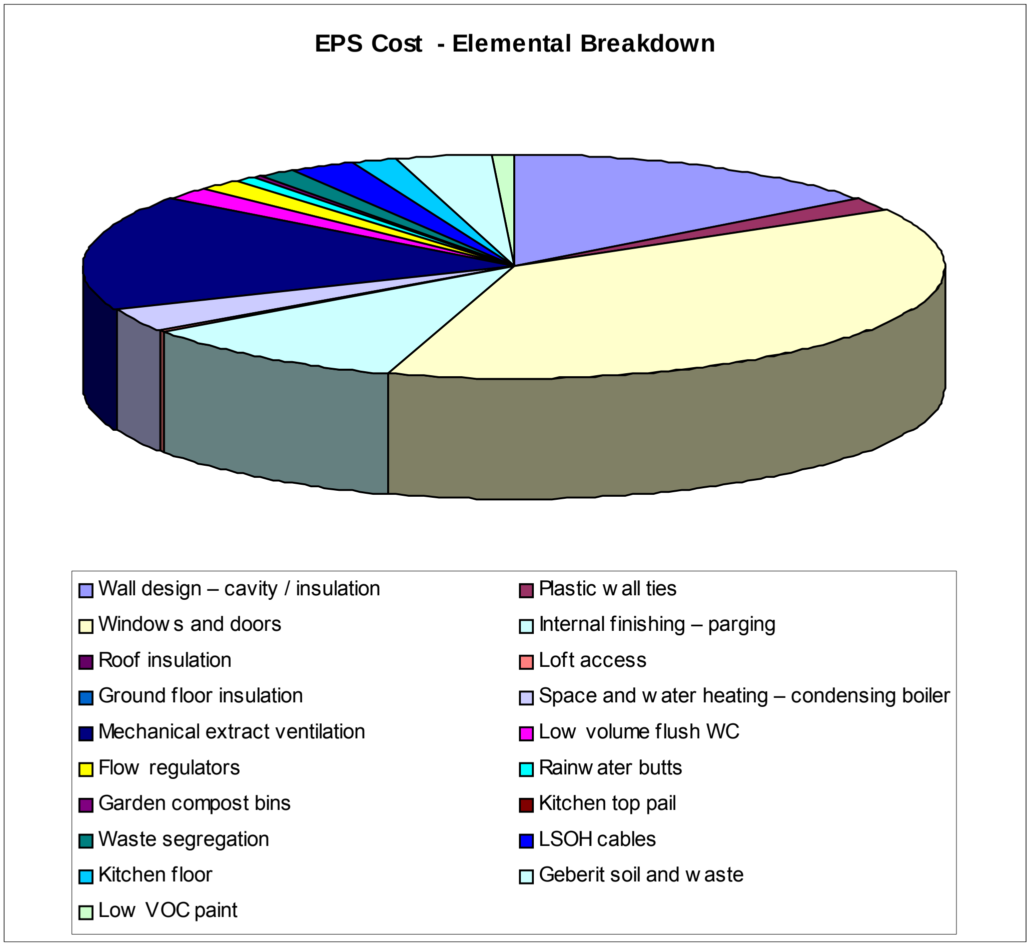
LSOH cables - Taylor Woodrow has included a general allowance of £75 per property, whereas Redrow Homes has included £120 per property, which represents an uplift of between 8% and 9% when compared to the standard specification. Detailed breakdowns and quotations are awaited from the suppliers.

Geberit soil and waste pipes - A general allowance of £100 per property has been included by Taylor Woodrow, whereas Redrow Homes, on the advice of the plumber, has increased their standard cost by 50%.

Low VOC paint – A general allowance of £40 per property has been included by Taylor Woodrow, whereas Redrow Homes has provided a quotation, resulting in an average additional cost of £34 per property.

All items noted as provisional above should be reviewed throughout the construction period, for agreement as soon as practicable.

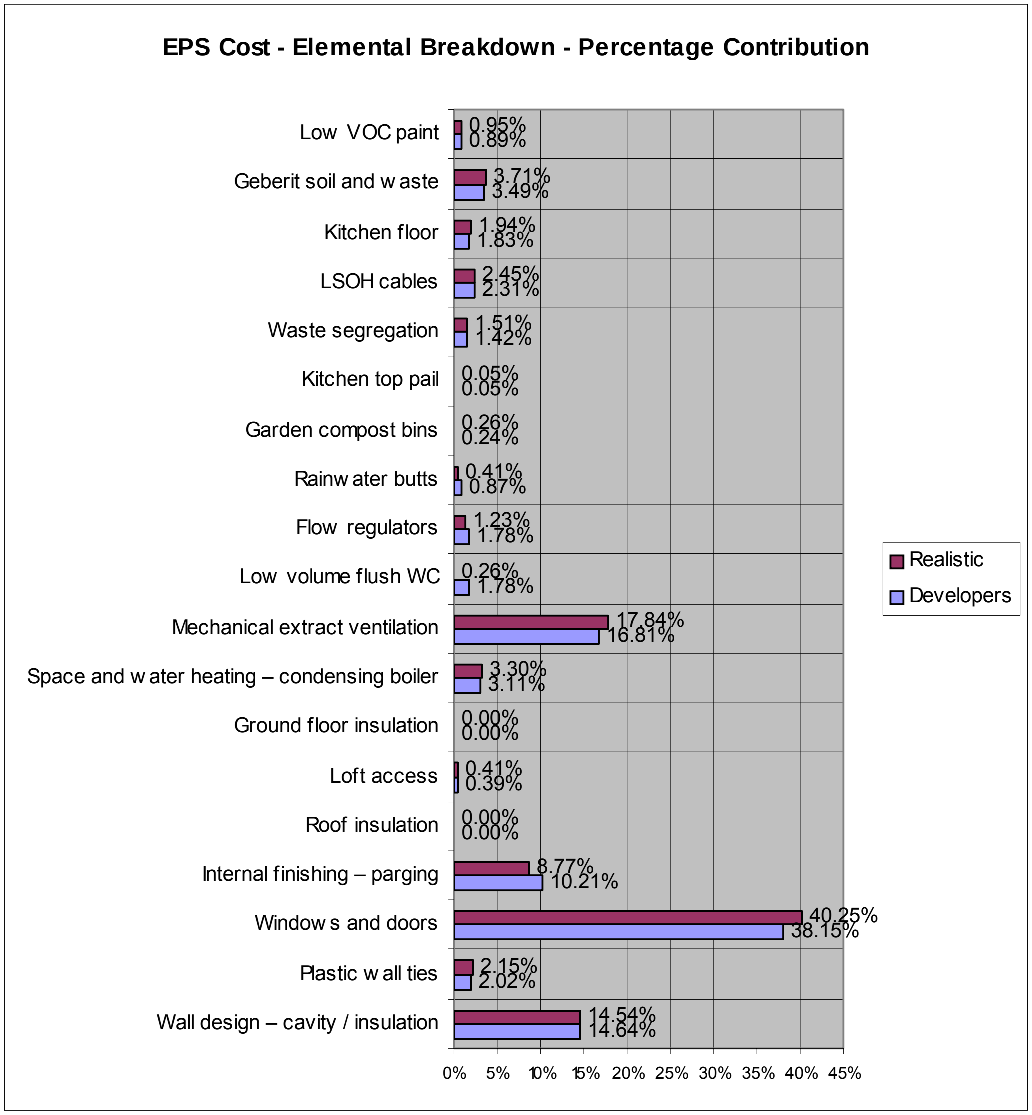
The pie chart and tables below illustrate graphically the elemental breakdown of extra over costs for EPS compliance, based on the average extra over cost per property for Areas 3, 4 and 6, currently under construction.



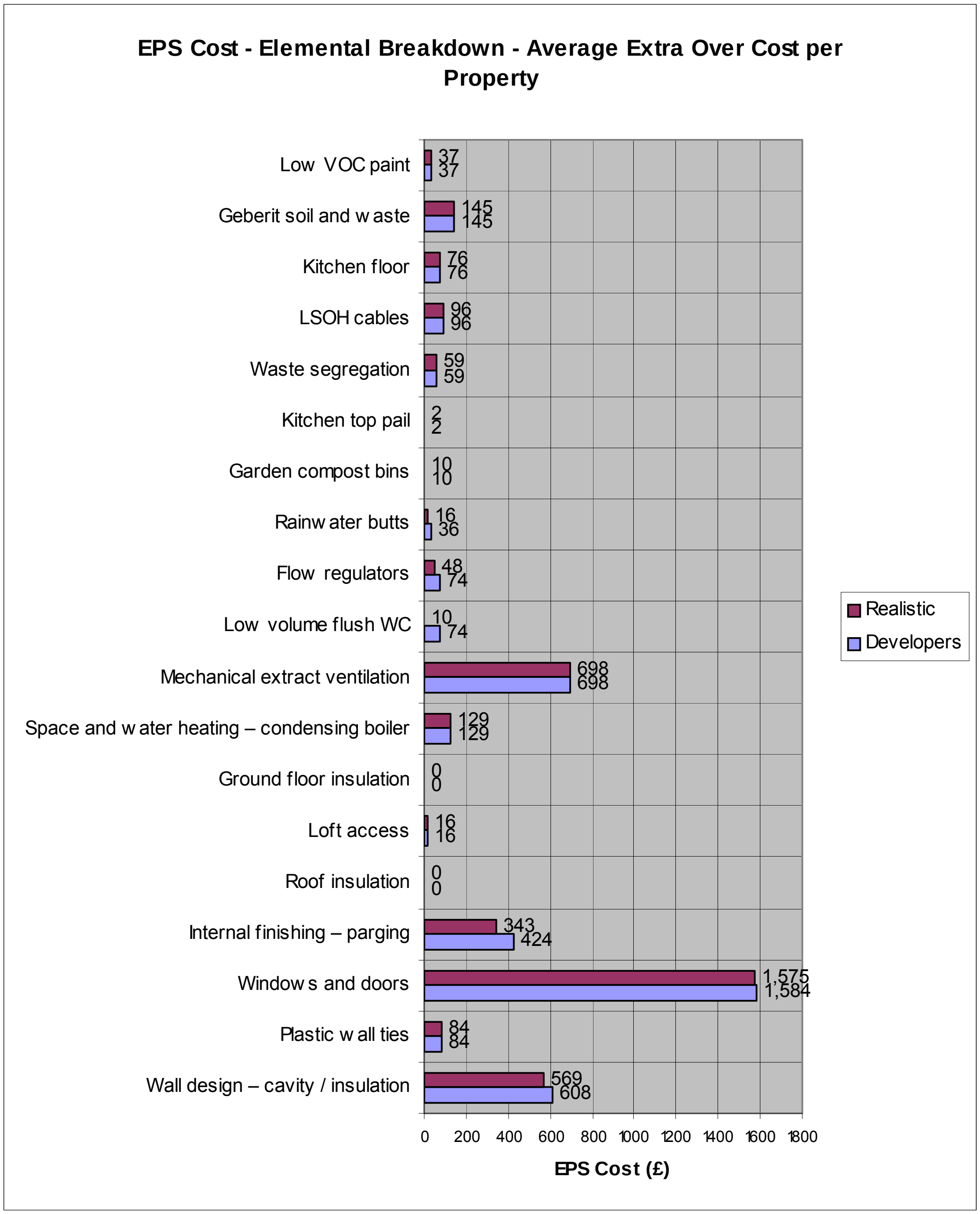
When considering the build-up to the total EPS cost, in excess of a third is made up of the windows and doors cost. Mechanical extract ventilation, the external wall design and the parging to external walls also represent a considerable proportion of the extra over cost.

The elemental breakdown of the main EPS items is analysed further below.

The table below illustrates the percentage contribution (Developers and Realistic) of each of the EPS items.



The table below illustrates the average extra over cost per property (Developers and Realistic) for each of the EPS items.



When analysing the data for some of the main elements in detail (based on the Developers cost data) the following statements summarises the impact of applying EPS, compared to standard construction.

Overall construction:

The cost data provided by Taylor Woodrow and Redrow Homes illustrate that the construction incorporating EPS at Stamford Brook (Areas 3, 4 and 6) is some 9% more expensive when compared to their standard basic construction costs. This results in an extra over cost per property of around £4,150.

External walls:

The external walls (including parging and wall ties) for the Stamford Brook development represent 27% of the total EPS extra over cost.

The overall external wall construction cost for the Stamford Brook development is 56% more expensive than Taylor Woodrow's standard wall construction and 44% more expensive that Redrow Homes' standard construction.

Excluding the parging and the wall ties the external wall construction is 24% and 28% more expensive than standard construction, for Taylor Woodrow and Redrow Homes respectively.

The material cost for the plastic wall ties represent a 329% increase compared to the standard steel ties. As tests have proven that the number of wall ties required is the same as standard there is no impact on the labour element of fixing the wall ties.

The parging represents 10% of the total extra over cost. However, the parging cost as a percentage of the total extra over cost for the external wall construction represents 53% for Taylor Woodrow and 27% for Redrow Homes.

Windows and doors:

The high performance timber windows and doors used at Stamford Brook represent 38% of the total EPS extra over cost and are 76% more expensive than the standard uPVC windows used by Taylor Woodrow and 86% more expensive than the standard windows used by Redrow Homes.

Should the increased scaffolding costs claimed by the Developers as attributable to the window installation be included (refer to section 4 above) within the costs, a cost increase of 81% and 92% when compared to the standard uPVC window costs would be incurred for Taylor Woodrow and Redrow Homes respectively.

Heating and ventilation

The extra over cost associated with the provision of mechanical extract ventilation represents 17% of the total EPS extra over cost.

As part of the overall heating and ventilation package for a property the mechanical extract ventilation represents on average 13% of the total heating and ventilation cost.

Water and waste minimisation

The costs associated with water and waste minimisation, although of great impact for the environment as a whole, represent only a small proportion of the total EPS cost at 4% and 2% respectively.

The individual EPS items, illustrated within the tables above, fall within eight general headings, as listed below.

Dwelling Energy Standards

External wall (wall design – cavity / insulation, plastic wall ties and internal finishing – parging)

Windows and doors

Roof (roof insulation and loft access)

Ground floor insulation

Heating and ventilation (space and water heating – condensing boiler and mechanical extract ventilation)

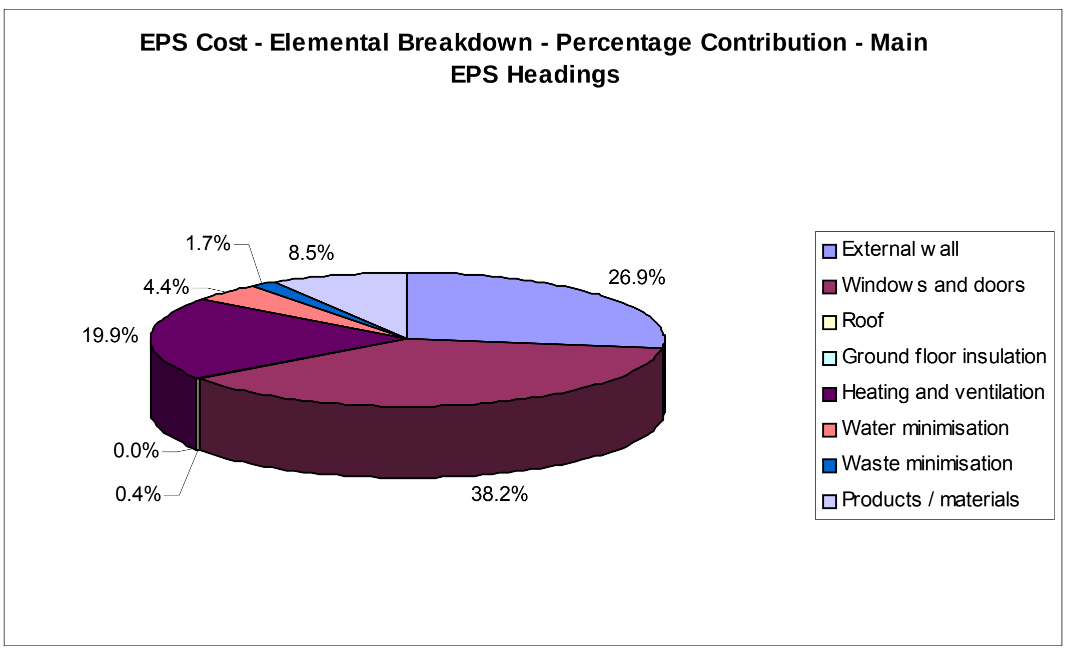
Sustainability Brief

Water minimisation (low volume flush WC, flow regulators and rainwater butts)

Waste minimisation (garden compost bins, kitchen top pail and waste segregation)

Products / materials (LSOH cables, non PVC kitchen floors, low VOC paint and Geberit soil and waste pipes)

The pie chart below demonstrate the percentage contribution of the extra over costs (based on the Developers cost data) using the above eight main EPS headings.



"Dwelling Energy Standards" v "Sustainability Brief"

If considering the EPS cost under the two main heading of "Dwelling Energy Standards" and "Sustainability Brief" as highlighted in section 3 above the data collated confirms that as much as 85% relates to the "Dwelling Energy Standards" compared to 15% for the "Sustainability Brief". With the introduction of ADL2005 this marked difference should be considerably reduced, as the Building Regulation will impact on the overall property external envelope construction and U value requirements.

Taylor Woodrow Cost Breakdown

The table below illustrates the average extra over cost attributable to each of the EPS cost headings for the first parcels, as submitted by Taylor Woodrow. As above, a second cost column has been included listing realistically expected cost i.e. the costs that are recommended for agreement between the National Trust and Taylor Woodrow, based on the substantiating information issued to date.

As appropriate costs have been indicated as provisional i.e. to be agreed at a later date once all the information is available.

Where the table below denotes a difference between Taylor Woodrow's costs and the costs realistically expected a brief explanation has been provided.

EPS Item	Taylor Woodrow (TW) - Cost per property (£)	Realistically Expected (TW) - Cost per property (£)	Difference (£)
External wall			
Wall design – cavity / insulation	554	554	-
Plastic wall ties	59	59	-
Internal finishing – parging	693	462	231
Windows and doors	1,673	1,649	24
Roof			
Roof insulation	0	0	-
Loft access	13	13	-
Ground floor insulation	0	0	-
Heating and ventilation			
Space and water heating – boiler	0	0	-
Mechanical extract ventilation Provisional	626	626	-
Water minimisation			
Low volume flush WC	28	28	-
Flow regulators Provisional	20	20	-
Rainwater butts	23	23	-
Waste minimisation			
Garden compost bins	11	11	-

Kitchen top pail	2	2	-
Waste segregation	36	36	-
Products / materials			
LSOH cables Provisional	78	78	-
Kitchen floor	0	0	-
Geberit soil and waste Provisional	100	100	-
Low VOC paint Provisional	41	41	-
Total:	3,957	3,702	255

Parging

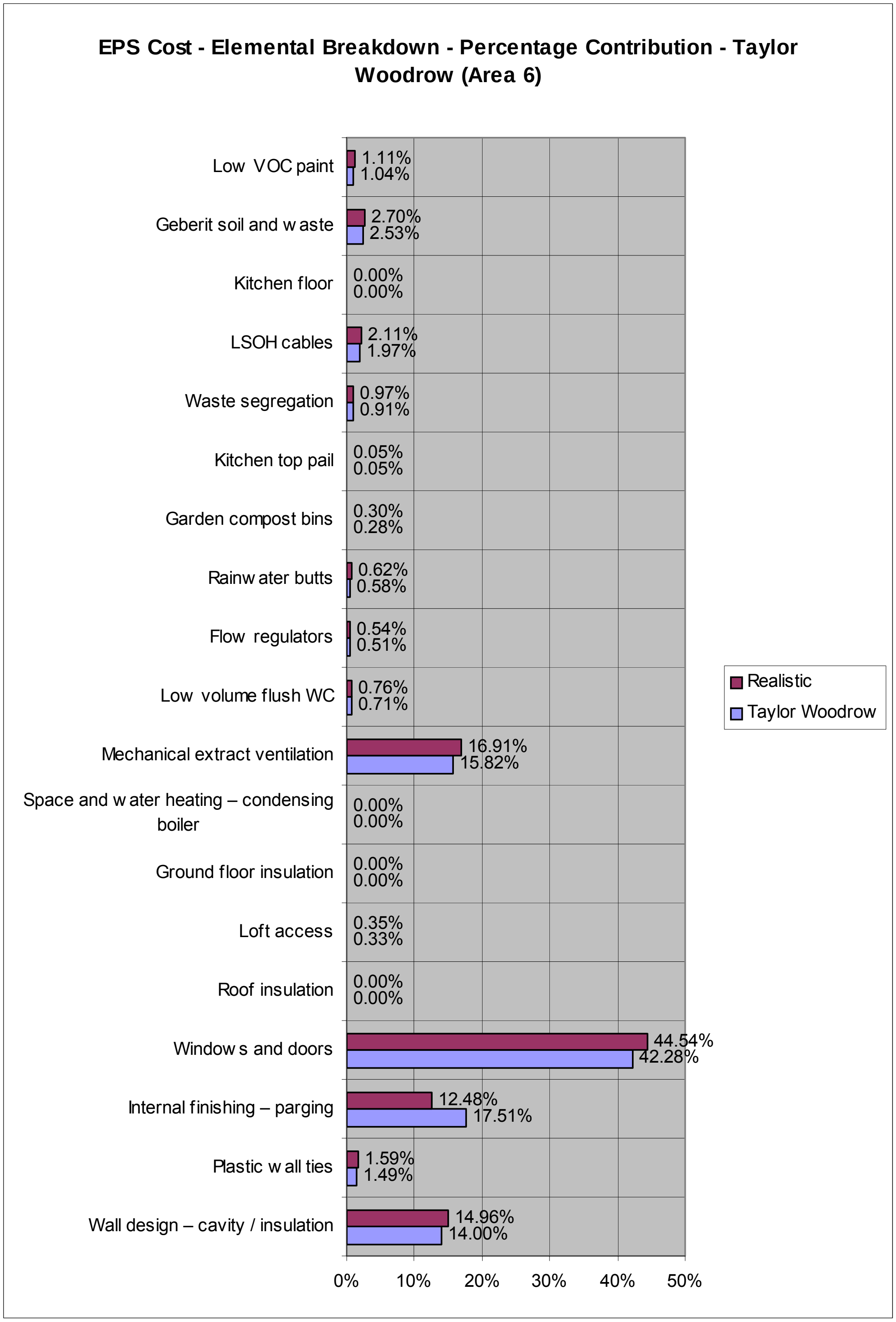
Taylor Woodrow's allowance for parging to the external walls appears excessive. The quoted rate per m2 is acceptable and realistic but does not, at present, relate to the overall property cost quoted.

A full drawing review is required to be undertaken once the drawings are available.

Windows and doors

The window protection cost included by Taylor Woodrow is considered excessive and is currently under review.

The diagram below illustrates the percentage contribution of each EPS item to the Taylor Woodrow total.



Redrow Homes Cost Breakdown

The table below illustrates the average extra over cost attributable to each of the EPS cost headings for the first parcels, as submitted by Redrow Homes. As above, a second cost column has been included listing realistically expected cost i.e. the costs that are recommended for agreement between the National Trust and Redrow Homes, based on the substantiating information issued to date.

As appropriate costs have been indicated as provisional i.e. to be agreed at a later date once all the information is available.

Where the table below denotes a difference between Redrow Homes' costs and the costs realistically expected a brief explanation has been provided.

EPS Item	Redrow Homes - Cost per property (£)	Realistically Expected - Cost per property (£)	Difference (£)
External wall			
Wall design – cavity / insulation	637	577	60
Plastic wall ties	98	98	-
Internal finishing – parging	277	277	-
Windows and doors	1,535	1,535	-
Roof			
Roof insulation	0	0	-
Loft access	18	18	-
Ground floor insulation	0	0	-
Heating and ventilation			
Space and water heating – boiler Provisional	200	200	-
Mechanical extract ventilation Provisional	737	737	-
Water minimisation			
Low volume flush WC	99	0	99
Flow regulators	104	63	41
Rainwater butts	42	42	-
Waste minimisation			
Garden compost bins	9	9	-
Kitchen top pail	2	2	-
Waste segregation	72	72	-
Products / materials			
LSOH cables Provisional	106	106	-
Kitchen floor	118	118	-

Geberit soil and waste Provisional	170	170	-
Low VOC paint	34	34	-
Total:	4,259	4,059	200

Wall design

The cost quoted by the bricklayers for the installation of the lintels and associated insulation, as well as cavity trays appears excessive. The quoted rates per metre are in excess of what would realistically be expected by around £60 per property.

Low volume flush WC

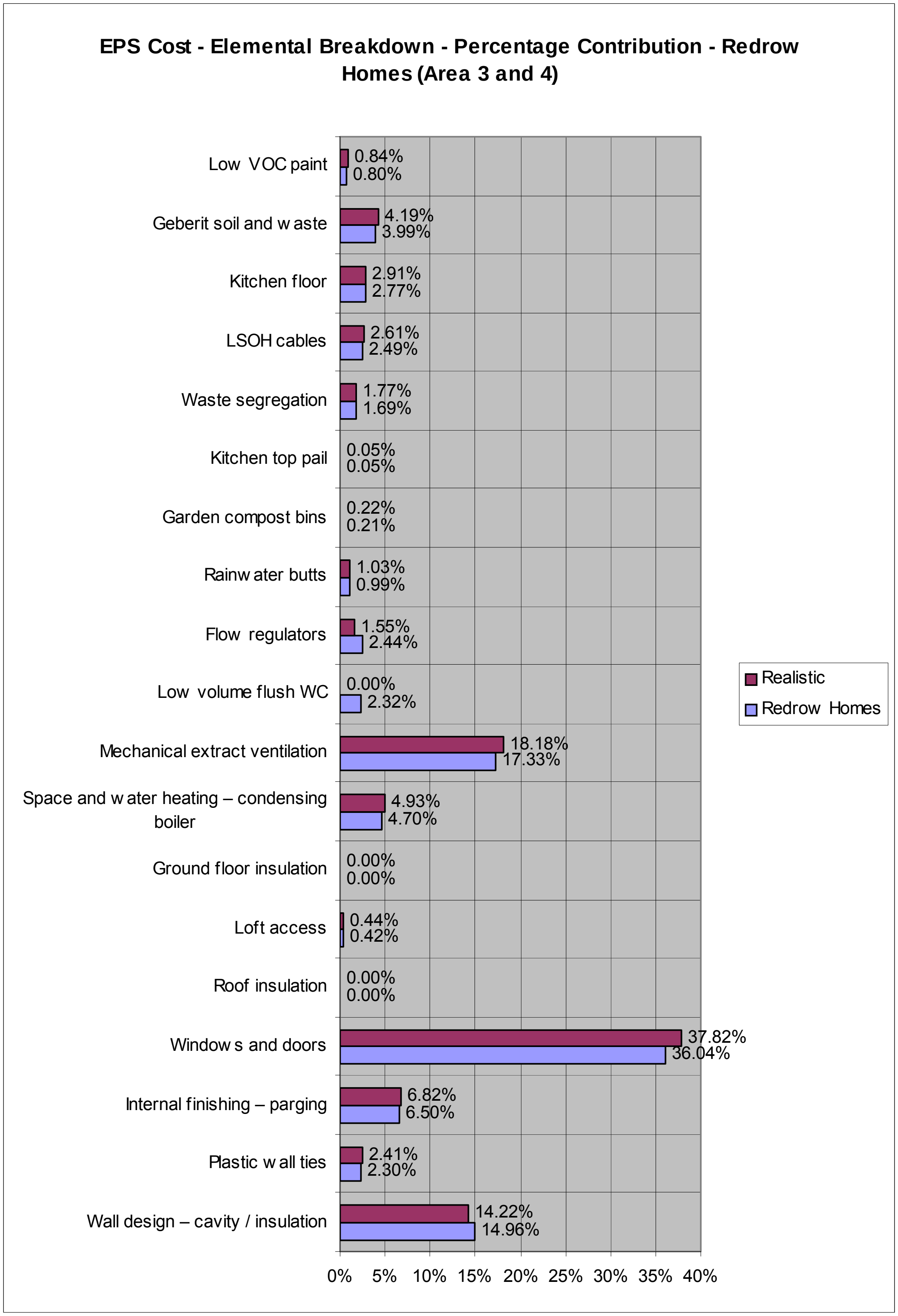
The Sandringham range of sanitary ware offers a low volume flush WC that meets the EPS. However, the Sandringham range is not one that Redrow Homes generally offer as standard for their properties and as a result an extra over cost of £99 per property is claimed by Redrow Homes, when compared to their basic range of sanitary ware.

The extra over cost does not directly relate to the WC as it applies to the completed suite of sanitary ware. As such this is considered a marketing and sales issue rather than a construction issue.

Flow regulators

The costs quoted for the flow regulators are considered excessive. Redrow Homes are, however, in the process of obtaining alternative quotations for the flow regulators.

The diagram below illustrates the percentage contribution of each EPS item to the Redrow Homes total.



Section 6 – Cost / Time Development Analysis

The costs associated with some of the EPS items changed considerably over time as more information became available and quotes were obtained.

Listed and demonstrated graphically below is a selection of EPS items that illustrate the development of costs over time.

Total external wall construction

Plastic wall ties

Mechanical extract ventilation

Roof insulation

Ground floor insulation

Windows and doors

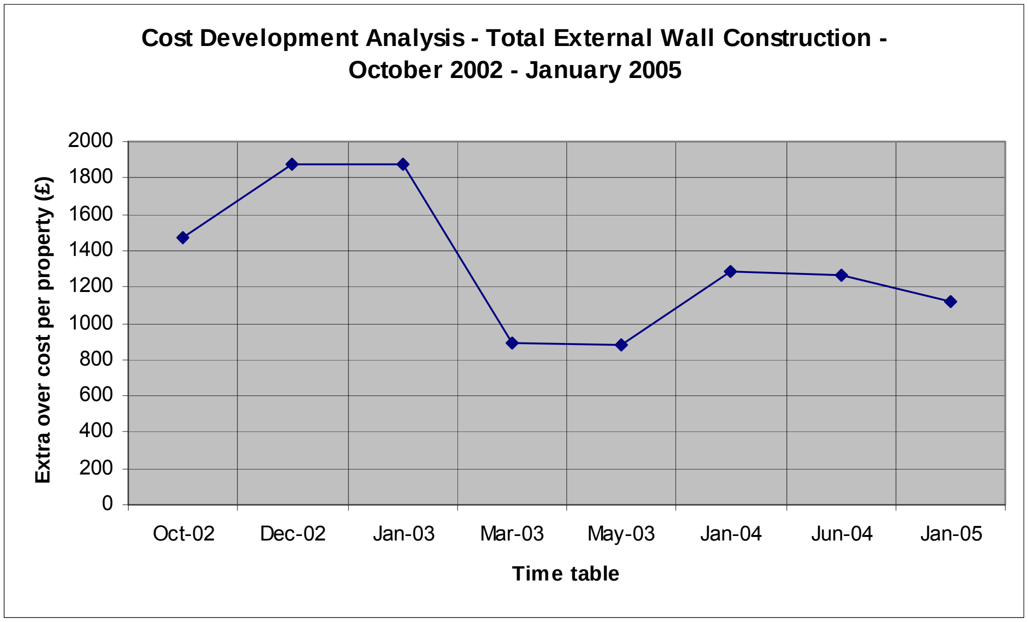
LSOH cables

The main reason for the fluctuation in costs can be attributed to the initial inclusion of “risk” within the pricing from suppliers and sub-contractors when dealing with something that is considered new and unfamiliar. As the appreciation of the aims and objectives of the Stamford Brook project grew with construction solutions being developed and buildability issues being considered the costs tended to reduce over time.

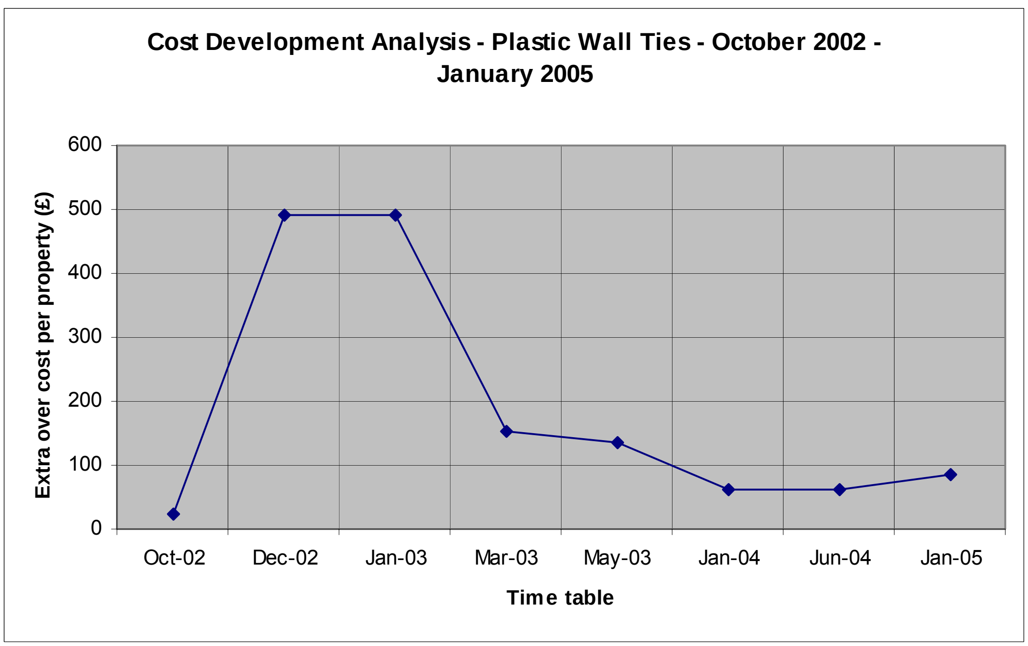
Although the basis upon which costs were estimated varied slightly over time as the property designs were developed the graphs below provide a good indication as to the development of costs over time.

In the initial stages all dwellings were assumed to be detached properties with an average property size of 100m2, as the property types and the property mix was as yet unknown. This assumption had the effect of over-estimating items such as wall tie numbers and external wall insulation as a detached property has a larger area of external wall. However, other items were under-estimated as a number of properties were found to be in excess of 100m2. The overall effect is, however, comparatively negligible.

As appropriate specific reasons for fluctuations and changes in costs are detailed below each graph.



Total external wall construction – The extra over cost for the external walls has gradually reduced over time. Once the construction details were finalised and a better understanding existed of the actual methods of construction and insulation requirements the costs stabilised.

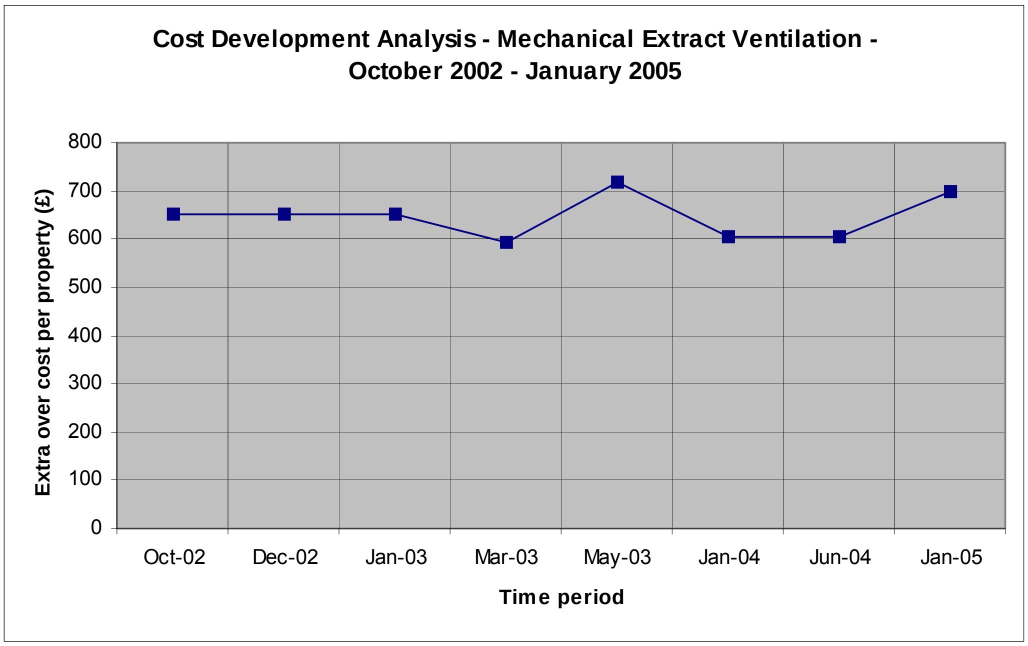


Plastic wall ties – Following an initial review of wall ties available within the UK market it became clear that no viable alternative to steel was available. As a result the wall ties were sourced from Denmark at a considerable additional cost. As a result of fluctuations in exchange rates the costs varied throughout the development period. Actual orders for the wall ties were placed by the Developers in late 2004 with each wall tie costing £0.17 as compared to £0.04 - £0.06 for a standard steel tie.

Although the British pound is still relatively strong the exchange rate at the time of placing orders was not as favourable as it had been, resulting in a slight increase in costs.

Another reason for the relatively high cost per property for such a small, although important, element of construction relates to the lack of competition for the supply of the wall ties. Having sourced and tested the Danish wall ties no further market research was undertaken to establish potential competitive suppliers.

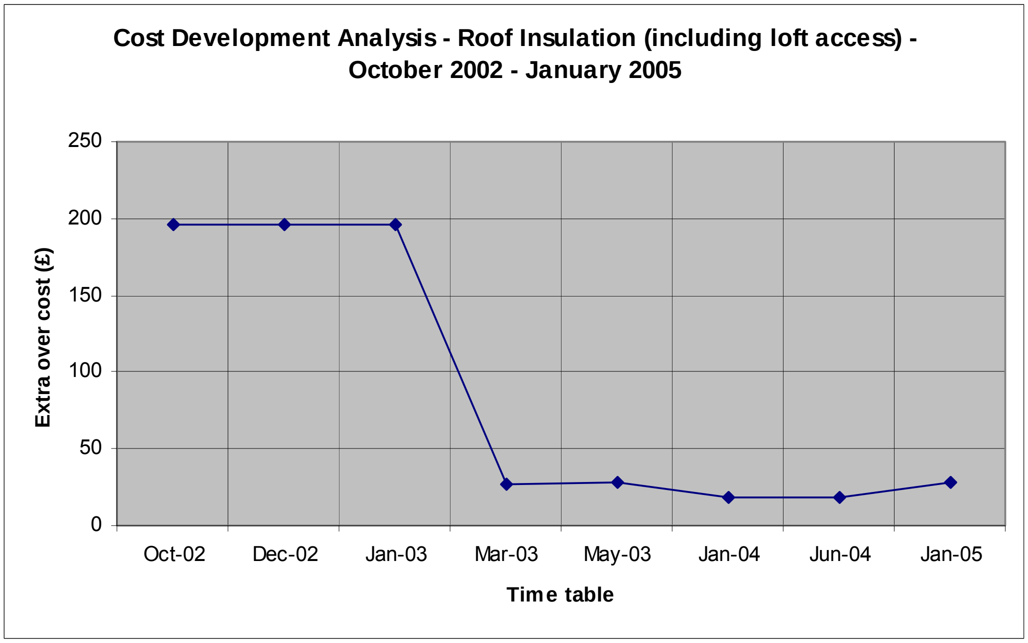
However, one reason for the continued reduction in costs relates to the number of wall ties required. As the wall ties were tested for approval and use within the UK the quantities required per m2 of external wall construction were reduced from 8 per sqm to 4 per m2.



Mechanical extract ventilation – As demonstrated by the above graph the costs have remained relatively stable throughout the development period. Unfortunately Baxi were recently taken over by Vent Axia, resulting in some of the early works and negotiations being in part redundant. This may account for the recent slight increase in costs.

The costs associated with the provision of mechanical extract ventilation within properties is at present considerable, however, with the proposed introduction of more stringent regulations for air tightness within properties this may be an area where costs will reduce over the coming years.

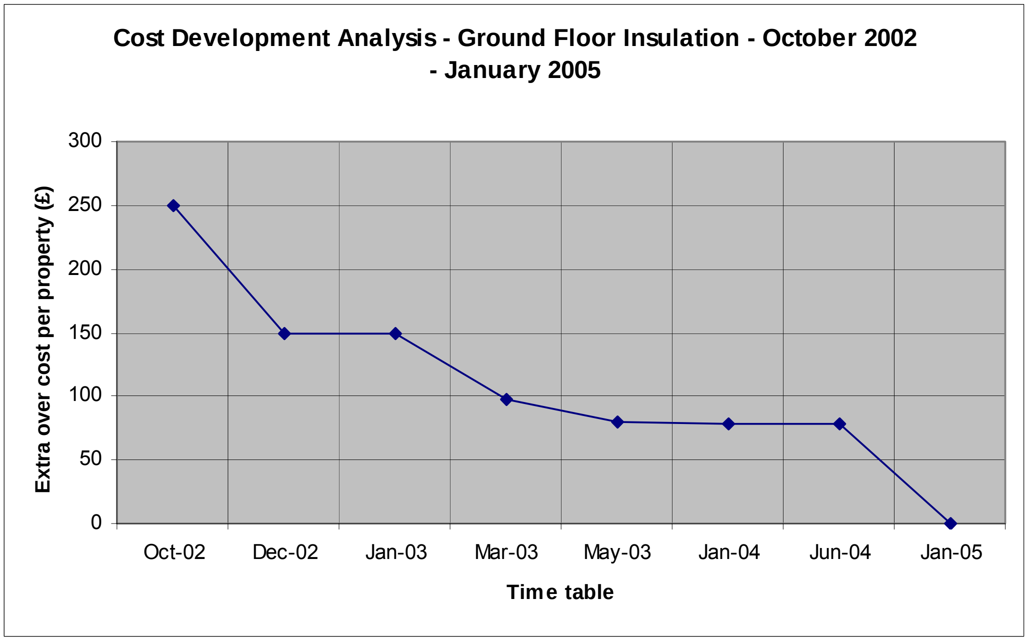
In addition the actual installation cost is only provisional at this stage.



Roof insulation – The only additional cost associated with the roof insulation relates to the loft access. In addition to requiring a specialist loft access hatch for U value compliance the special hatch is required to provide airtightness.

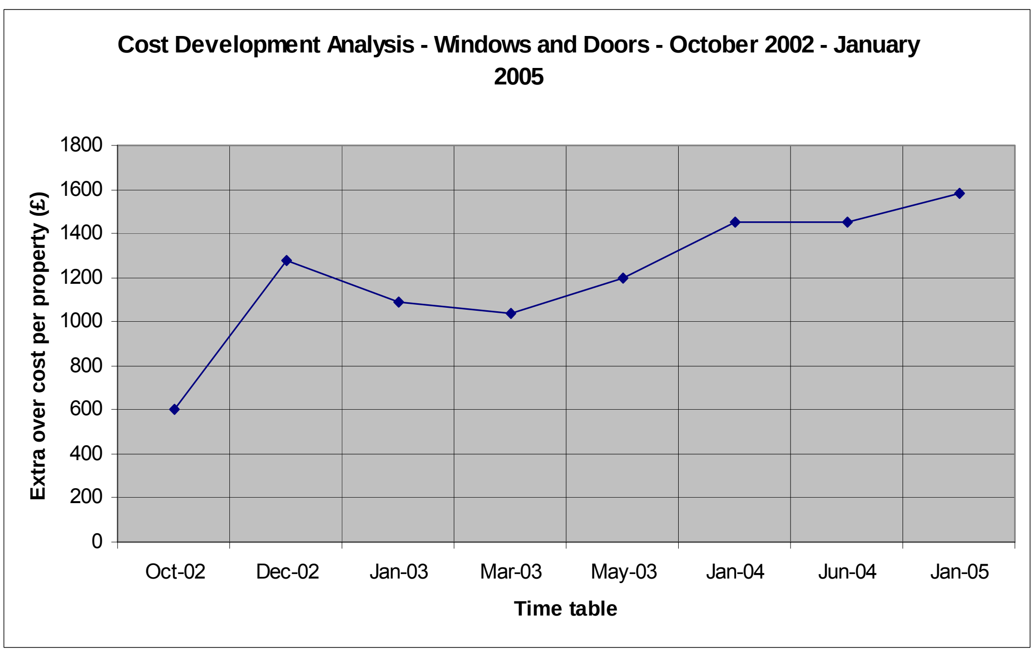
The specialist hatch has only been introduced as part of the requirements in the last few months and was not previously reflected within the costs.

There are no longer any additional costs associated with the provision of the recycled cellulose insulation. The reason for this is considered to be the relatively recently increased availability of alternative materials on the market and their ability to compete with the products that would be used as standard by the Developers.



Ground floor insulation – There are no additional costs associated with the ground floor construction.

In the early stage of the development period the Developers were not, as standard, insulating the ground floor slab, however, both Developers now consider this to be standard practice. As a result the energy efficiency of the property is improved.

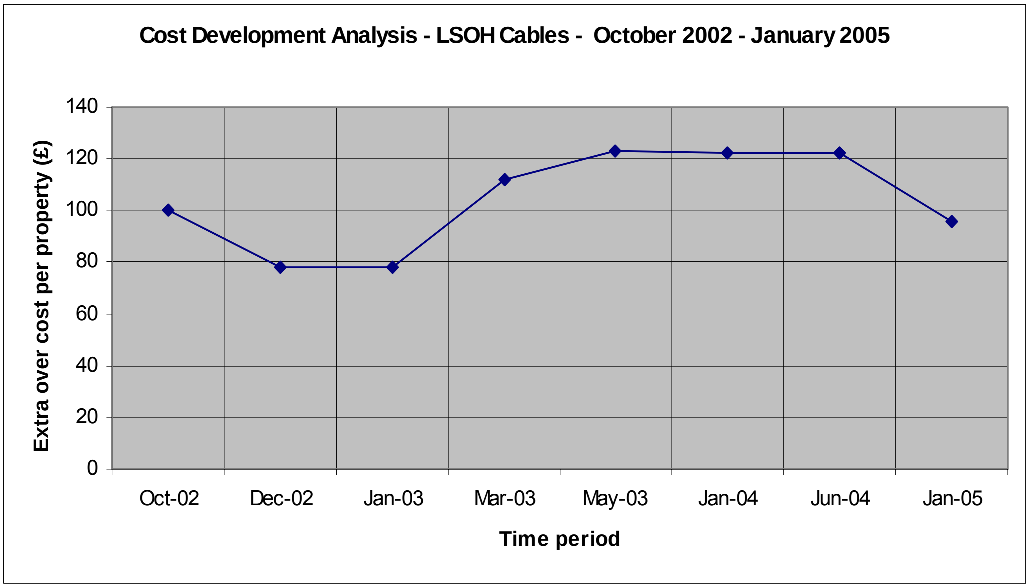


Windows and doors – The costs for the high performance windows and doors has gradually increased during the development period and represents the highest individual extra over cost attributable to EPS compliance.

Again, as for the plastic wall ties above, the product is a Danish product and has as such been affected by the fluctuation in exchange rates. The supply of the windows and doors, like the wall ties above, has also suffered from the lack of competition within the market. As for all products the impact of this is to increase costs.

Another reason for the continued cost increase is the development of the design, window sizes and the detailing of the windows and doors, from inception to completion of the window and door designs.

The above cost per property of around £1,500 is, however, not fully representative as this includes an allowance for rear doors and patio doors which does not apply to every property.



LSOH cables – The cost associated with the requirement for non-PVC wiring and the provision of LSOH cables as demonstrated by the above graph has remained relatively constant throughout the development period.

This is still an area where costs are comparatively high and where the market appears reluctant to consider a change away from PVC.

As demonstrated by all graphs above the general trend has been for EPS costs to gradually reduce over time. This trend is expected to continue, as the Developers and sub-contractors become more familiar with the EPS requirements.

Section 7 – Conclusion and Recommendations

This report demonstrates that the incorporation of the EPS into construction at Stamford Brook increases the capital cost of a typical property (89.8m2) by around £4,150, which represents an increase of some 9% compared to standard construction.

The report has concentrated on the 79 properties currently under construction at Stamford Brook and has highlighted a number of areas where further works ought to be undertaken.

The list below summarises the recommendations.

Incorporation of EPS items within the Developers national trade agreements to ensure equivalent discounts are being obtained when compared to standard construction items.

Continued review, during construction, of the areas of the extra over costs currently noted as provisional.

Continued review of extra over costs associated with EPS compliance at regular intervals.

Review of excess material wastage associated with EPS compliance (e.g. marmoleum flooring).

Re-establishment of market research to source alternative products such as for example wall ties and windows and doors, to ensure competition between suppliers.

This report does not consider the cost-in-use savings associated with the properties constructed in compliance with EPS and consideration should be given to the commissioning of separate modelling of the properties to establish the reduced energy consumption per property.

In addition, this report does not consider any potential benefits to the property sales prices associated with the incorporation of EPS.

Subject to the recommendations above the extra over costs associated with EPS compliance should reduce for the next areas of construction and should continue to reduce throughout the development period. In addition the EPS related costs are anticipated to reduce as a result of the introduction of ADL2005 at the end of 2005.

It is recommended that a separate cost analysis exercise be undertaken as soon as the Developers have confirmed how they intend to ensure compliance with ADL2005.

Appendix 3: EPS08 and ADL2005 compared

Stamford Brook Project Working Paper
A comparison of predicted carbon emissions under ADL02, EPS08, and the draft ADL05.

Robert Lowe and David Roberts

Centre for the Built Environment, Leeds Metropolitan University

Introduction

1 The immediate objective of this short paper is to compare the CO2 emissions that would result from application of the EPS08 and draft ADL05 energy performance standards to 4 standard dwelling types. This comparison has been done using the parametric energy performance calculator version 11.5.

2 The wider objective of the paper is to provide a starting point for a discussion of what energy and CO2 performance targets should be adopted for future phases of the Stamford Brook development. The intention of the Stamford Brook Partnership has been that each phase of the development would be built to energy and CO2 performance targets that were significantly ahead of the requirements of prevailing national standards. As this paper makes clear, the introduction of a new Part L based on the targets published in the consultation document will narrow the performance margin in all dwelling types and, in larger detached dwellings, close it completely. The new Part L will also change the structure within which performance standards are expressed. This structural change will also require a response from the Partnership.

Summary of EPS08 and the draft ADL05

3 The forerunner of the energy and ventilation performance standard for Stamford Brook was originally written in 1999, based on an expansion and revision of the proposals for 2005 contained in Towards Sustainable Housing. This standard went through a number of revisions, culminating in a version written in November 2001 and referred to as EPS08 (Lowe and Bell 2001).

4 EPS08 provides two basic compliance methods – an Elemental Method and a Carbon Rating Method. A third method, based on whole dwelling heat loss is a variant of the Elemental Method.

5 The elemental requirements of EPS08 are presented in Table 0.1 below:

Table 1 U values and other performance parameters for dwellings	
exposed walls	0.25 W/m^{2}K
roofs	0.16 W/m^{2}K
floors	0.22 W/m2K
windows, outer doors & rooflights (no more than 25% of gross floor area)	1.3 W/m^{2}K or DWER $\geq$ 70
air permeability at 50 Pa	5 m/h
maximum carbon intensity for space and water heating	70 kg/GJ

6 The Target Carbon Index for dwellings was set at 9.1, based on the defining equation that appeared in the June 2000 Part L Consultation Document. This defining equation was subsequently modified with the publication of SAP 9.7 (2001). The modification offset the carbon index scale by 0.4 points. To retain consistency, the Target Carbon Index for Stamford Brook was reset at 8.7.

7 When the Target Carbon Index for EPS08 was originally defined, it was assumed that the Carbon Rating and Elemental targets were broadly comparable. Subsequent work through 2002 and 2003 showed that the two approaches diverged significantly. It was clear that for large detached houses, compliance via the Carbon Rating approach was significantly more difficult than via the Elemental approach. However at this stage, the full nature of the problem was not appreciated.

8 In the Spring of 2004, work commissioned as part of the review of Part L of the Building Regulations finally forced a thorough re-evaluation of the problem of setting carbon targets for dwellings (Lowe & Wingfield 2004). This confirmed that the form of the Carbon Index, coupled with the relative inflexibility of carbon emissions from dwellings using the mix of envelope and energy conversion technologies currently available in the UK, would lead to significant problems with a single Target Carbon Index approach to building regulations. Two alternative approaches to defining carbon targets were explored and it appears likely that one of these – the Variable Target Carbon Emission Rate approach – will form the basis for the draft ADL1a.

9 The starting point for defining a possible compliance envelope for ADL05 was a set of performance parameters that appeared in an interim report to ODPM (Irving 2004). These parameters, which are not greatly different from the equivalent parameters in EPS08 (Table 1 above), are set out below.

Table 2: base case envelope performance targets for 2005 (Irving 2004)	
wall	0.27
windows and doors	1.8 (25% of floor area)
floors	0.22
roofs (joist level)	0.13
boiler	86%
ventilation	natural
air permeability	7m/h @ 50 Pa

10 The final analytical form of the compliance envelope was:

$$TCER = 18.0 \cdot (TFA/TFA_0)^{0.3} \cdot (form/form_0)^{0.1} \cdot (c/c_{gas})^{0.7} \qquad 1.$$

where:

$TFA_0 = 55\ m^2$

$form_0 = 2.0$

$c_{gas} = 54\ kg(CO_2)/GJ$

This was subsequently incorporated into the parametric energy calculator.

11 The intention for ADL05 is that equation 1 would define the primary compliance route. The task for the rest of this paper is therefore to compare the CO_2 emissions that would result from application of the:

- EPS08 elemental standard
- EPS08 Target Carbon Index
- ADL05 variable Target Carbon Emission Rate.

Comparison of standards

12 Figure 1 shows the CO_2 emissions that would result from the application of these three standards to four standard dwelling types:

a) a detached house with 100 m^2 gross floor area

b) a semi-detached house with 80 m^2 gross floor area

c) a mid-terrace house with 55 m^2 gross floor area

d) a mid-block, dual-aspect, single storey flat of 50 m^2 gross floor area

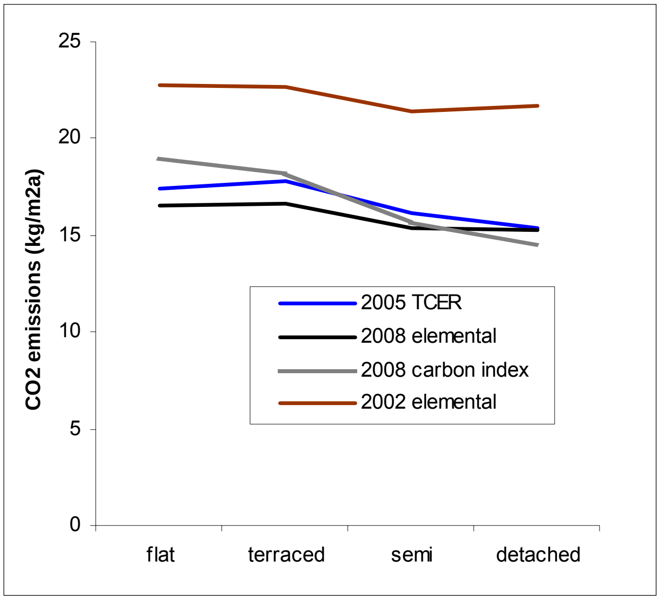


Figure 1. CO_2 emissions for 4 standard dwelling types, under the current ADL02, EPS08 elemental and EPS08 Carbon Rating approaches and the draft ADL05.

13 Figure 1 indicates that emissions under the proposed ADL05 standard will be between 25 and 30% lower than under the current 2002 Part L.

14 Emissions under the EPS08 elemental approach should be lower than the Target Carbon Emission Rates (TCER) proposed for ADL05, except for detached houses.

15 In practice, envelope standards and choice of heating systems for Stamford Brook have been dominated by a desire to ensure the detached houses complied with the EPS08 Target Carbon Index. There has been no attempt to capitalise on the relative leniency of the EPS08 Carbon Rating Method for more compact dwelling types, by adopting less efficient heating systems or moving to higher elemental U values.

16 The actual performance of most dwellings at Stamford Brook is likely to be a few percent lower than the 2008 elemental line. Higher emissions from electric focal point fires are predicted to be more than offset by improved performance from A-rated boilers. The small impact of electric focal point fires stems from the assumption, in SAP2002, that such fires will only displace 5% of total space heating load (focal point gas fires are assumed to displace 15% of space heating). Empirical data on actual use of focal point fires in highly insulated dwellings will be one of the results from the Stamford Brook project.

17 The bunching of the lower 3 curves in Figure 1 is an indication of the decreasing scope for reducing overall CO2 emissions from dwellings by focusing on envelope performance and boiler efficiency. A large proportion of potential savings have already been taken by the 2002 revision to Part L and, while marginal improvements in performance remain possible, each successive step will be smaller and more difficult to achieve than the last.

18 The figure illustrates the difficulties that arise from application of a fixed Target Carbon Index to a wide range of dwelling types. EPS08 elemental and carbon rating methods are inconsistent except for a small proportion of dwellings grouped around 80 m2 semi-detached houses. Emissions for the detached house under the EPS08 Target Carbon Index of 8.7 are significantly lower than under the other two standards. At the same time emissions for the most compact dwelling type, a small, mid-block, mid-floor flat, are significantly higher.

Conclusions

19 The work described in this paper suggests that the Stamford Brook dwellings will exceed the requirements of ADL05. The margin between predicted CO2 emissions for space and water heating and ventilation and the ADL05 Target Carbon Emission Rate is in the region of 4-8%.

20 The intention of the Stamford Brook Partnership has been that each phase of the development would be built to energy and CO2 performance targets that were significantly ahead of the requirements of prevailing national standards. As this paper makes clear, the introduction of a new Part L based on the targets published in the consultation document will narrow the performance margin in all dwelling types.

21 An indication of the level of performance that may be required in the next revision of Part L is given in the latest Part L Consultation Document (ODPM 2004), under the heading Future thinking for parts L1 and L2. This suggests that the 2010 revision of Part L will reduce CO2 emission targets for space and water heating in new dwellings by a further 20-30%. Any revision of EPS08 would need to be set at something like this level if the project is to retain its national significance as a pathfinder for energy performance standards in mass housing. This would require consideration of technologies - including active solar water heating, heat pumps and district heating - that have not been on the agenda for Stamford Brook so far.

22 The proposed new Part L will also change the structure within which performance standards are expressed. The effects of this change are to resolve the conflict between the elemental and carbon rating approaches (see figure 1) and to provide a framework that incentivises a much wider range of technologies than hitherto. This structural change will need to be reflected in any future revision of EPS08.

23 One of the most important unknowns in all of the above is the gap between predicted and actual performance. The care spent on the construction of the dwellings, together with pressurisation testing and energy monitoring should ensure that actual performance at Stamford Brook comes reasonably close to predicted and, therefore, that the estate performs better than the industry average in this respect. But lack of empirical data on energy performance for new housing will make this assertion difficult or impossible to confirm.

References

Lowe, R.J. & Bell, M. (2001) *A Trial of Dwelling Energy Performance Standards for 2008: Prototype standards for energy and ventilation performance*, Centre for the Built Environment, Leeds Metropolitan University.

Lowe R.J. & Wingfield, J. (2004) *Setting carbon performance targets for dwellings*. Interim Report to ODPM Building Regulations Division Under the Building Operational Performance Framework.

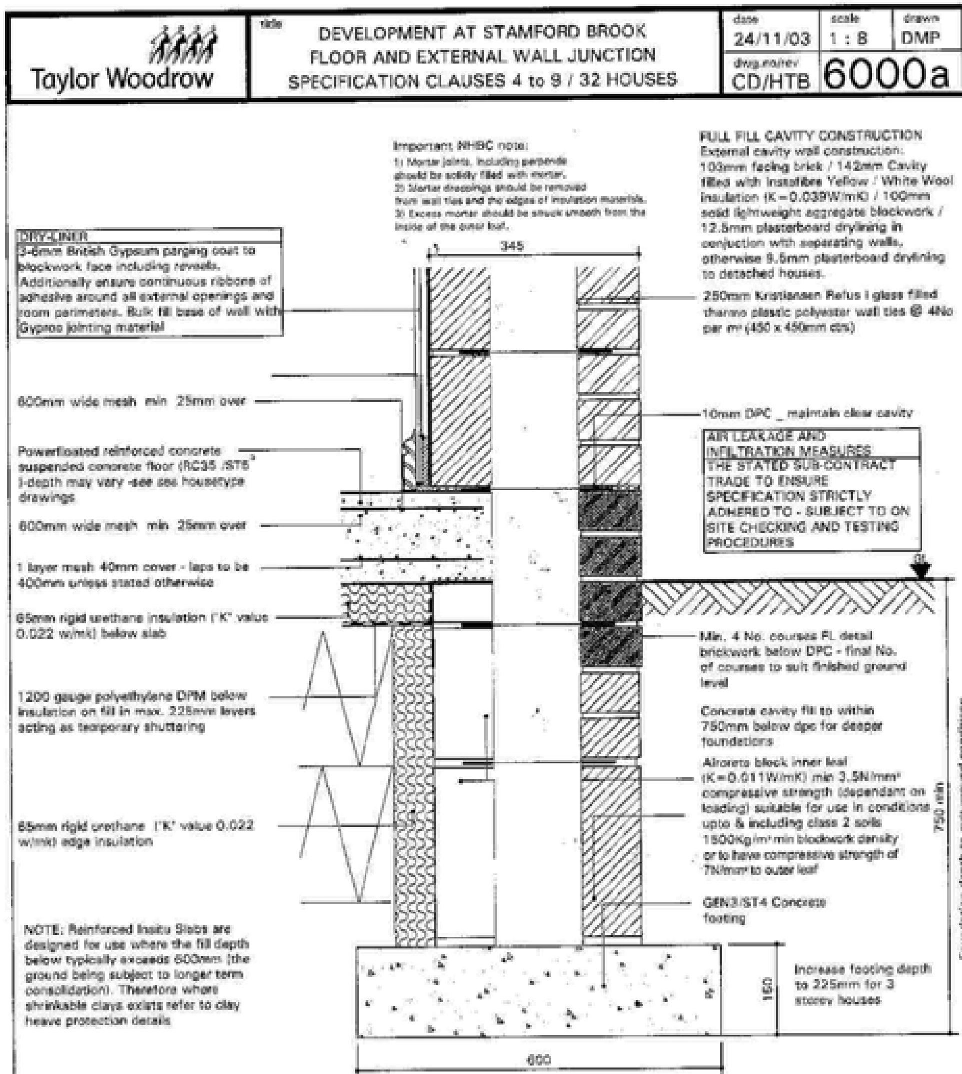
Irving, S. (2004) *New build dwellings - setting the TCI v1 (February 2004)*, Report to ODPM Building Regulations Division Under the Building Operational Performance Framework, St Albans: FaberMaunsell.

DETR (2000) *The Building Regulations 2000. Proposals for Amending the Energy Efficiency Provisions*. A Consultation Paper issued by the Building Regulations Division. London: DETR.

BRECSU (2001) *The Government's Standard Assessment Procedure for Energy Rating of Dwellings. 2001 edition*, Watford: BRECSU. http://projects.bre.co.uk/sap2001/.

ODPM (2004) Proposals for amending Part L of the Building Regulations and implementing the Energy Performance of Buildings Directive: A consultation document. www.odpm.gov.uk/br/consult.

Appendix 4: Stamford Brook Working Details



Ground floor / external wall junction
Reinforced insitu slab
(under floor insulation)

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK FLOOR AND EXTERNAL WALL JUNCTION SPECIFICATION CLAUSES 4 to 9 / 32 APARTMENTS	date: 24/11/03	scale: 1 : 8	drawn: DMP
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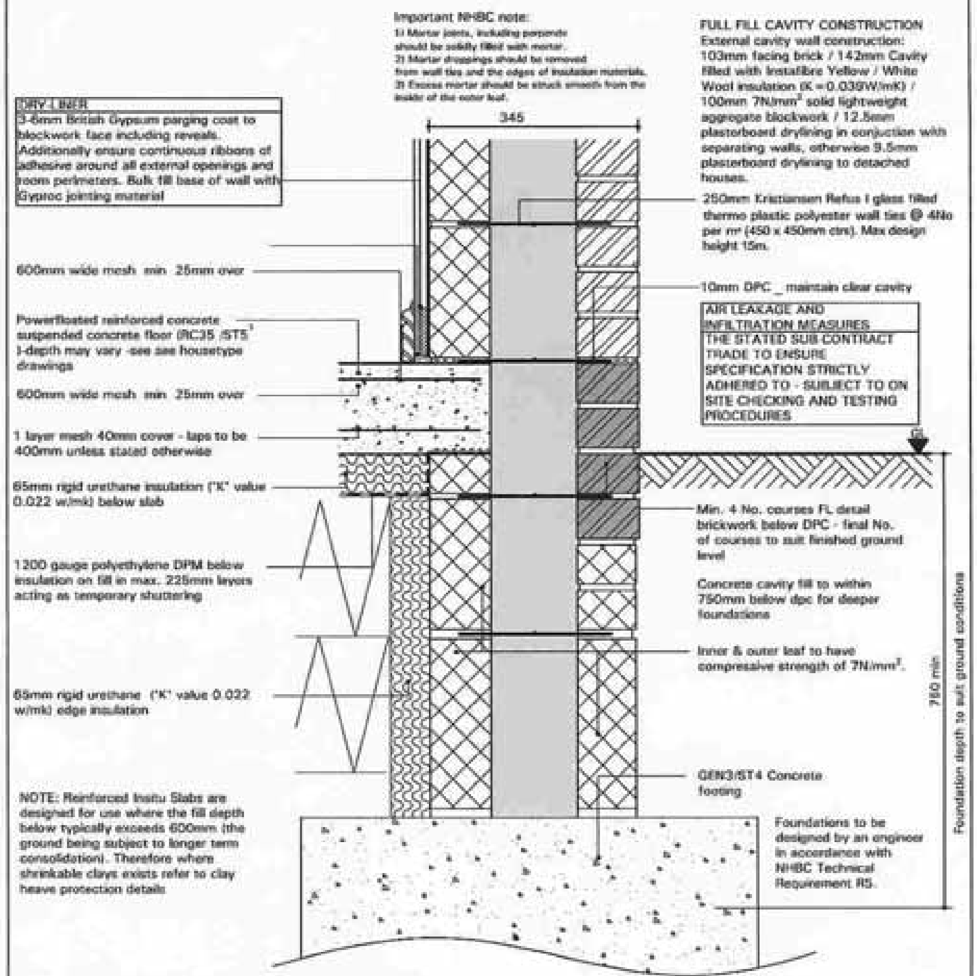
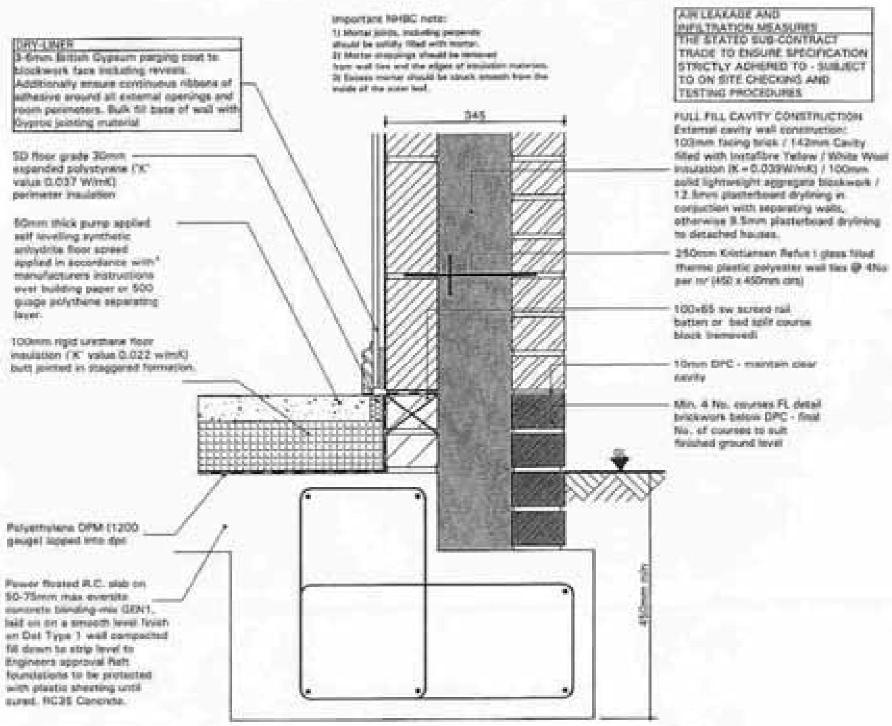


Ground floor / external wall junction
Reinforced insitu slab
(under floor insulation)
BROOKSIDE / CONTRACT DETAILS

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK FLOOR AND EXTERNAL WALL JUNCTION SPECIFICATION CLAUSES 4 to 9 / 32 HOUSES	date: 02/08/04	scale: 1 : 10	drawn: DMP
		dwg.no/rev: CD/HTB	6002a	



Ground floor / external
wall junction with raft

Typical raft shown - refer to consulting engineers site specification details and dimensions

NOTE: FLOOR RAFT FOUNDATION NOT ACCEPTABLE UNDER APPROVED DOCUMENT E & RSD's FOR USE IN CONJUNCTION WITH SEPARATING WALLS - CONSULT T.W. STRUCTURAL ENGINEER.

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL OPENINGS SPECIFICATION CLAUSES 10/14/15/32 HOUSES	date: 23/02/05	scale: 1 : 10	drawn: DMP
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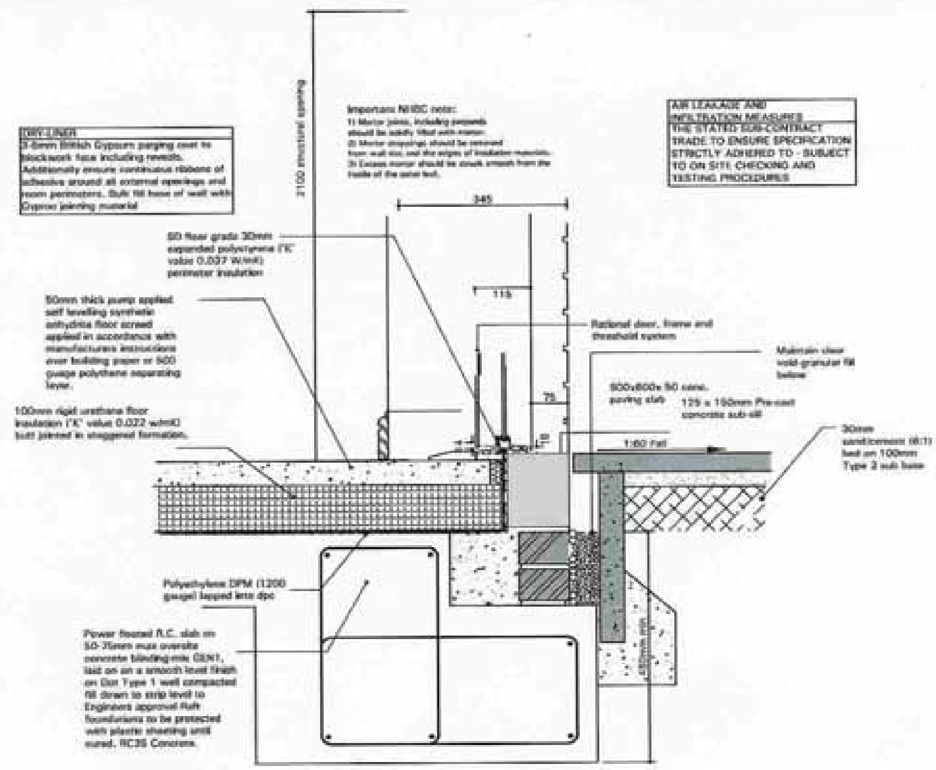

Mobility entrance threshold

<u>Typical raft shown - refer to consulting engineers site specification details and dimensions</u>

NOTE: FLOOR RAFT FOUNDATION NOT ACCEPTABLE UNDER APPROVED DOCUMENT E & RSD's FOR USE IN CONJUNCTION WITH SEPARATING WALLS - CONSULT T.W. STRUCTURAL ENGINEER.

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL WALL CONSTRUCTIONS SPECIFICATION CLAUSES 10/32 HOUSES	date: 05/03/04	scale: 1 : 10	drawn: DMP
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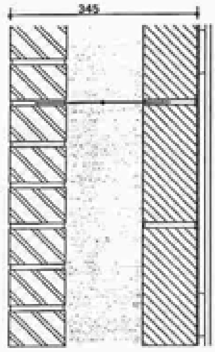
WALL DETAILS AND LOCATIONS ('U' VALUES)



250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m^2 (450 x 450mm ctrs)

FOR FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K = 0.039W/mK) / 100mm solid light weight aggregate blockwork (K = 0.47-0.51W/mK)(Density = 1200-1600kg/m^3) / 12.5mm plasterboard drylining in conjuction with separating walls, otherwise 9.5mm plasterboard drylining to detached houses.

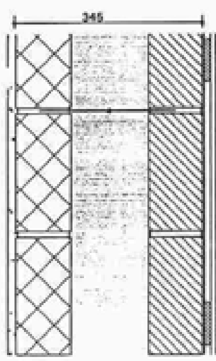
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES

DRY-LINER
3-6mm British Gypsum perging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and room perimeters. Bulk fill base of wall with Gyproc jointing material

Important NHBC note:
1) Mortar joints, including perpends should be solidly filled with mortar.
2) Mortar droppings should be removed from wall ties and the edges of insulation materials.
3) Excess mortar should be struck smooth from the inside of the outer leaf.

'U' VALUE = 0.22 (one dimensional heat flow)
'U' VALUE = 0.24 approx (thermal bridging)

STANDARD EXTERNAL WALL (FACING BRICK FINISH)



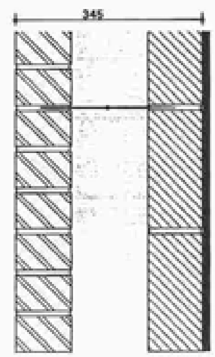
Two Coat Cement Lime Sand Render Undercoat thickness 10mm nominal. Final coat cement thickness 5mm textured.

FOR FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 100mm solid light weight aggregate blockwork (K = 0.47-0.51W/mK)(Density = 1350-1600kg/m^3) / 142mm Cavity filled with Yellow / White Wool insulation (K = 0.039W/mK) / 100mm solid light weight aggregate blockwork (K = 0.47-0.51W/mK)(Density = 1200-1600kg/m^3) / 12.5mm plasterboard drylining in conjuction with separating walls, otherwise 9.5mm plasterboard drylining to detached houses.

Ventilate cavity in accordance with NHBC standards

'U' VALUE = 0.? (one dimensional heat flow)
'U' VALUE = 0.? approx (thermal bridging)

STANDARD EXTERNAL WALL (RENDERED FINISH)



250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m^2 (450 x 450mm ctrs)

FOR FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K = 0.039W/mK) / 100mm solid light weight aggregate blockwork (K = 0.47-0.51W/mK)(Density = 1200-1600kg/m^3) / 13mm wet plaster internal finish

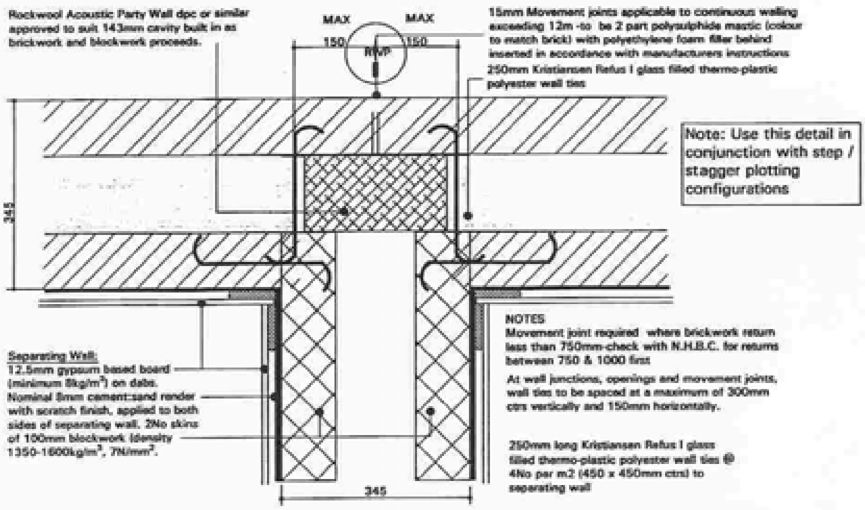
Pre-mixed gypsum based Thistle wet plaster system conforming to BS 1191- 11-13mm first coat with 2mm finish coat applied in accordance with manufacturers recommendations

'U' VALUE = 0.22 (one dimensional heat flow)
'U' VALUE = 0.24 approx (thermal bridging)

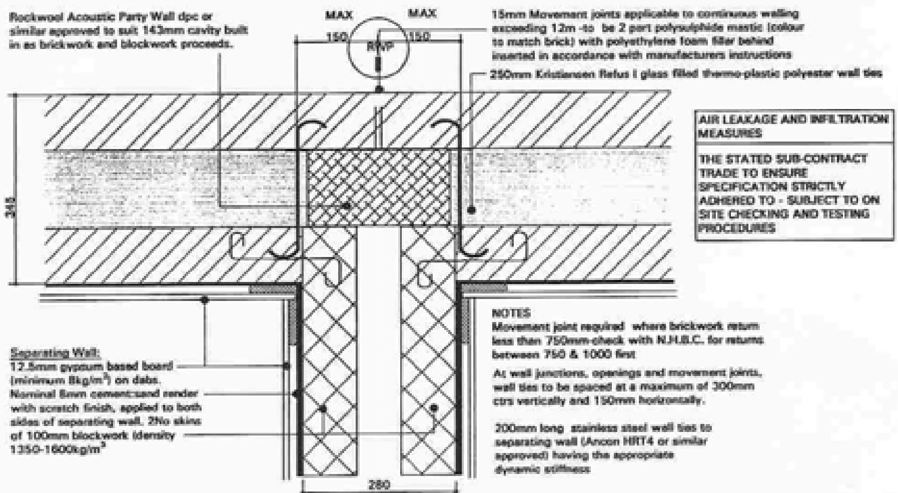
WET PLASTER EXTERNAL WALL (FACING BRICK FINISH)

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL & SEPARATING WALL JUNCTIONS SPECIFICATION CLAUSES 10/11/17 HOUSES	date: 05/03/04	scale: 1 : 10	drawn: DMP
		dwg.no/rev: CD/HTB 6021a		

LIGHTWEIGHT AGGREGATE BLOCKWORK CAVITY MASONARY WALL (345mm) WITH RENDER AND GYPSUM BASED BOARD ON DABS - (BLOCK DENSITY 1350 - 1600 kg/m ³)



LIGHTWEIGHT AGGREGATE BLOCKWORK CAVITY MASONARY WALL (280mm) WITH RENDER AND GYPSUM BASED BOARD ON DABS - (BLOCK DENSITY 1350 - 1600 kg/m ³)



BUILDING REGULATIONS
Minimum 45 dB $D_{nT,w} + C_{tr}$

RSD E-WM-4 PERFORMANCE
Range (47-58 dB) Mean 51 dB

Subject to completion of test programme and final audit.

DO

Keep cavity and wall ties free from mortar droppings and debris.

Fully fill all blockwork joints with mortar.

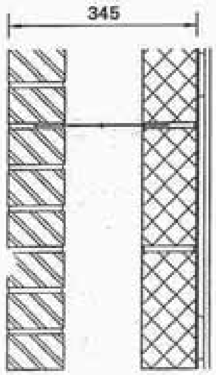
Make sure there is no connection between the two leaves except for wall ties and foundation.

Keep any chases for services to a minimum and fill well with mortar.

Ensure that render is applied to the complete face of each leaf with a scratch finish.

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL WALL CONSTRUCTIONS SPECIFICATION CLAUSES 10/32 APARTMENTS	date: 05/03/04	scale: 1 : 10	drawn: DMP
		dwg.no/rev: CD/ATB	6022b	

WALL DETAILS AND LOCATIONS ('U' VALUES)



250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m² (450 x 450mm ctrs). Max design height 15m.

FOR FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K=0.039W/mK) / 100mm 7N/mm² solid light weight aggregate blockwork (K=0.47-0.51W/mK) (Density=1200-1600kg/m³) / 12.5mm plasterboard drylining.

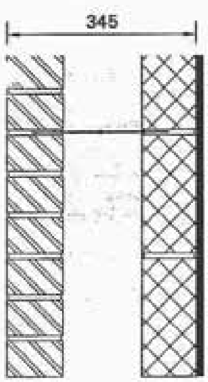
'U' VALUE = 0.22 (one dimensional heat flow)
'U' VALUE = 0.24 approx (thermal bridging)

STANDARD EXTERNAL WALL (FACING BRICK FINISH)

Important NHBC note:
1) Mortar joints, including perpends should be solidly filled with mortar.
2) Mortar droppings should be removed from wall ties and the edges of insulation materials.
3) Excess mortar should be struck smooth from the inside of the outer leaf.

AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES

DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and room perimeters. Bulk fill base of wall with Gyproc jointing material



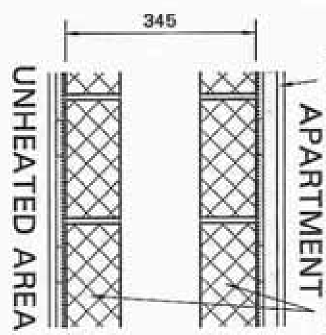
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m² (450 x 450mm ctrs). Max design height 15m.

FOR FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K=0.039W/mK) / 100mm 7N/mm² solid light weight aggregate blockwork (K=0.47-0.51W/mK) (Density=1200-1600kg/m³) / 12.5mm plasterboard drylining.

Pre-mixed gypsum based Thistle wet plaster system conforming to BS 1191- 11-13mm first coat with 2mm finish coat applied in accordance with manufacturers recommendations.

'U' VALUE = 0.22 (one dimensional heat flow)
'U' VALUE = 0.24 approx (thermal bridging)

WET PLASTER EXTERNAL WALL (FACING BRICK FINISH)



Thermal laminate plasterboard (R-value 1.07m²K/W min.) on plaster dabs. Minimum 2No mechanical fixings per sheet. Plaster skim finish.

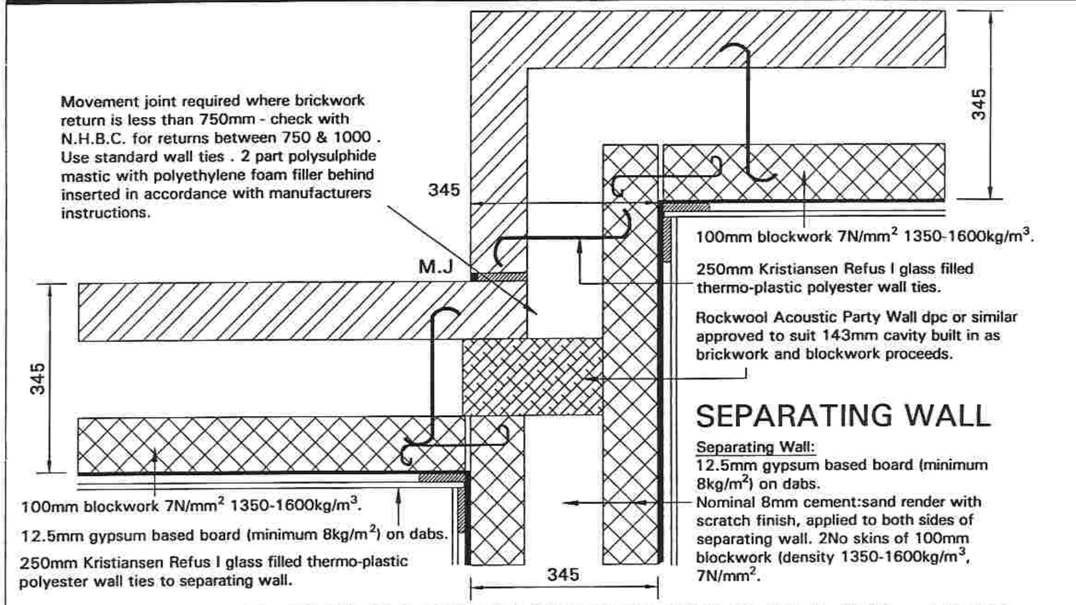
8mm nominal cement/lime/sand render coat full height both sides.

100mm Medium density blockwork 1350-1600 kg/m3, 7N/mm² all joints fully filled.

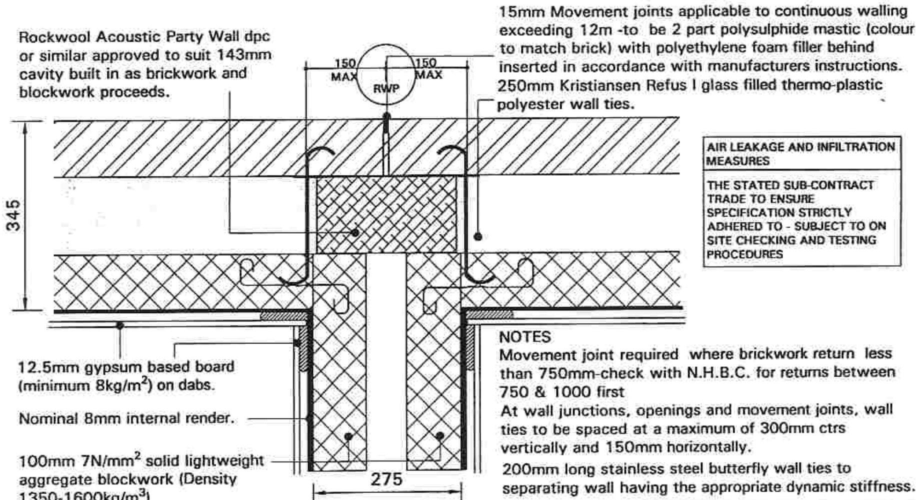
RENDER COAT
Nominal 8mm cement:sand render with scratch finish, applied to both sides of separating wall. Typical render mix 1:1:6 to 1:½:4. Render mix must not be stronger than background.

SEMI-EXPOSED SEPARATING WALL - ENTRANCE HALL : ALL STOREYS

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL & SEPARATING WALL JUNCTIONS SPECIFICATION CLAUSES 10/11/17 APARTMENTS	date: 05/03/04	scale: 1 : 10	drawn: DMP
		dwg.no/rev: CD/ATB	6023a	



LIGHTWEIGHT AGGREGATE BLOCKWORK CAVITY MASONARY WALL (275mm) WITH RENDER AND GYPSUM BASED BOARD ON DABS - (BLOCK DENSITY 1350 - 1600 kg/m ³)



AIR LEAKAGE AND INFILTRATION MEASURES

THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES

NOTES
Movement joint required where brickwork return less than 750mm-check with N.H.B.C. for returns between 750 & 1000 first
At wall junctions, openings and movement joints, wall ties to be spaced at a maximum of 300mm ctrs vertically and 150mm horizontally.
200mm long stainless steel butterfly wall ties to separating wall having the appropriate dynamic stiffness.

BUILDING REGULATIONS
Minimum 45 dB $D_{nT,w} + C_{tr}$

RSD E-WM-4 PERFORMANCE
Range (47-58 dB) Mean 51 dB

Subject to completion of test programme and final audit.

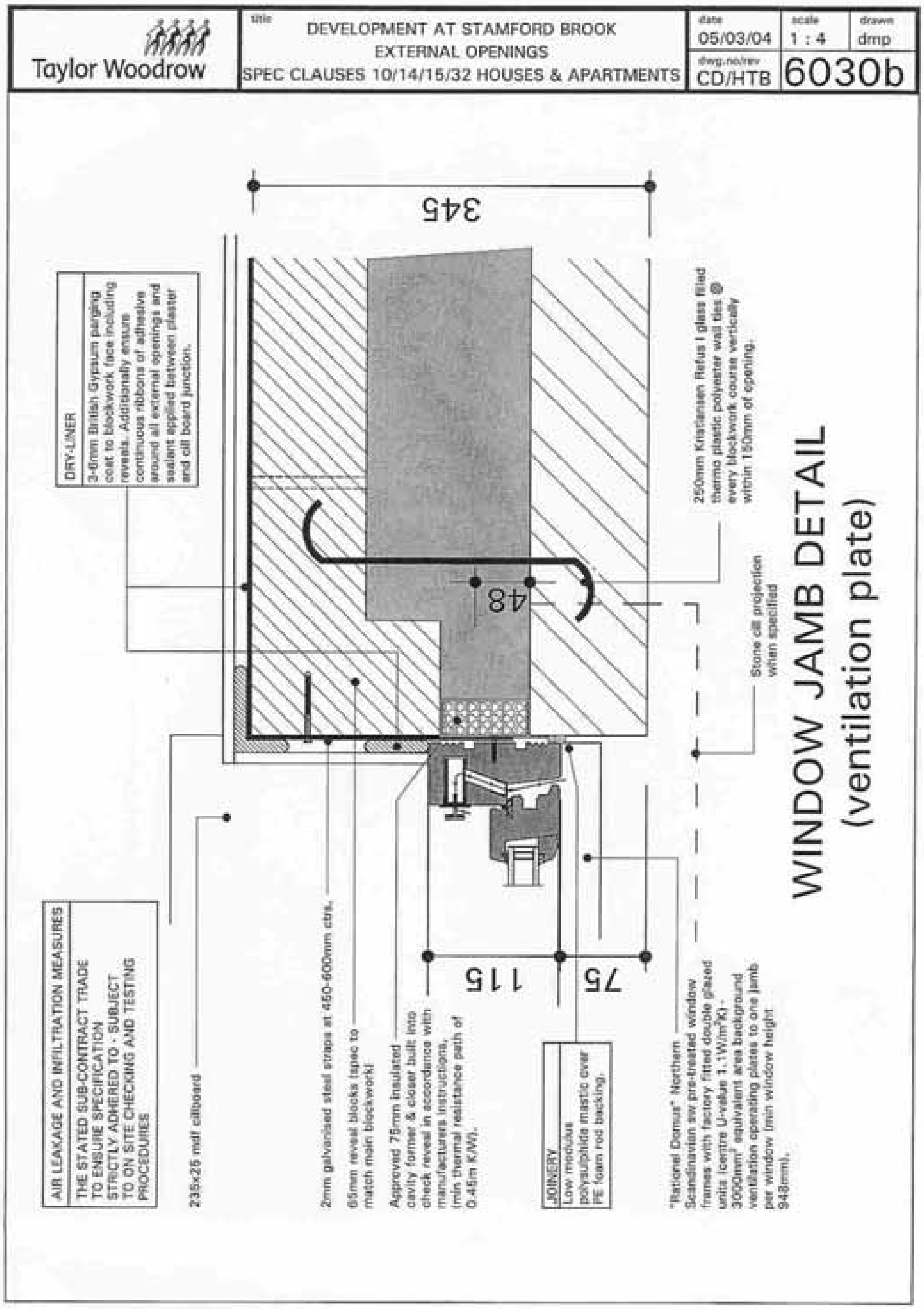
DO
Keep cavity and wall ties free from mortar droppings and debris.

Fully fill all blockwork joints with mortar.

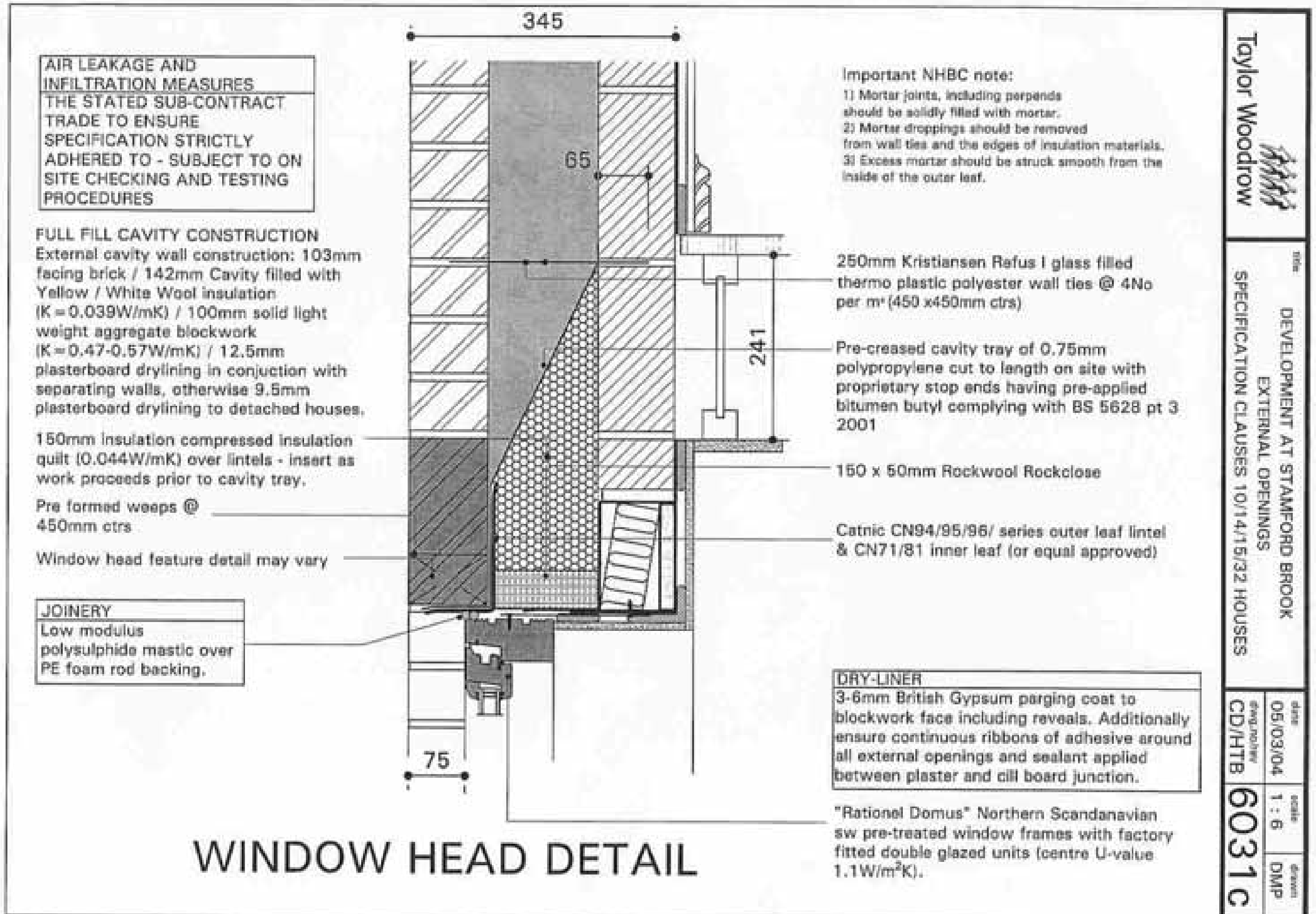
Make sure there is no connection between the two leaves except for wall ties and foundation.

Keep any chases for services to a minimum and fill well with mortar.

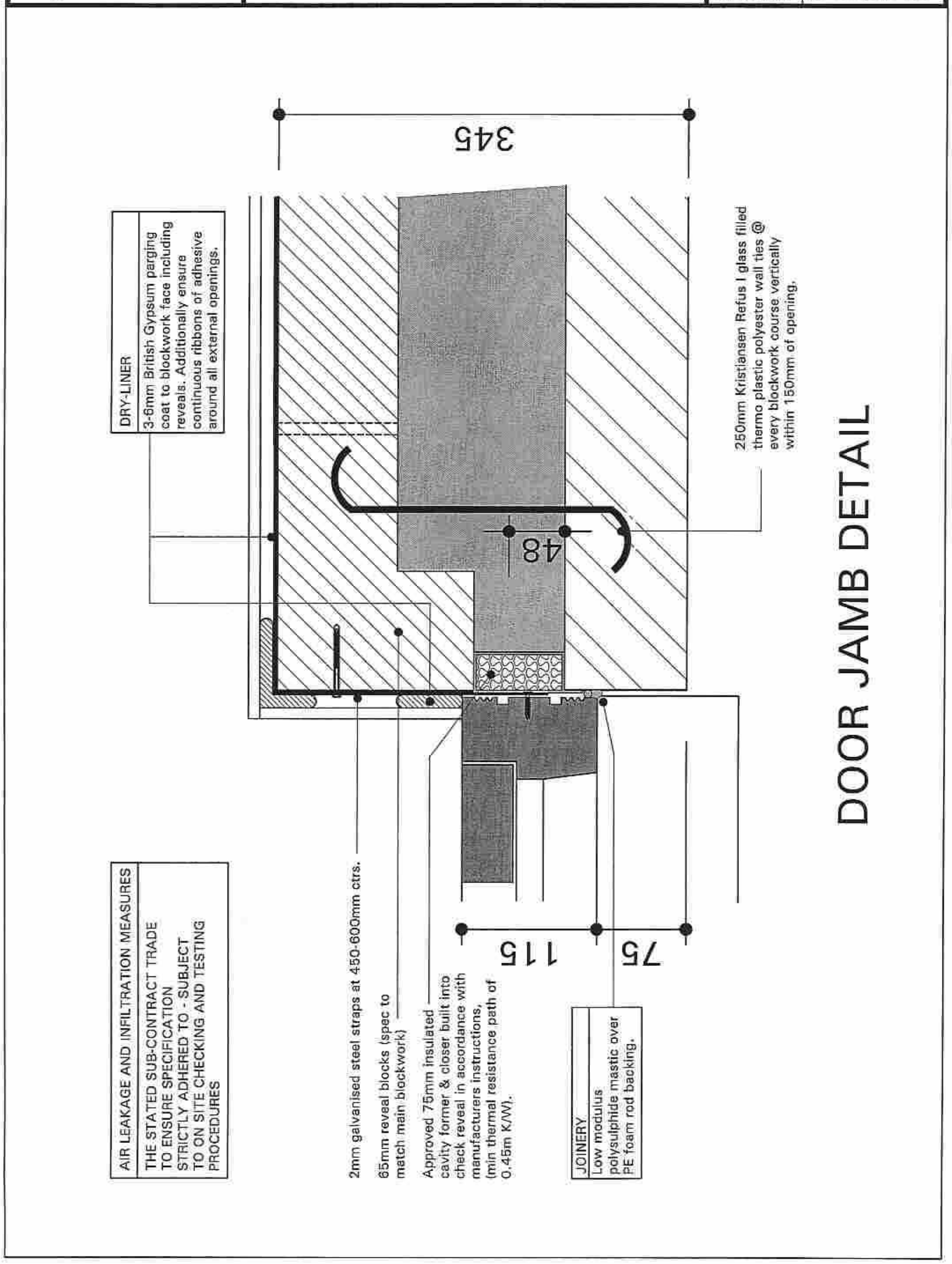
Ensure that render is applied to the complete face of each leaf with a scratch finish.

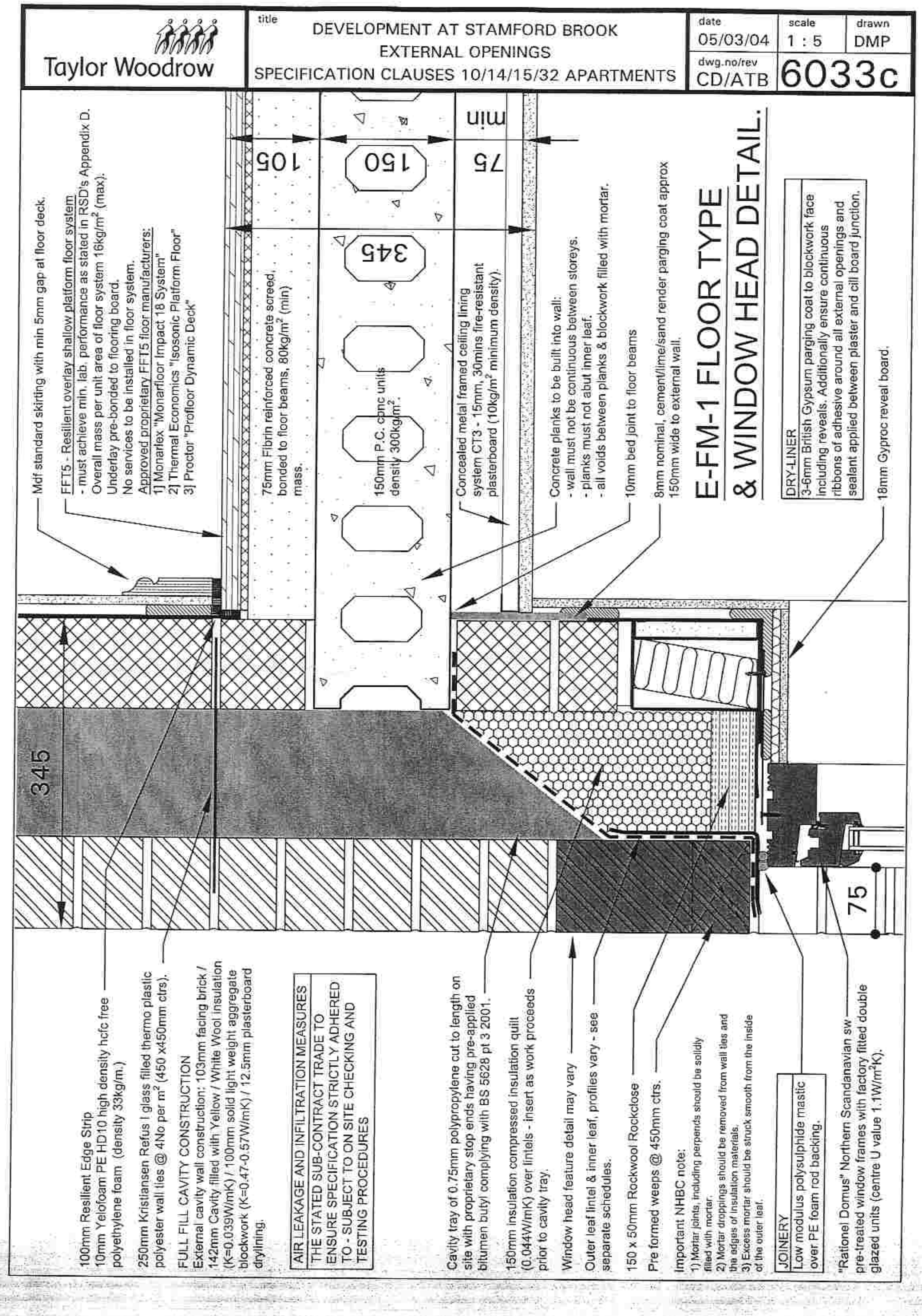


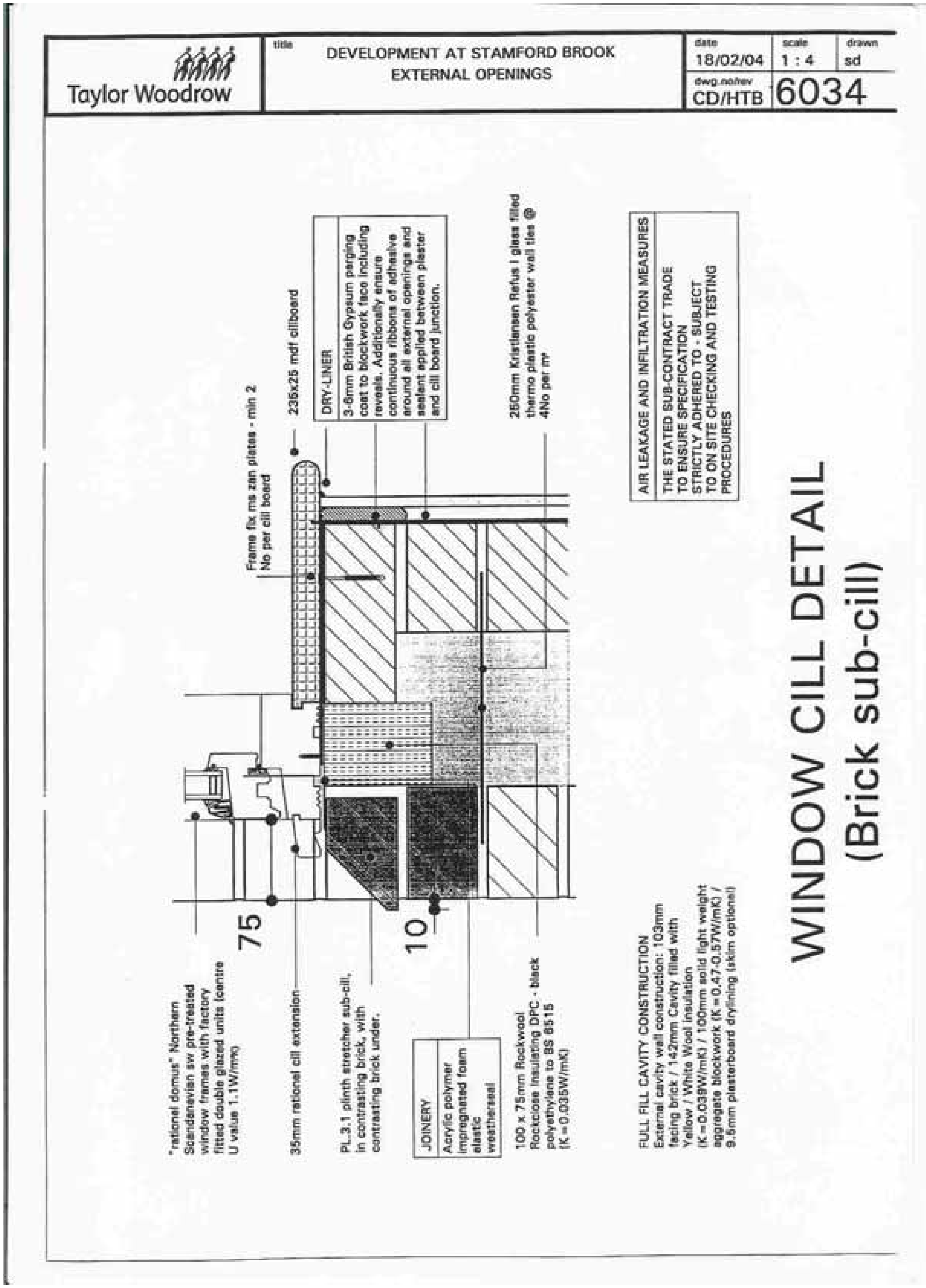
Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
SPEC CLAUSES 10/14/15/32 HOUSES & APARTMENTS
date
05/03/04
scale
1 : 4
drawn
dmp
dwg.no/rev
CD/HTB
6030b
345
48
115
75
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ every blockwork course vertically within 150mm of opening.
Stone cill projection when specified
WINDOW JAMB DETAIL
(ventilation plate)
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
235x25 mdf cillboard
2mm galvanised steel straps at 450-600mm ctrs.
65mm reveal blocks (spec to match main blockwork)
Approved 75mm insulated cavity former & closer built into check reveal in accordance with manufacturers instructions. (min thermal resistance path of 0.45m K/W).
JOINERY
Low modulus polysulphide mastic over PE foam rod backing.
"Rational Domus" Northern Scandinavian sw pre-treated window frames with factory fitted double glazed units (centre U-value 1.1W/m²K) - 3000mm² equivalent area background ventilation operating plates to one jamb per window (min window height 948mm).


Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
SPECIFICATION CLAUSES 10/14/15/32 HOUSES
date 05/03/04
scale 1 : 6
drawn DMP
dwg.no/rev CD/HTB 6031c
345
65
241
75
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 12.5mm plasterboard drylining in conjuction with separating walls, otherwise 9.5mm plasterboard drylining to detached houses.
150mm insulation compressed insulation quilt (0.044W/mK) over lintels - insert as work proceeds prior to cavity tray.
Pre formed weeps @ 450mm ctrs
Window head feature detail may vary
JOINERY
Low modulus polysulphide mastic over PE foam rod backing.
Important NHBC note:
1) Mortar joints, including perpends should be solidly filled with mortar.
2) Mortar droppings should be removed from wall ties and the edges of insulation materials.
3) Excess mortar should be struck smooth from the inside of the outer leaf.
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m² (450 x450mm ctrs)
Pre-creased cavity tray of 0.75mm polypropylene cut to length on site with proprietary stop ends having pre-applied bitumen butyl complying with BS 5628 pt 3 2001
150 x 50mm Rockwool Rockclose
Catnic CN94/95/96/ series outer leaf lintel & CN71/81 inner leaf (or equal approved)
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
"Rationel Domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U-value 1.1W/m²K).
WINDOW HEAD DETAIL

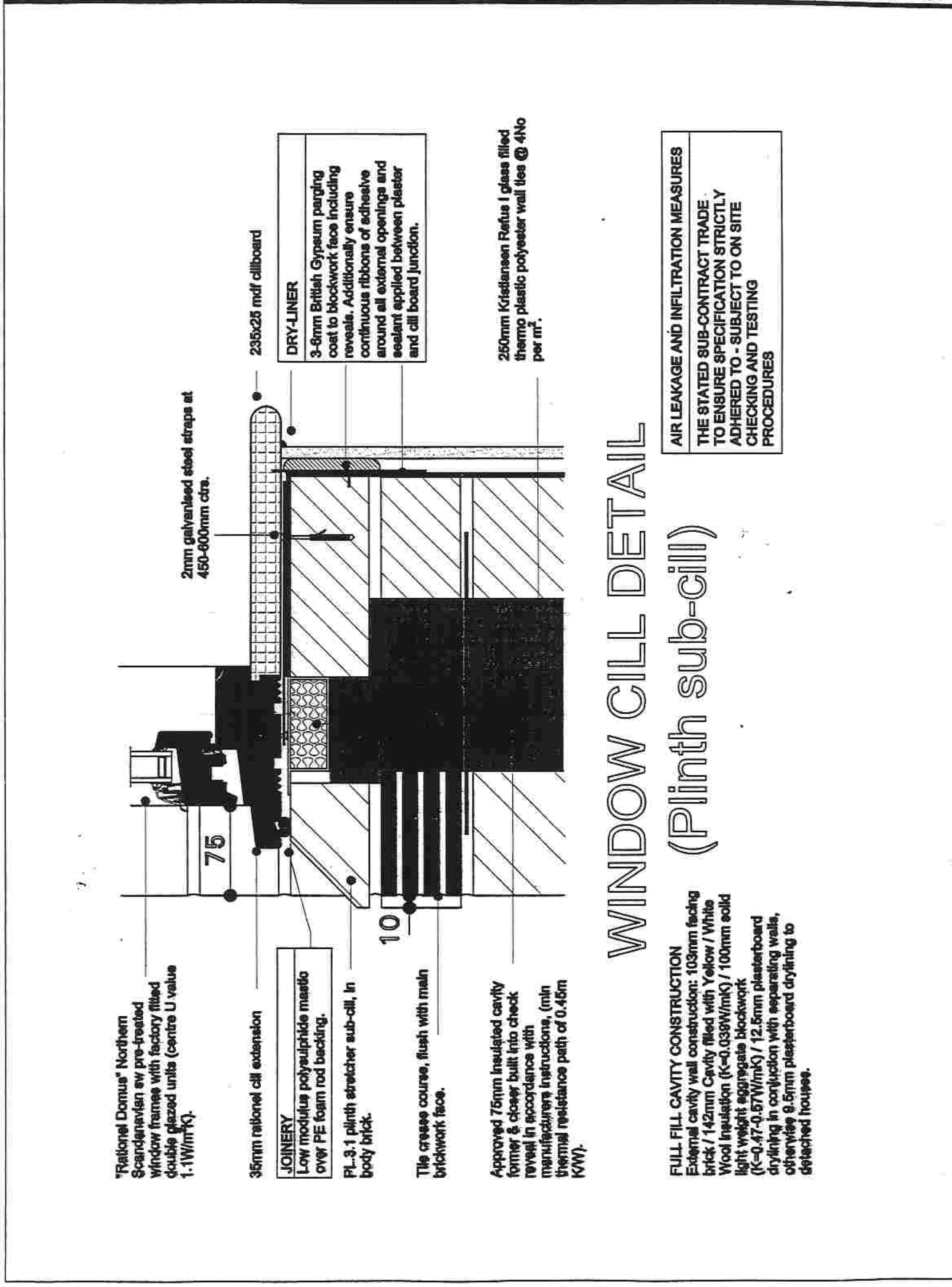
	title	date	scale	drawn
Taylor Woodrow	DEVELOPMENT AT STAMFORD BROOK EXTERNAL OPENINGS SPECIFICATION CLAUSES 10/14/15/32 HOUSES	05/03/04	1 : 4	DMP
		dwg.no/rev CD/HTB	6032b	

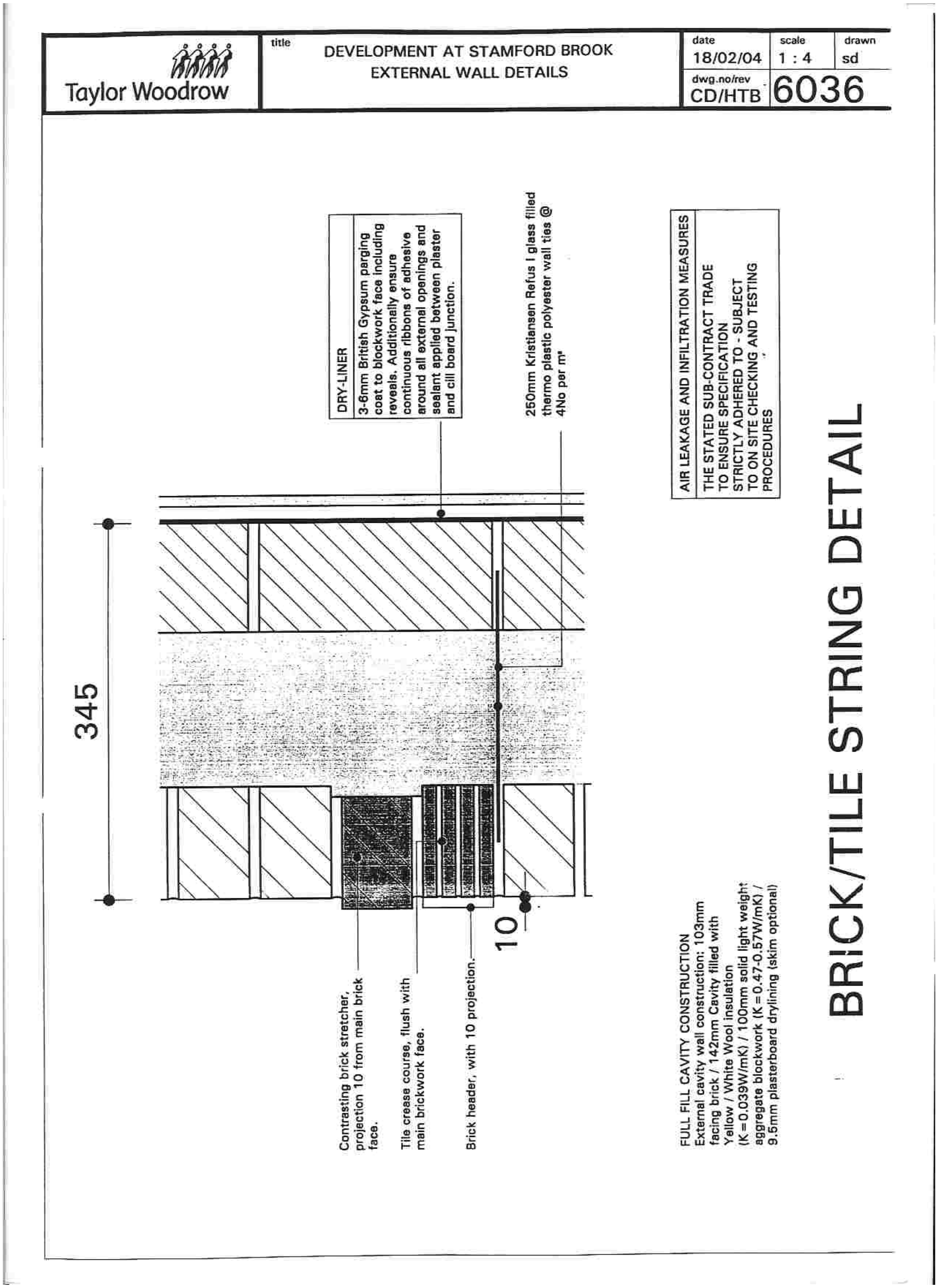


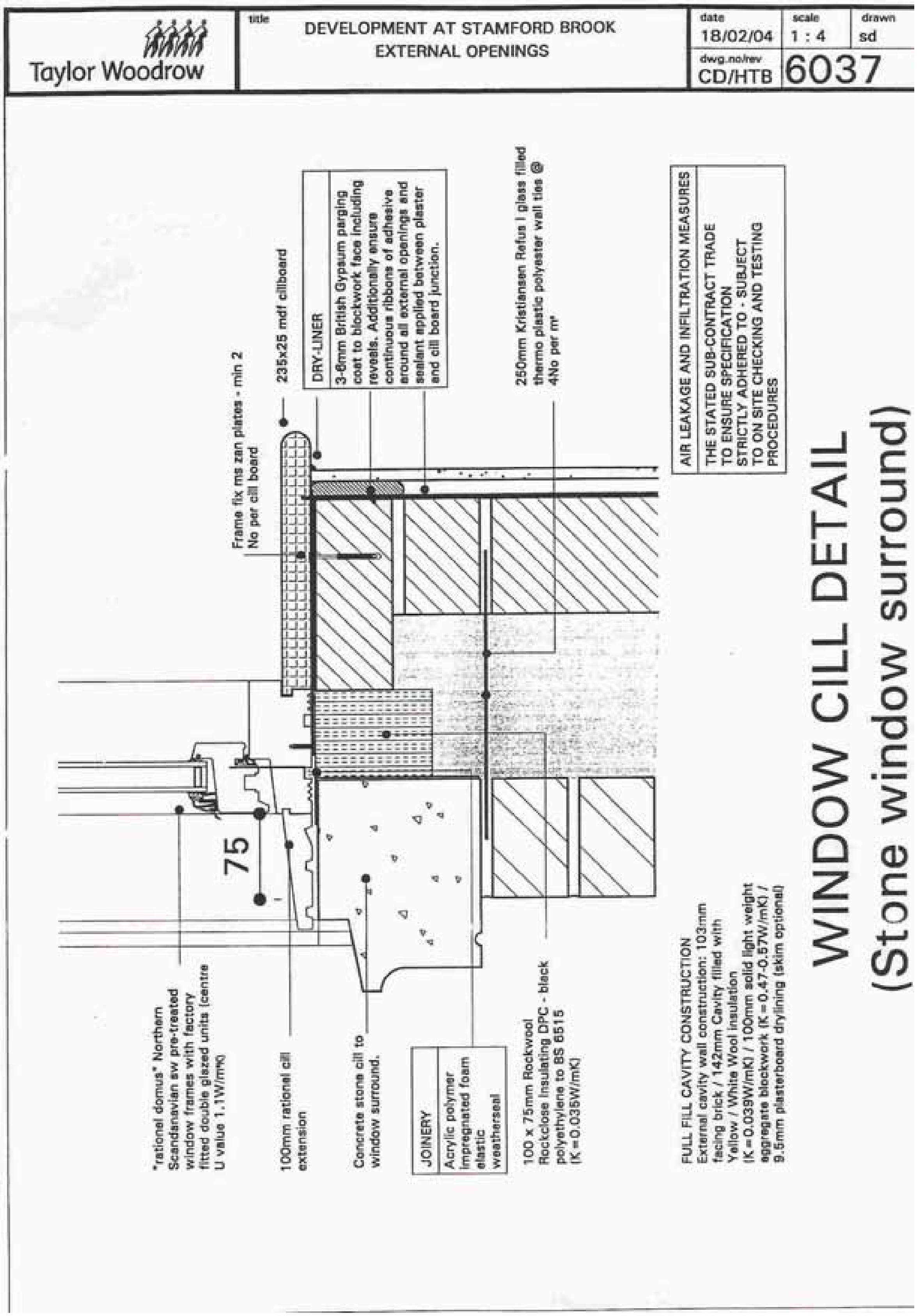

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
SPECIFICATION CLAUSES 10/14/15/32 APARTMENTS
date
05/03/04
scale
1 : 5
drawn
DMP
dwg.no/rev
CD/ATB
6033c
105
150
75
min
345
345
75
Mdf standard skirting with min 5mm gap at floor deck.
FFT5 - Resilient overlay shallow platform floor system
- must achieve min. lab. performance as stated in RSD's Appendix D.
Overall mass per unit area of floor system 16kg/m² (max).
Underlay pre-bonded to flooring board.
No services to be installed in floor system.
Approved proprietary FFT5 floor manufacturers:
1] Monarflex "Monarfloor Impact 18 System"
2] Thermal Economics "Isosonic Platform Floor"
3] Proctor "Profloor Dynamic Deck"
75mm Fibrin reinforced concrete screed, bonded to floor beams, 80kg/m² (min) mass.
150mm P.C. conc units density 300kg/m².
Concealed metal framed ceiling lining system CT3 - 15mm, 30mins fire-resistant plasterboard (10kg/m² minimum density).
Concrete planks to be built into wall:
- wall must not be continuous between storeys.
- planks must not abut inner leaf.
- all voids between planks & blockwork filled with mortar.
10mm bed joint to floor beams
8mm nominal, cement/lime/sand render parging coat approx 150mm wide to external wall.
E-FM-1 FLOOR TYPE
& WINDOW HEAD DETAIL.
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
18mm Gyproc reveal board.
100mm Resilient Edge Strip
10mm Yelofoam PE HD10 high density hcfc free polyethylene foam (density 33kg/m³)
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m² (450 x450mm ctrs).
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 12.5mm plasterboard drylining.
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
Cavity tray of 0.75mm polypropylene cut to length on site with proprietary stop ends having pre-applied bitumen butyl complying with BS 5628 pt 3 2001.
150mm insulation compressed insulation quilt (0.044W/mK) over lintels - insert as work proceeds prior to cavity tray.
Window head feature detail may vary
Outer leaf lintel & inner leaf, profiles vary - see separate schedules.
150 x 50mm Rockwool Rockclose
Pre formed weeps @ 450mm ctrs.
Important NHBC note:
1) Mortar joints, including perpends should be solidly filled with mortar.
2) Mortar droppings should be removed from wall ties and the edges of insulation materials.
3) Excess mortar should be struck smooth from the inside of the outer leaf.
JOINERY
Low modulus polysulphide mastic over PE foam rod backing.
"Rationel Domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K).

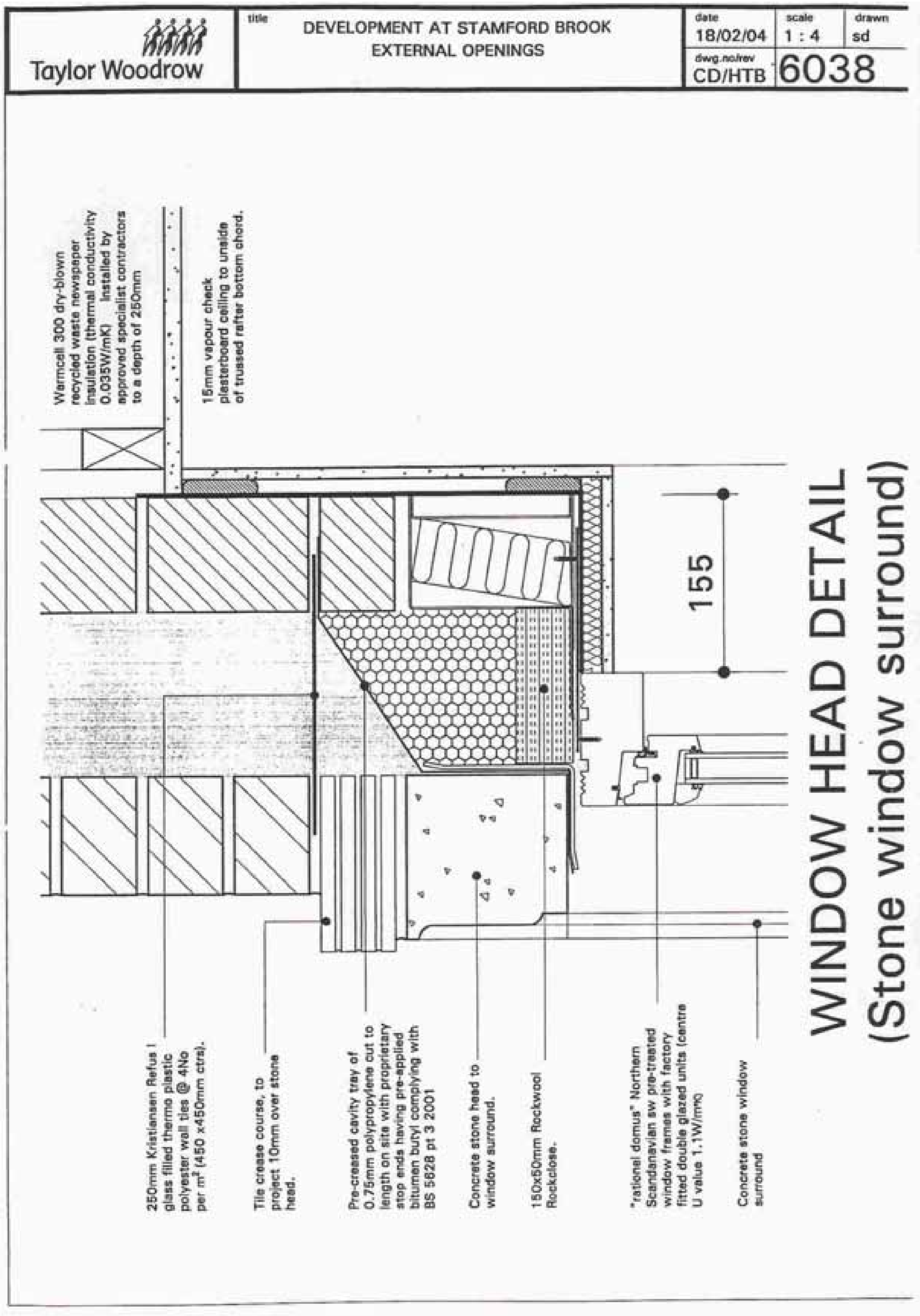

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
date 18/02/04
scale 1 : 4
drawn sd
dwg.no/rev CD/HTB 6034
WINDOW CILL DETAIL
(Brick sub-cill)
Frame fix ms zan plates - min 2 No per cill board
235x25 mdf cillboard
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m²
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
"rationel domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K)
75
35mm rationel cill extension
PL.3.1 plinth stretcher sub-cill, in contrasting brick, with contrasting brick under.
10
JOINERY
Acrylic polymer impregnated foam elastic weatherseal
100 x 75mm Rockwool Rockclose Insulating DPC - black polyethylene to BS 6515 (K=0.035W/mK)
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 9.5mm plasterboard drylining (skim optional)

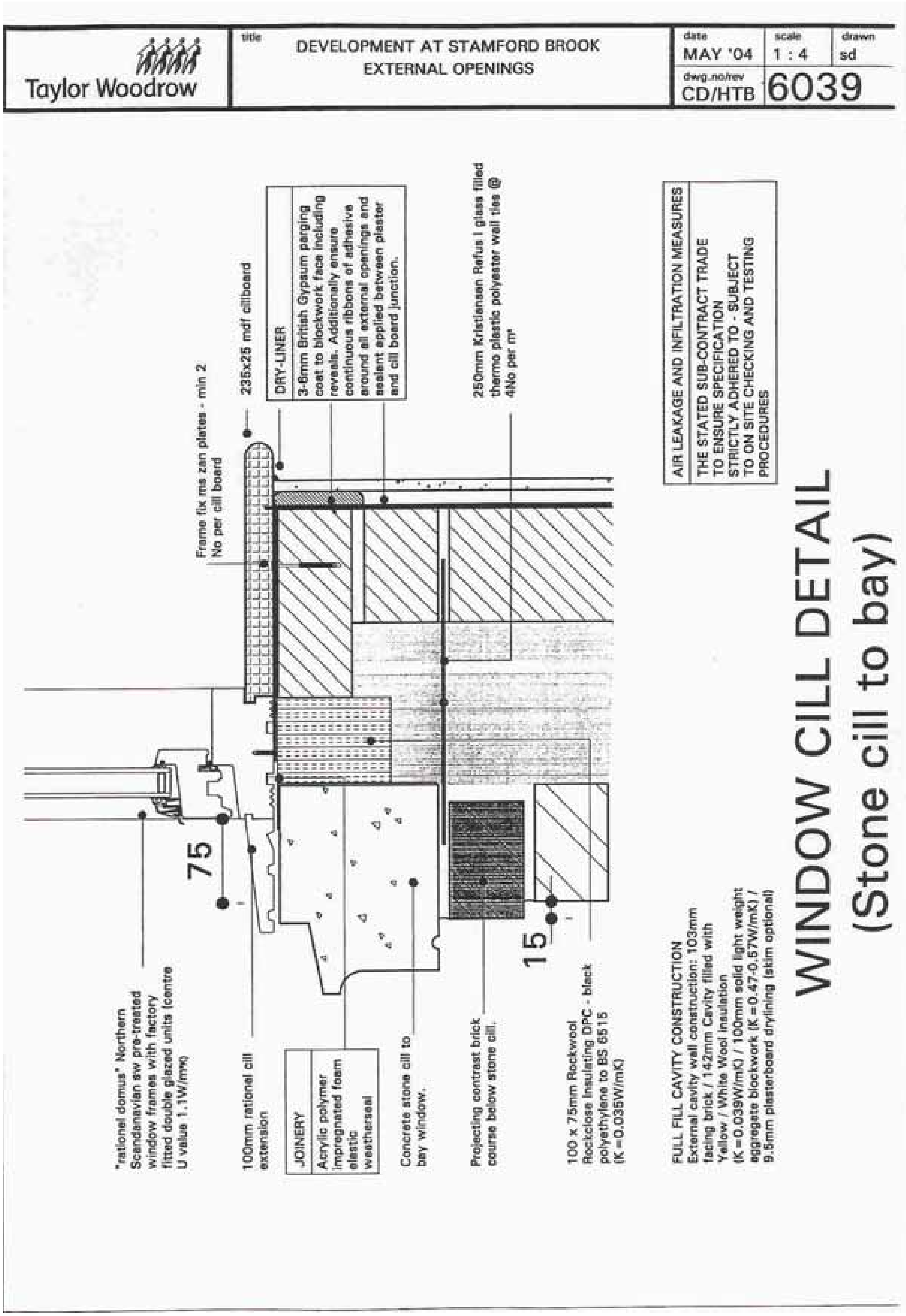
Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL OPENINGS SPECIFICATION CLAUSES 10/14/15/32 HOUSES	date: 05/03/04 dwg.no/rev: CD/HTB	scale: 1 : 4 6035	drawn: DMP a

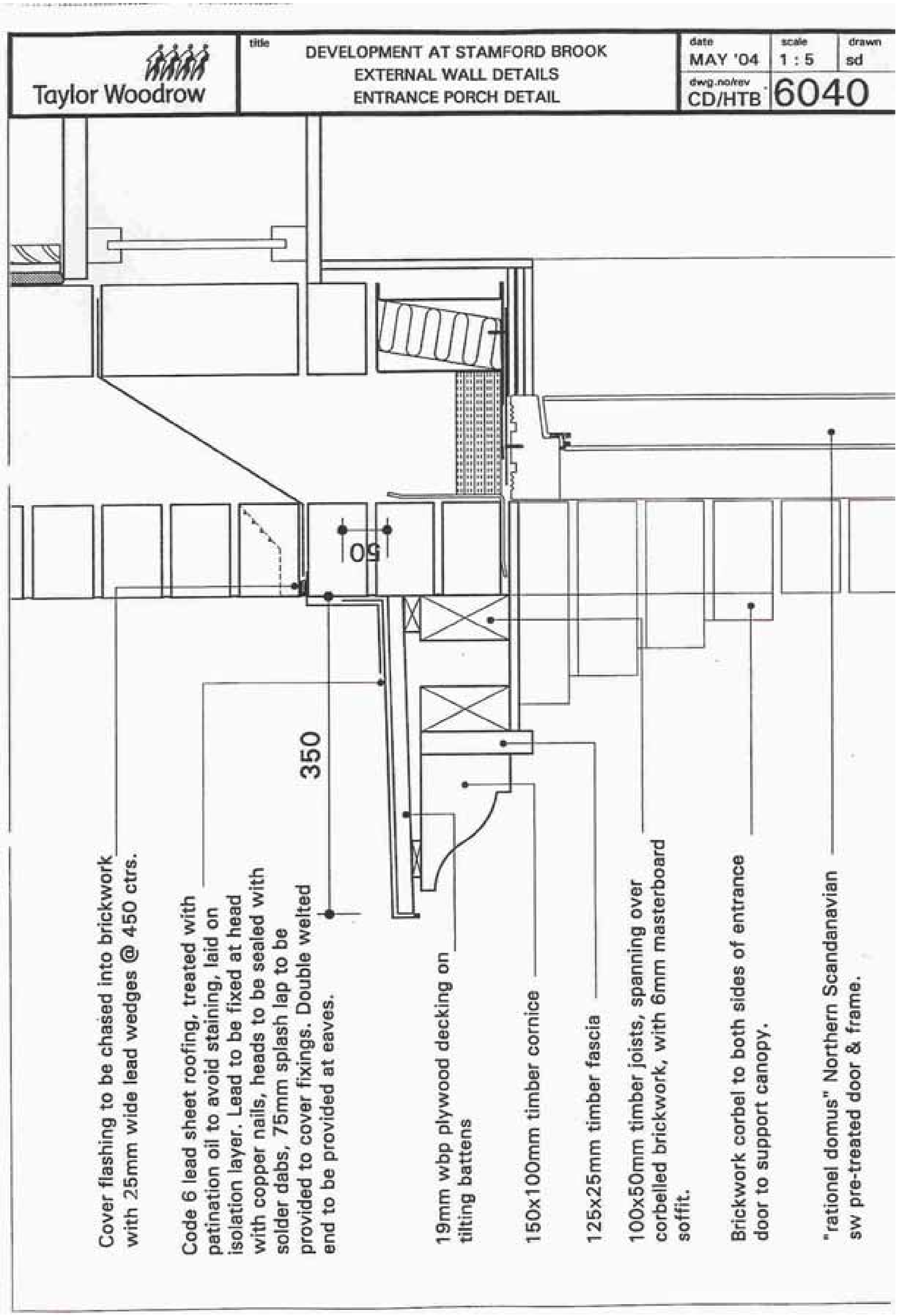



Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL WALL DETAILS
date
18/02/04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6036
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
250mm Kristiensen Refus I glass filled thermo plastic polyester wall ties @ 4No per m²
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
345
10
Contrasting brick stretcher, projection 10 from main brick face.
Tile crease course, flush with main brickwork face.
Brick header, with 10 projection.
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K = 0.039W/mK) / 100mm solid light weight aggregate blockwork (K = 0.47-0.57W/mK) / 9.5mm plasterboard drylining (skim optional)
BRICK/TILE STRING DETAIL


Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
date
18/02/04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6037
Frame fix ms zan plates - min 2 No per cill board
235x25 mdf cillboard
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
250mm Kristiansen Rafus I glass filled thermo plastic polyester wall ties @ 4No per m²
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
75
"rational domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K)
100mm rational cill extension
Concrete stone cill to window surround.
JOINERY
Acrylic polymer impregnated foam elastic weatherseal
100 x 75mm Rockwool Rockclose Insulating DPC - black polyethylene to BS 6515 (K=0.035W/mK)
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 9.5mm plasterboard drylining (skim optional)
WINDOW CILL DETAIL
(Stone window surround)

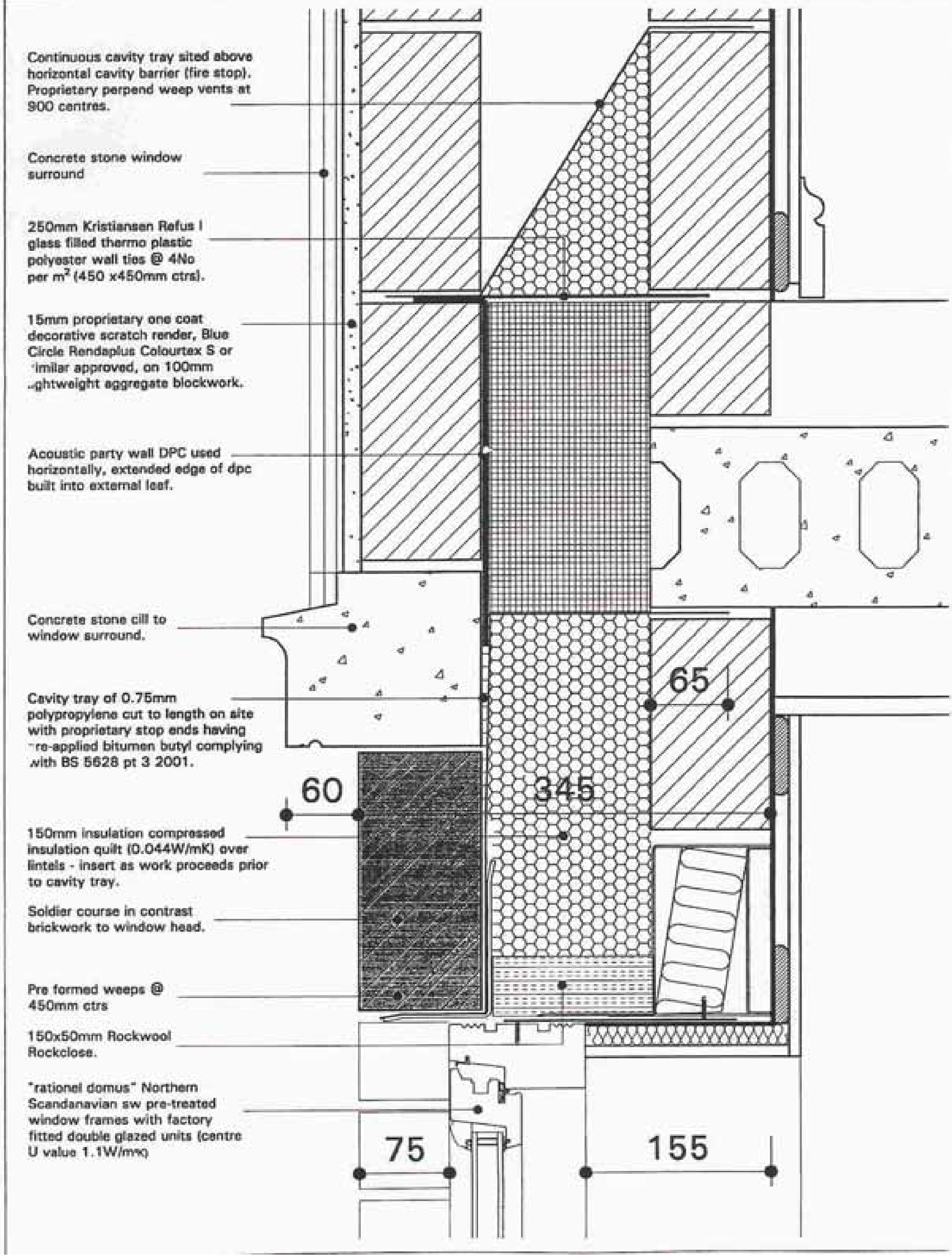

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
date
18/02/04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6038
Warmcell 300 dry-blown recycled waste newspaper insulation (thermal conductivity 0.035W/mK) Installed by approved specialist contractors to a depth of 250mm
15mm vapour check plasterboard ceiling to unside of trussed rafter bottom chord.
155
WINDOW HEAD DETAIL
(Stone window surround)
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m² (450 x450mm ctrs).
Tile crease course, to project 10mm over stone head.
Pre-creased cavity tray of 0.75mm polypropylene cut to length on site with proprietary stop ends having pre-applied bitumen butyl complying with BS 5628 pt 3 2001
Concrete stone head to window surround.
150x50mm Rockwool Rockclose.
"rational domus" Northern Scandinavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K)
Concrete stone window surround

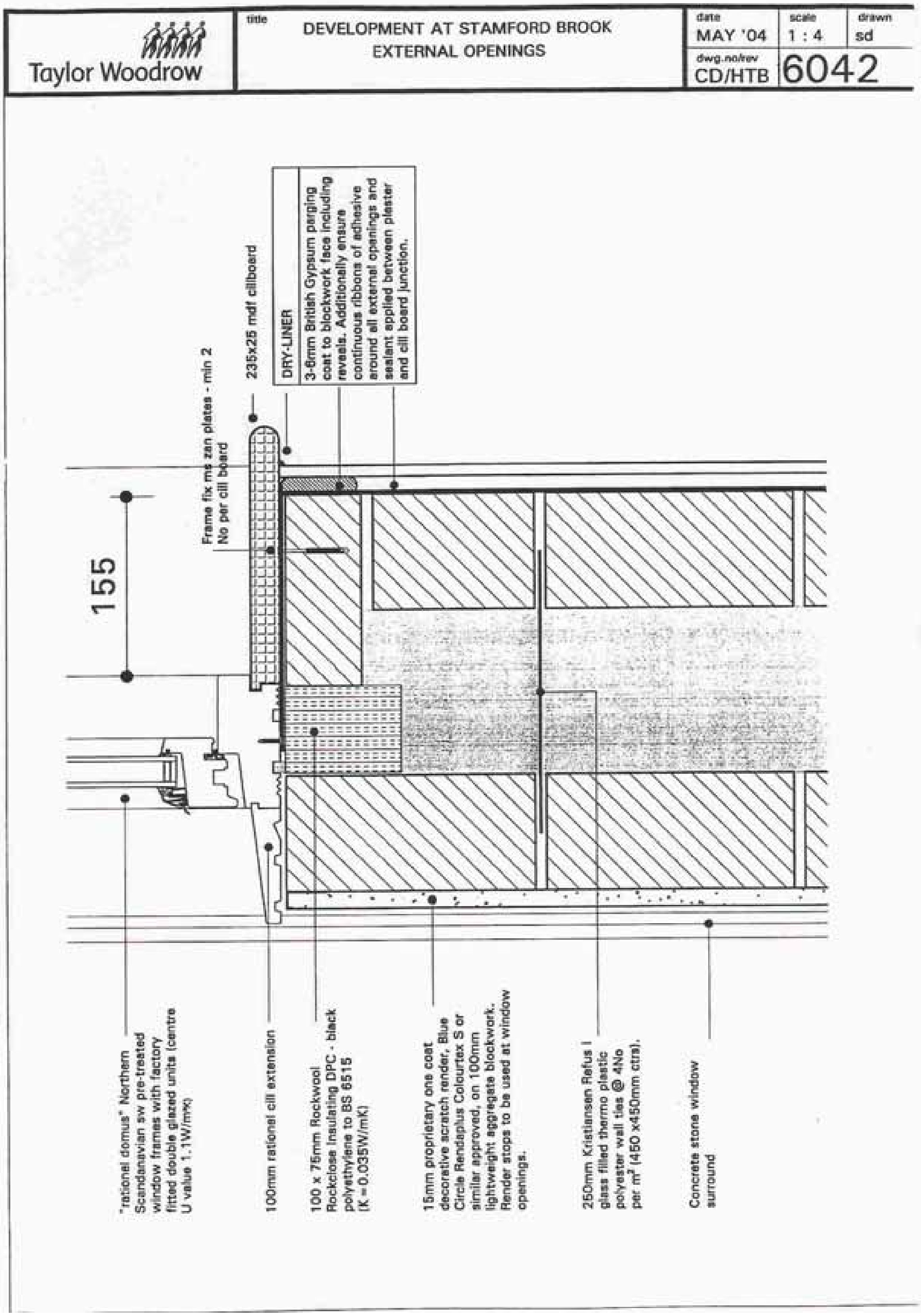

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
date
MAY '04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6039
Frame fix ms zan plates - min 2 No per cill board
235x25 mdf cillboard
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m²
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
"rationel domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K)
75
15
100mm rationel cill extension
JOINERY
Acrylic polymer impregnated foam elastic weatherseal
Concrete stone cill to bay window.
Projecting contrast brick course below stone cill.
100 x 75mm Rockwool Rockclose Insulating DPC - black polyethylene to BS 6515 (K =0.035W/mK)
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 9.5mm plasterboard drylining (skim optional)
WINDOW CILL DETAIL
(Stone cill to bay)

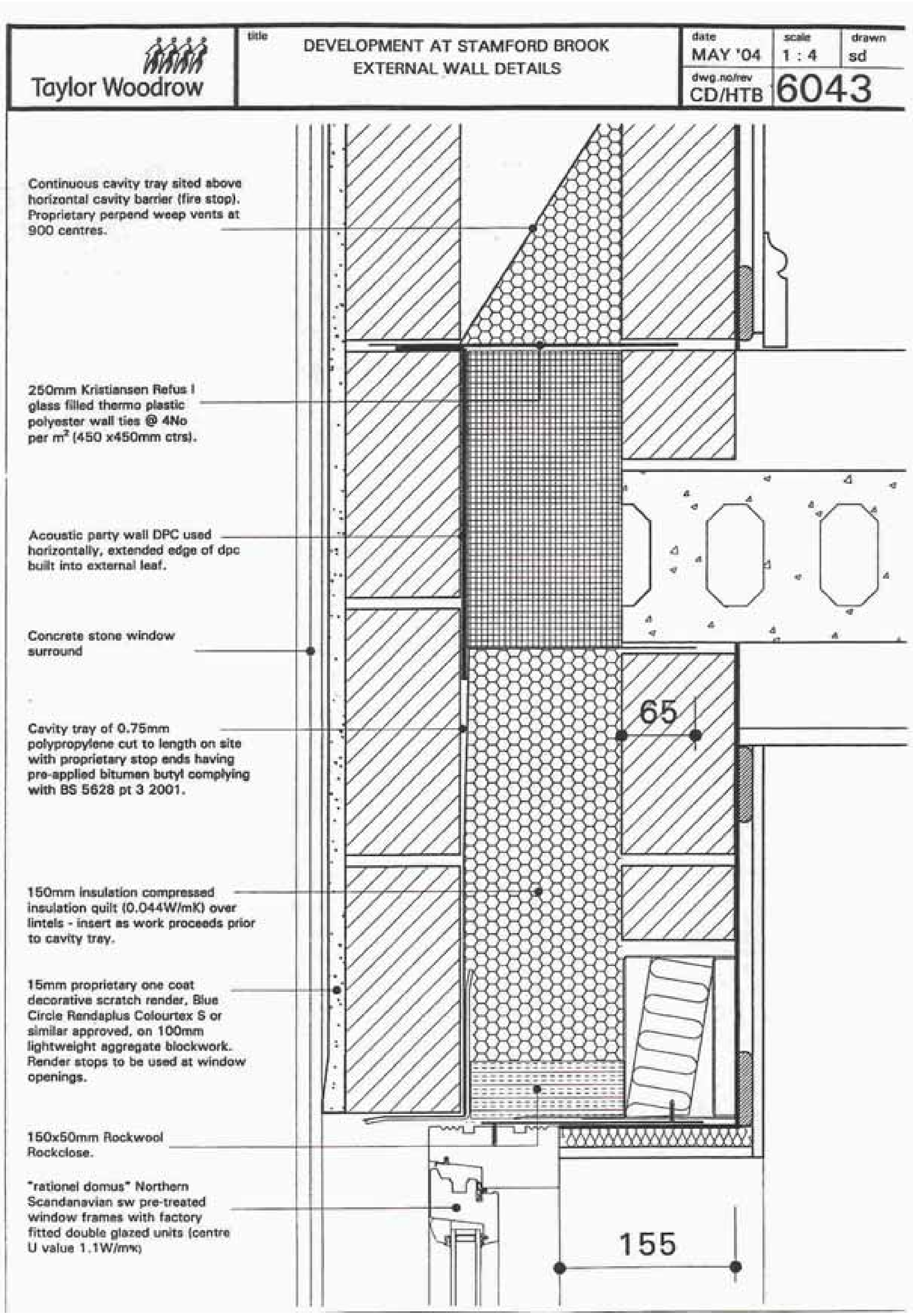

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL WALL DETAILS
ENTRANCE PORCH DETAIL
date
MAY '04
scale
1 : 5
drawn
sd
dwg.no/rev
CD/HTB
6040
50
350
Cover flashing to be chased into brickwork with 25mm wide lead wedges @ 450 ctrs.
Code 6 lead sheet roofing, treated with patination oil to avoid staining, laid on isolation layer. Lead to be fixed at head with copper nails, heads to be sealed with solder dabs, 75mm splash lap to be provided to cover fixings. Double welted end to be provided at eaves.
19mm wbp plywood decking on tilting battens
150x100mm timber cornice
125x25mm timber fascia
100x50mm timber joists, spanning over corbelled brickwork, with 6mm masterboard soffit.
Brickwork corbel to both sides of entrance door to support canopy.
"rationel domus" Northern Scandanavian sw pre-treated door & frame.

Taylor Woodrow

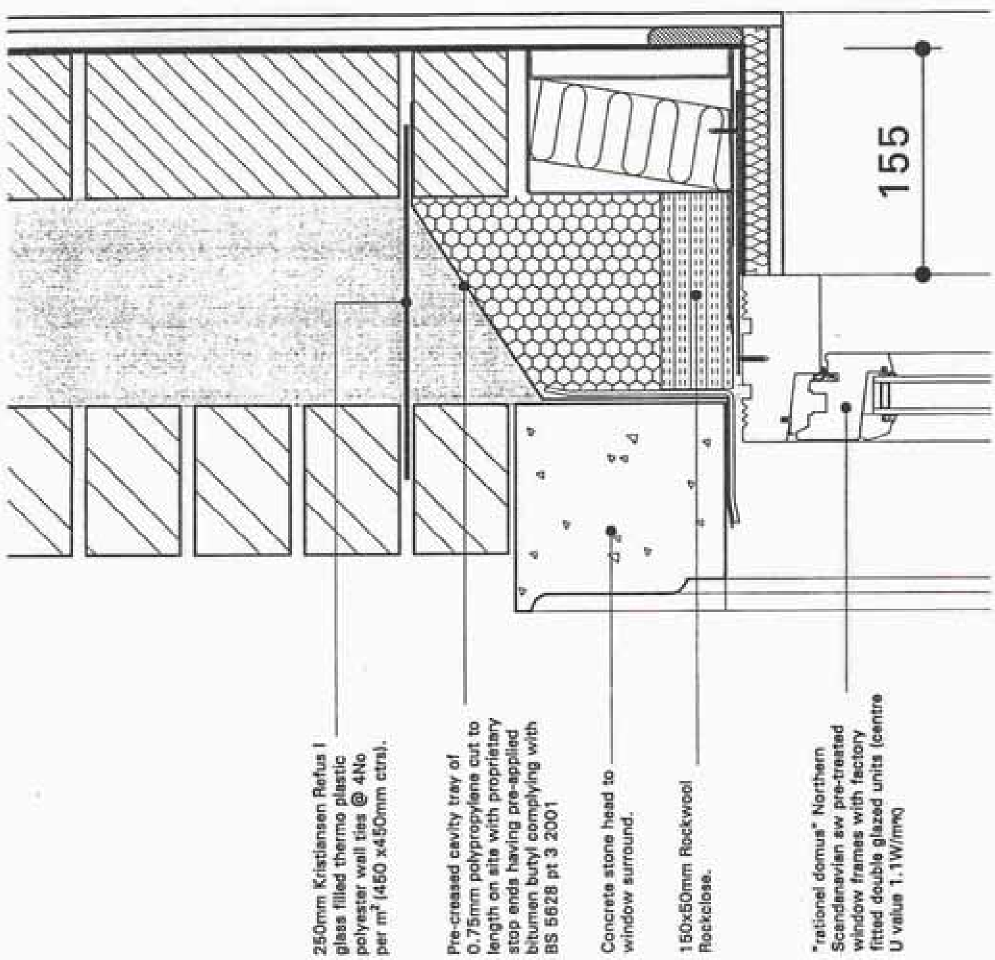
title	date	scale	drawn
DEVELOPMENT AT STAMFORD BROOK EXTERNAL WALL DETAILS	MAY '04	1 : 4	sd
	dwg.no/rev CD/HTB	6041	



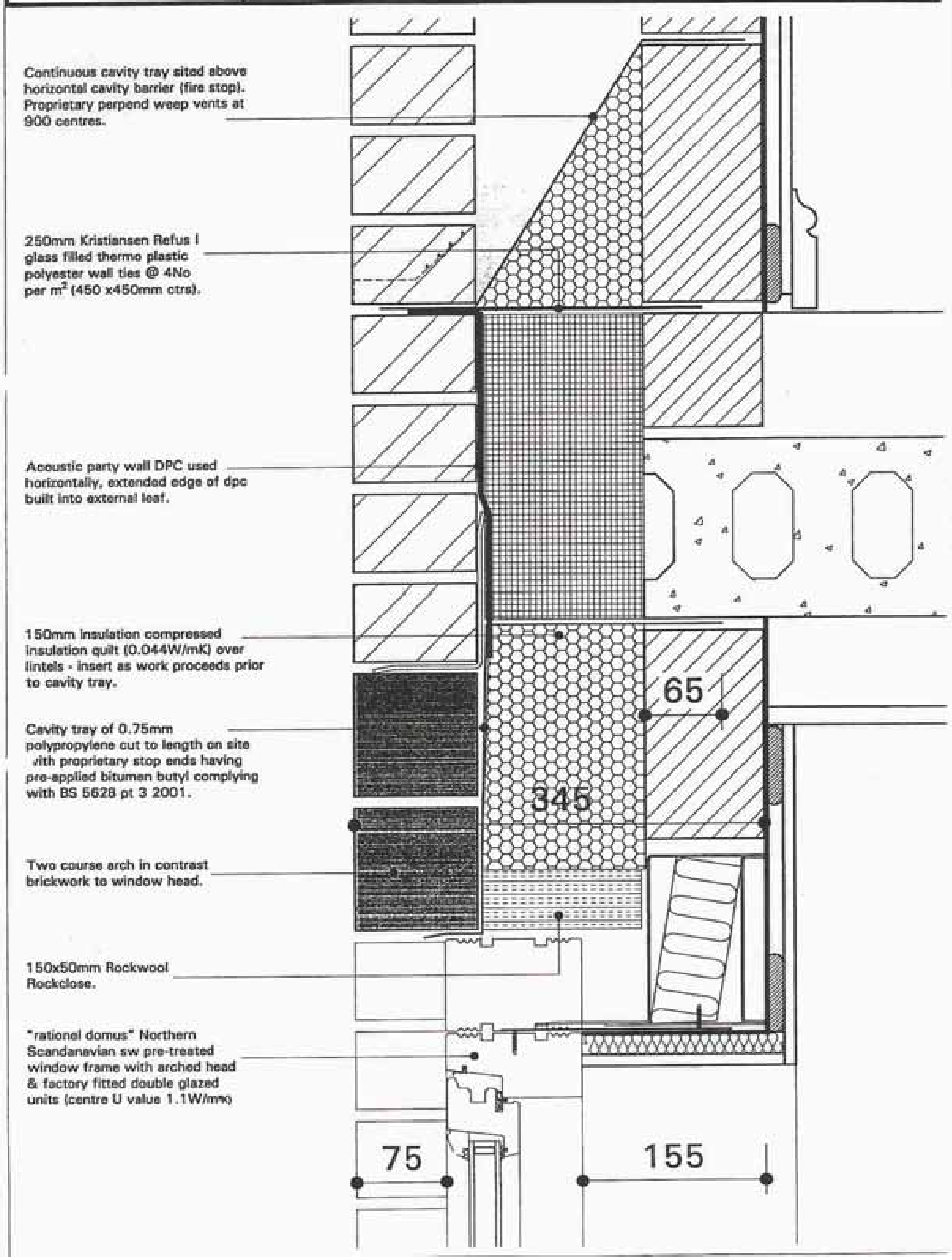

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
date
MAY '04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB 6042
235x25 mdf cillboard
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
Frame fix ms zan plates - min 2 No per cill board
155
"rational domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K)
100mm rational cill extension
100 x 75mm Rockwool Rockclose Insulating DPC - black polyethylene to BS 6515 (K=0.035W/mK)
15mm proprietary one coat decorative scratch render, Blue Circle Rendaplus Colourtex S or similar approved, on 100mm lightweight aggregate blockwork. Render stops to be used at window openings.
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m² (450 x450mm ctrs).
Concrete stone window surround

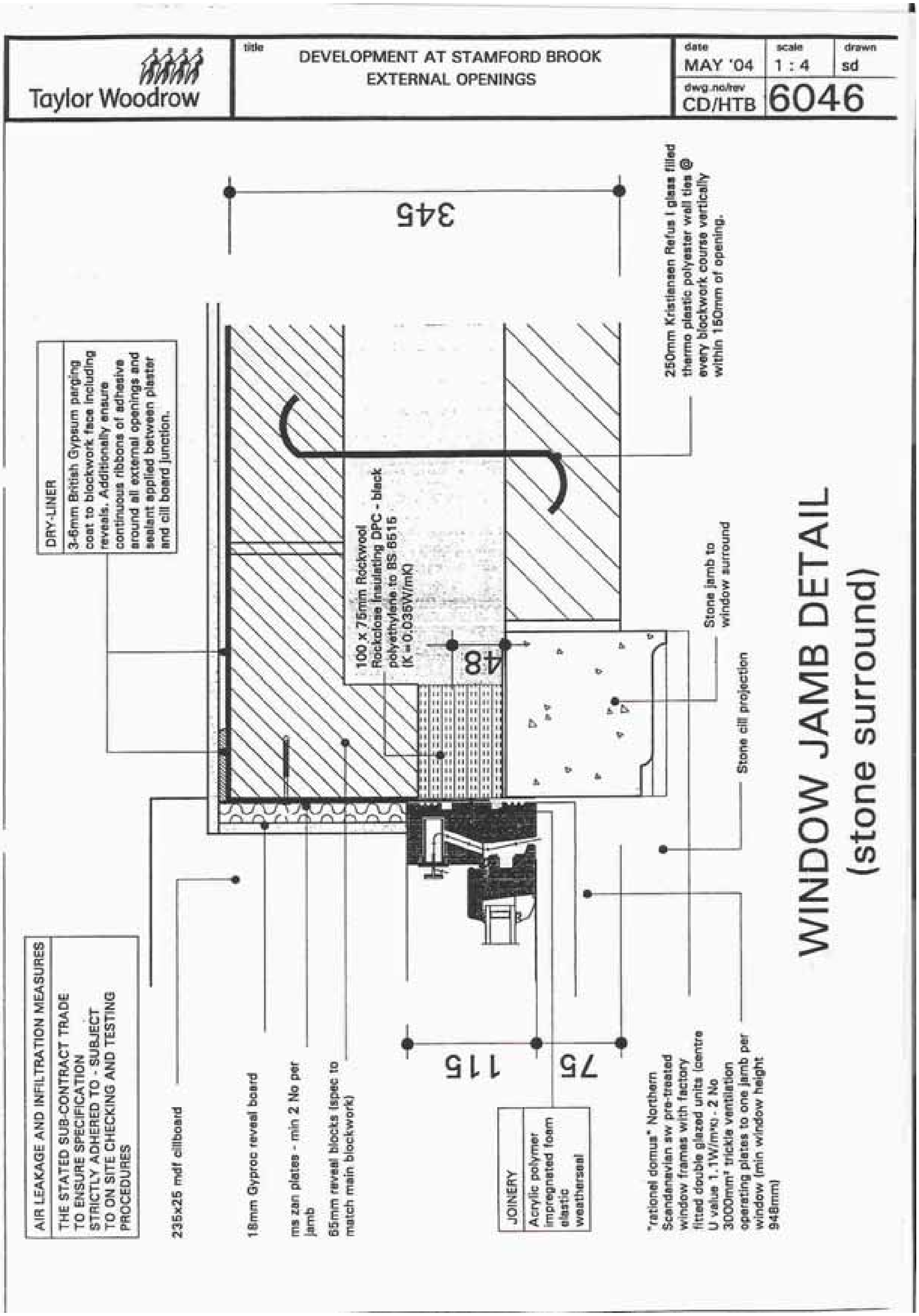

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL WALL DETAILS
date
MAY '04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6043
Continuous cavity tray sited above horizontal cavity barrier (fire stop). Proprietary perpend weep vents at 900 centres.
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ 4No per m² (450 x450mm ctrs).
Acoustic party wall DPC used horizontally, extended edge of dpc built into external leaf.
Concrete stone window surround
Cavity tray of 0.75mm polypropylene cut to length on site with proprietary stop ends having pre-applied bitumen butyl complying with BS 5628 pt 3 2001.
150mm insulation compressed insulation quilt (0.044W/mK) over lintels - insert as work proceeds prior to cavity tray.
15mm proprietary one coat decorative scratch render, Blue Circle Rendaplus Colourtex S or similar approved, on 100mm lightweight aggregate blockwork. Render stops to be used at window openings.
150x50mm Rockwool Rockclose.
"rationel domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K)
65
155

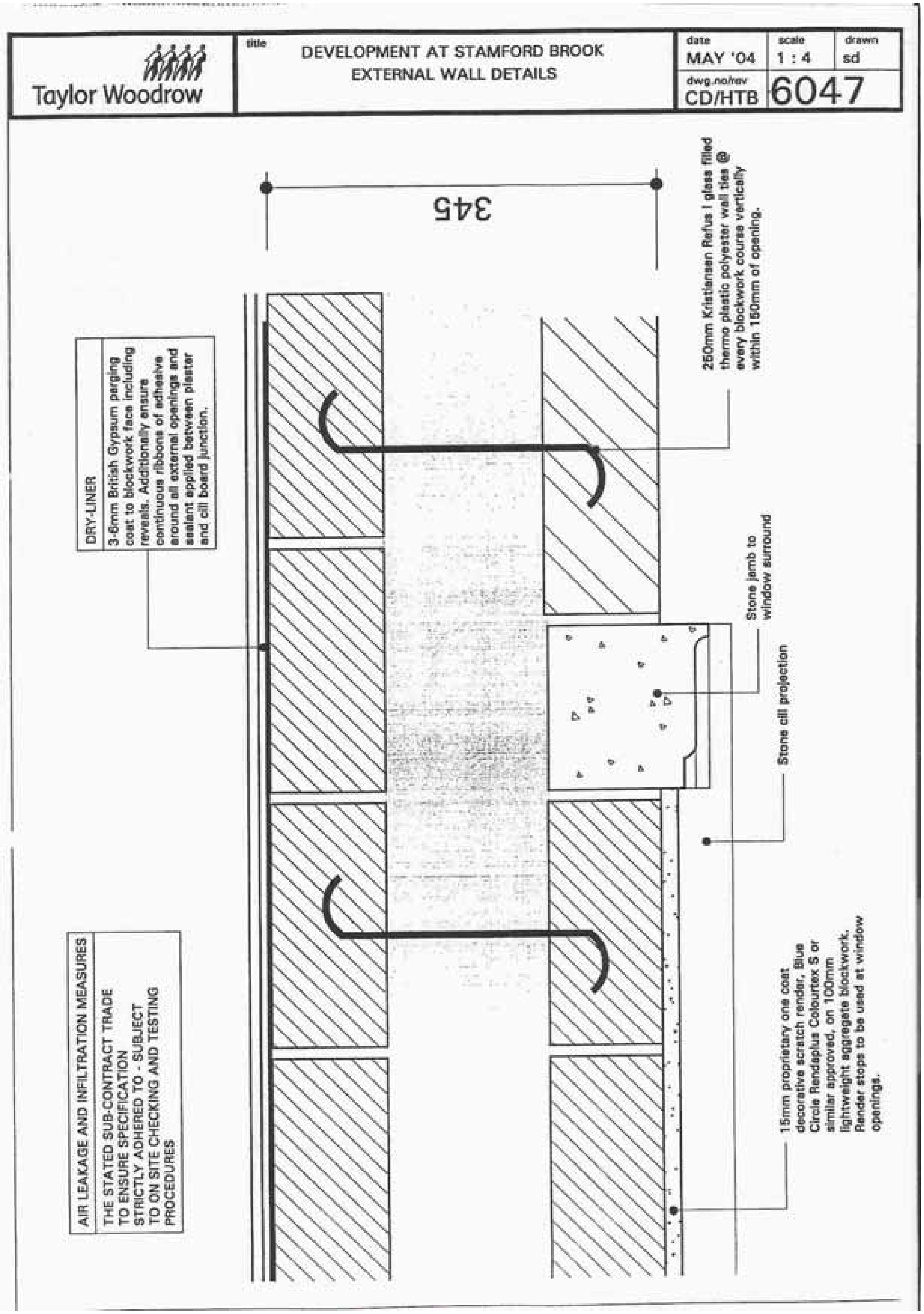
Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL OPENINGS	date: MAY '04	scale: 1 : 4	drawn: sd
		dwg.no/rev: CD/HTB	6044	

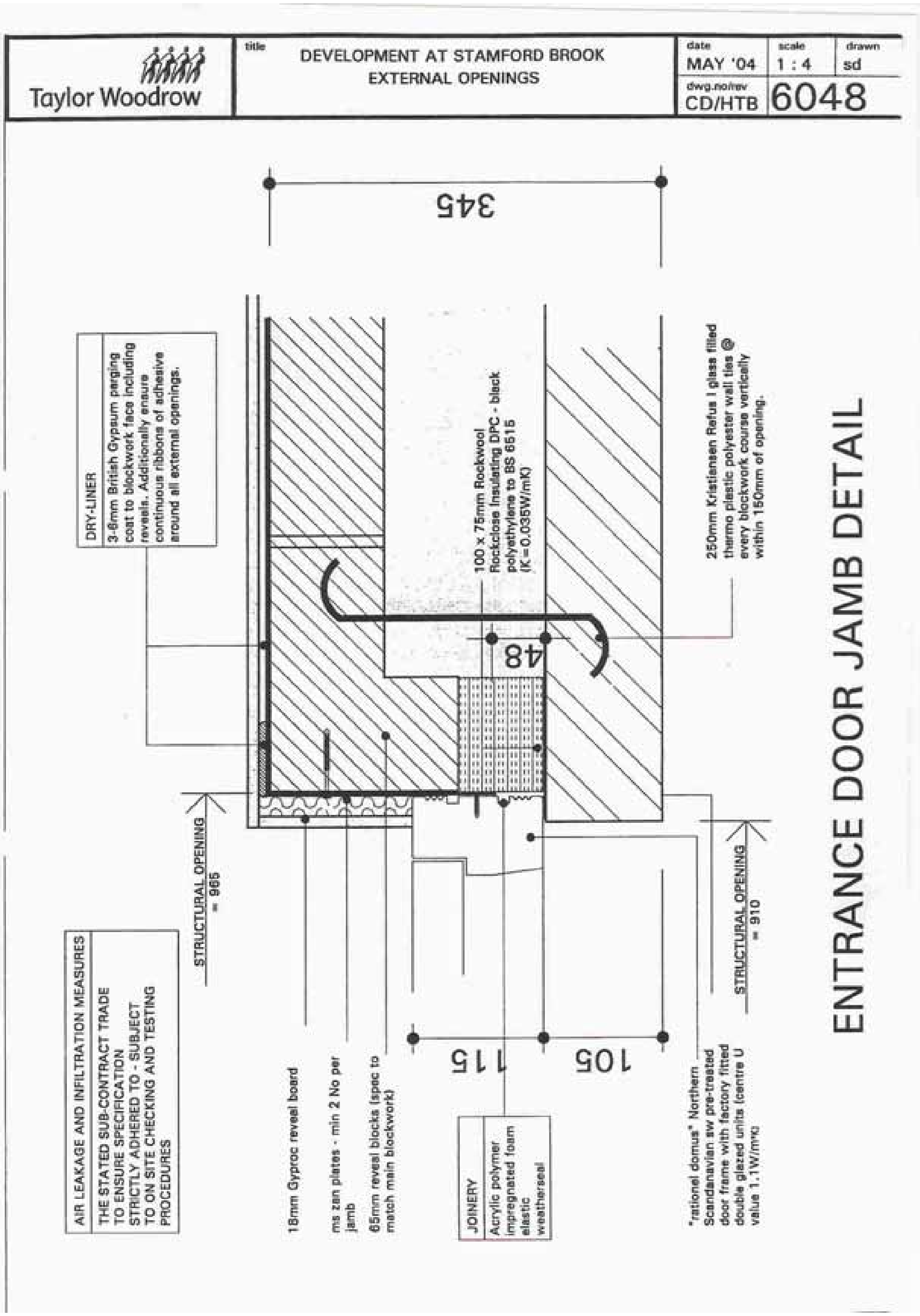


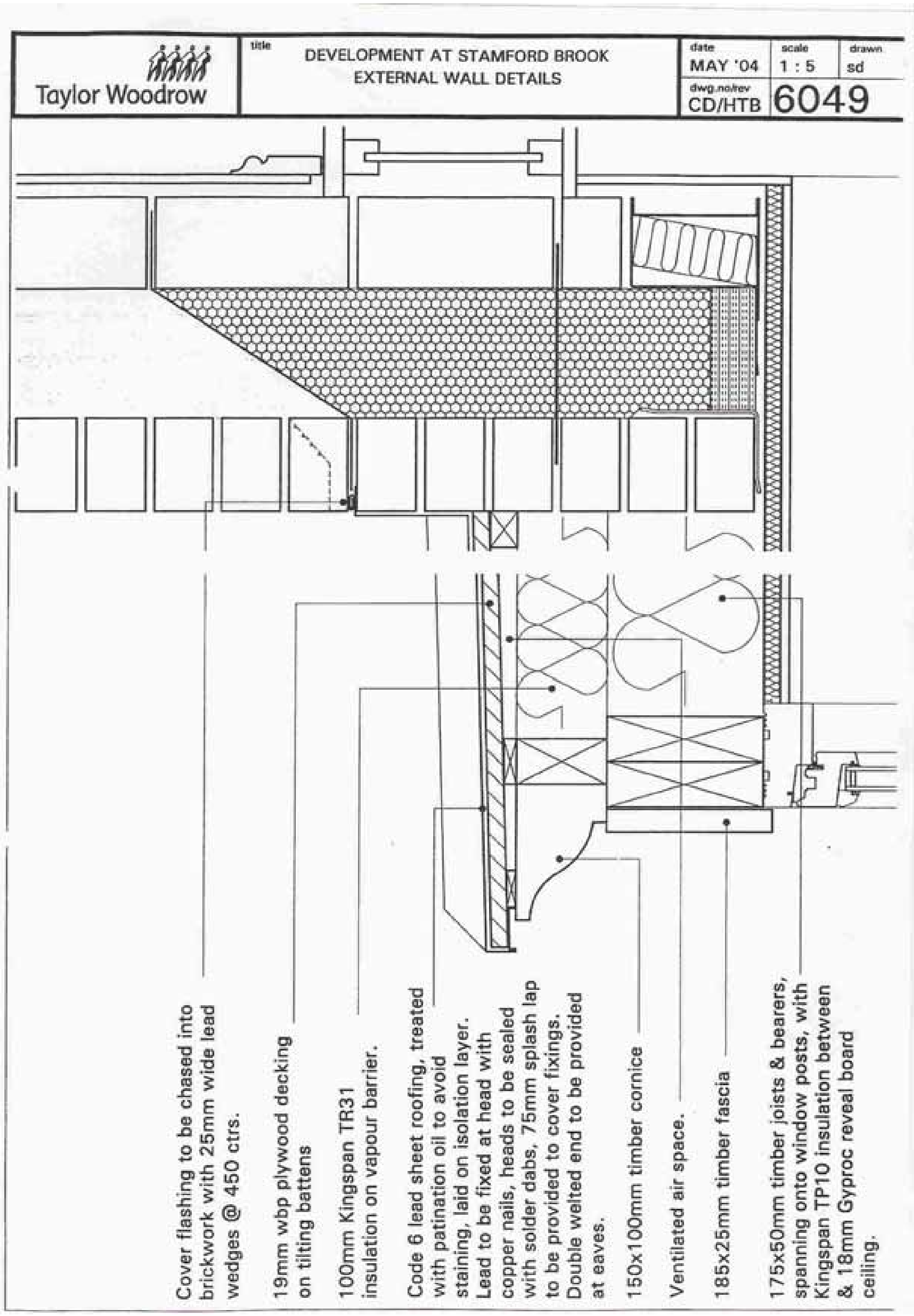
Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK EXTERNAL OPENINGS	date: MAY '04	scale: 1 : 4	drawn: sd
		dwg.no/rev: CD/HTB	6045	



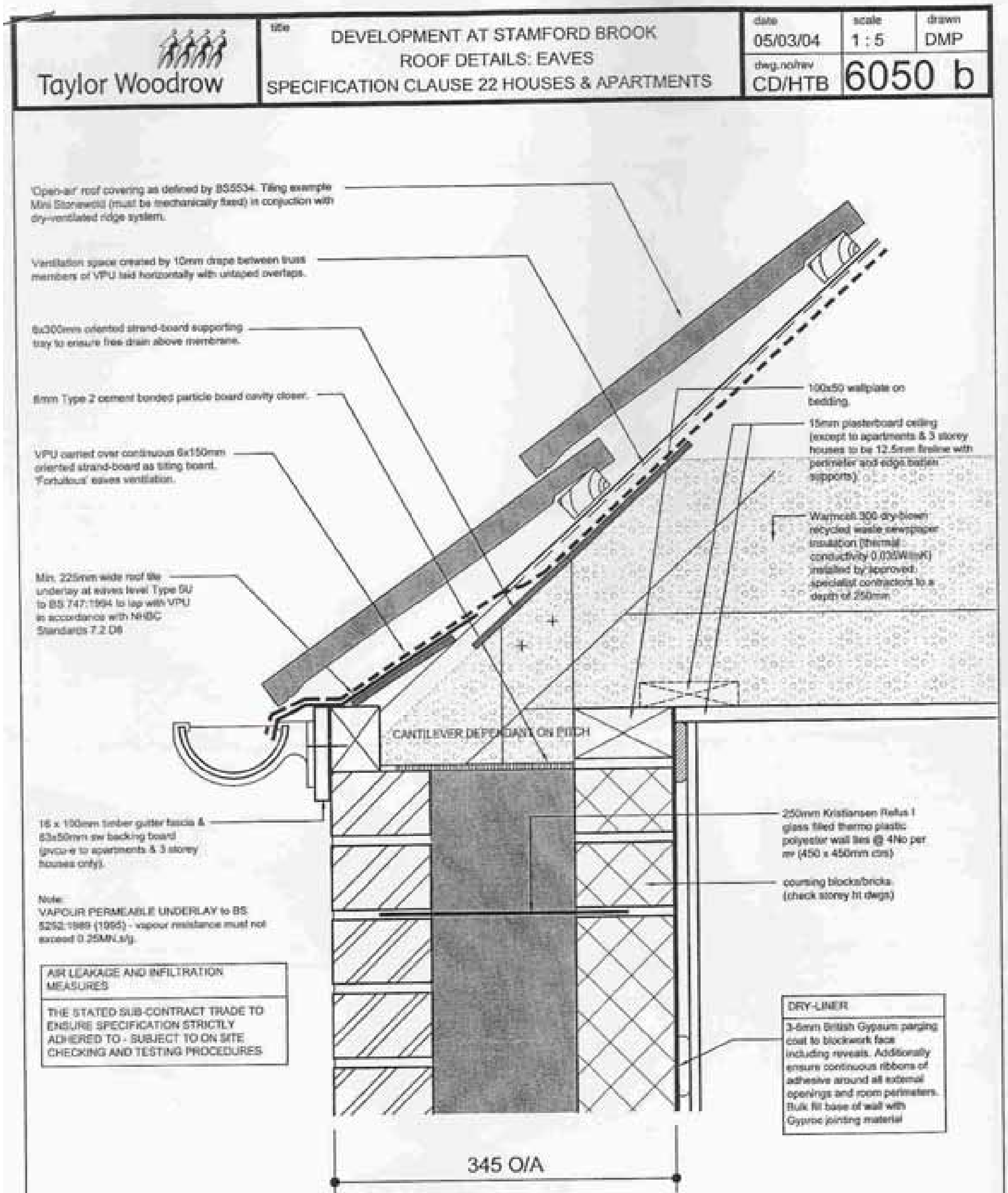

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
date
MAY '04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6046
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
235x25 mdf cillboard
18mm Gyproc reveal board
ms zan plates - min 2 No per jamb
65mm reveal blocks (spec to match main blockwork)
100 x 75mm Rockwool Rockclose Insulating DPC - black polyethylene to BS 6515 (K = 0.035W/mK)
345
115
48
75
JOINERY
Acrylic polymer impregnated foam elastic weatherseal
"rationel domus" Northern Scandanavian sw pre-treated window frames with factory fitted double glazed units (centre U value 1.1W/m²K) - 2 No 3000mm² trickle ventilation operating plates to one jamb per window (min window height 948mm)
Stone cill projection
Stone jamb to window surround
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ every blockwork course vertically within 150mm of opening.
WINDOW JAMB DETAIL
(stone surround)


Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL WALL DETAILS
date
MAY '04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6047
345
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ every blockwork course vertically within 150mm of opening.
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings and sealant applied between plaster and cill board junction.
Stone jamb to window surround
Stone cill projection
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
15mm proprietary one coat decorative scratch render, Blue Circle Rendaplus Colourtex S or similar approved, on 100mm lightweight aggregate blockwork. Render stops to be used at window openings.

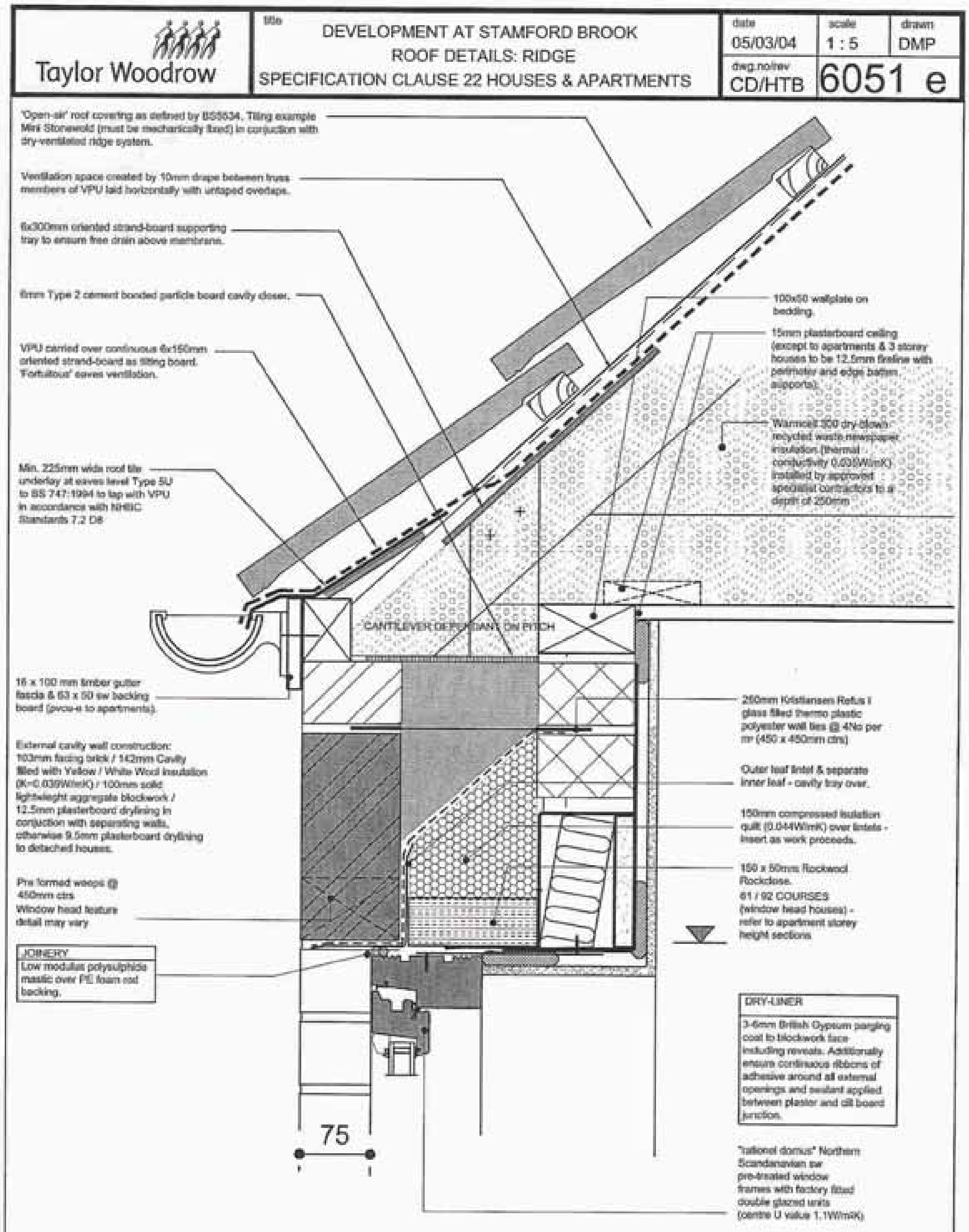

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL OPENINGS
date
MAY '04
scale
1 : 4
drawn
sd
dwg.no/rev
CD/HTB
6048
345
DRY-LINER
3-6mm British Gypsum perging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all external openings.
100 x 75mm Rockwool Rockclose Insulating DPC - black polyethylene to BS 6515 (K=0.035W/mK)
250mm Kristiansen Refus I glass filled thermo plastic polyester wall ties @ every blockwork course vertically within 150mm of opening.
48
STRUCTURAL OPENING = 965
STRUCTURAL OPENING = 910
115
105
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES
18mm Gyproc reveal board
ms zen plates - min 2 No per jamb
65mm reveal blocks (spec to match main blockwork)
JOINERY
Acrylic polymer impregnated foam elastic weatherseal
"rationel domus" Northern Scandanavian sw pre-treated door frame with factory fitted double glazed units (centre U value 1.1W/m²K)
ENTRANCE DOOR JAMB DETAIL



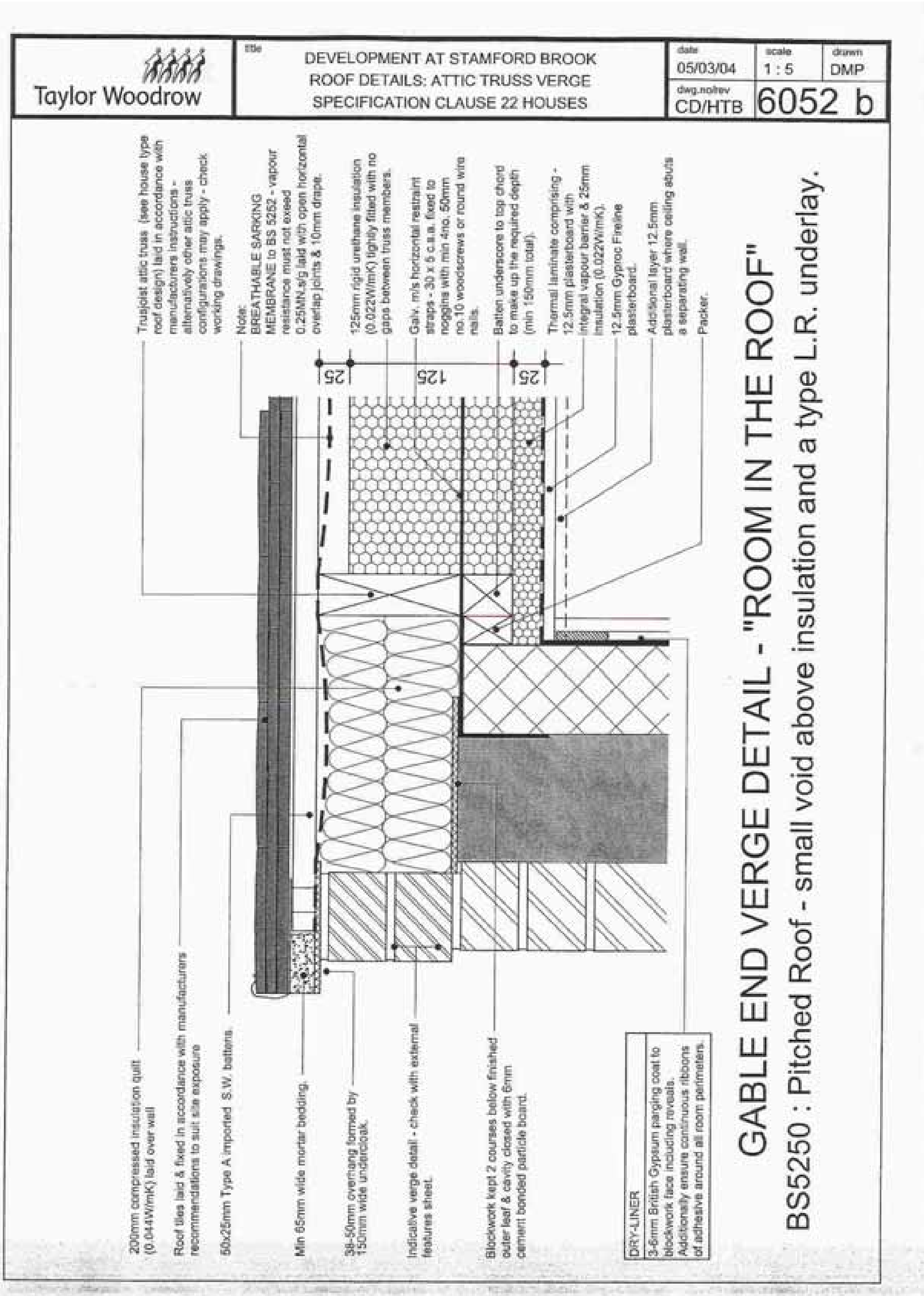
Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
EXTERNAL WALL DETAILS
date
MAY '04
scale
1 : 5
drawn
sd
dwg.no/rev
CD/HTB
6049
Cover flashing to be chased into brickwork with 25mm wide lead wedges @ 450 ctrs.
19mm wbp plywood decking on tilting battens
100mm Kingspan TR31 insulation on vapour barrier.
Code 6 lead sheet roofing, treated with patination oil to avoid staining, laid on isolation layer. Lead to be fixed at head with copper nails, heads to be sealed with solder dabs, 75mm splash lap to be provided to cover fixings. Double welted end to be provided at eaves.
150x100mm timber cornice
Ventilated air space.
185x25mm timber fascia
175x50mm timber joists & bearers, spanning onto window posts, with Kingspan TP10 insulation between & 18mm Gyproc reveal board ceiling.



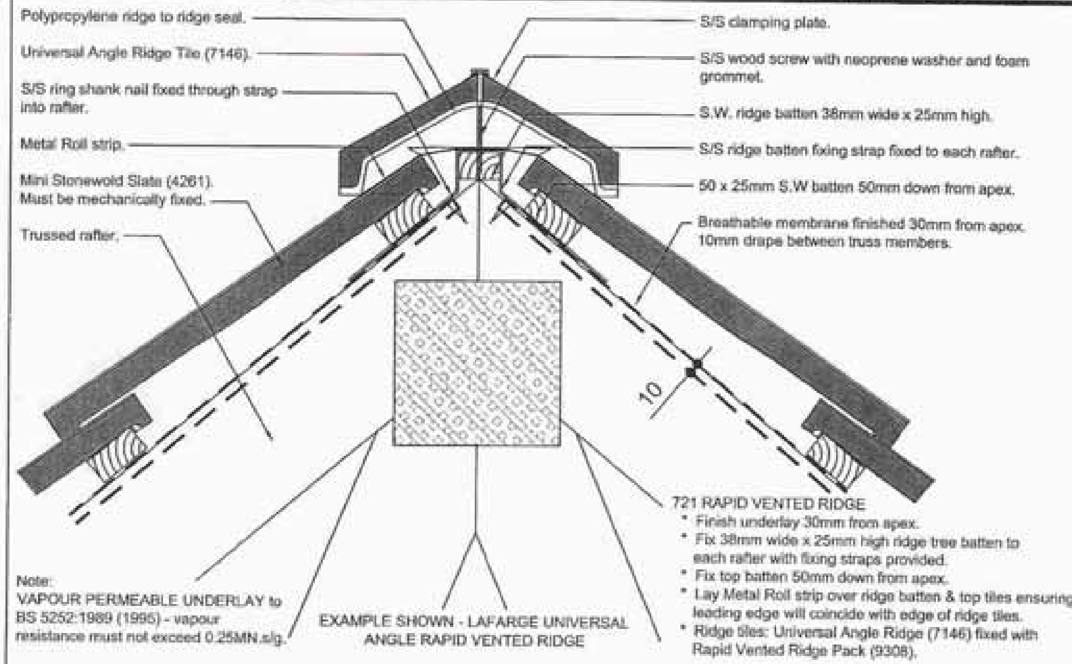
COLD "Breathing" ROOF: Eaves
(Eaves detail indicative)

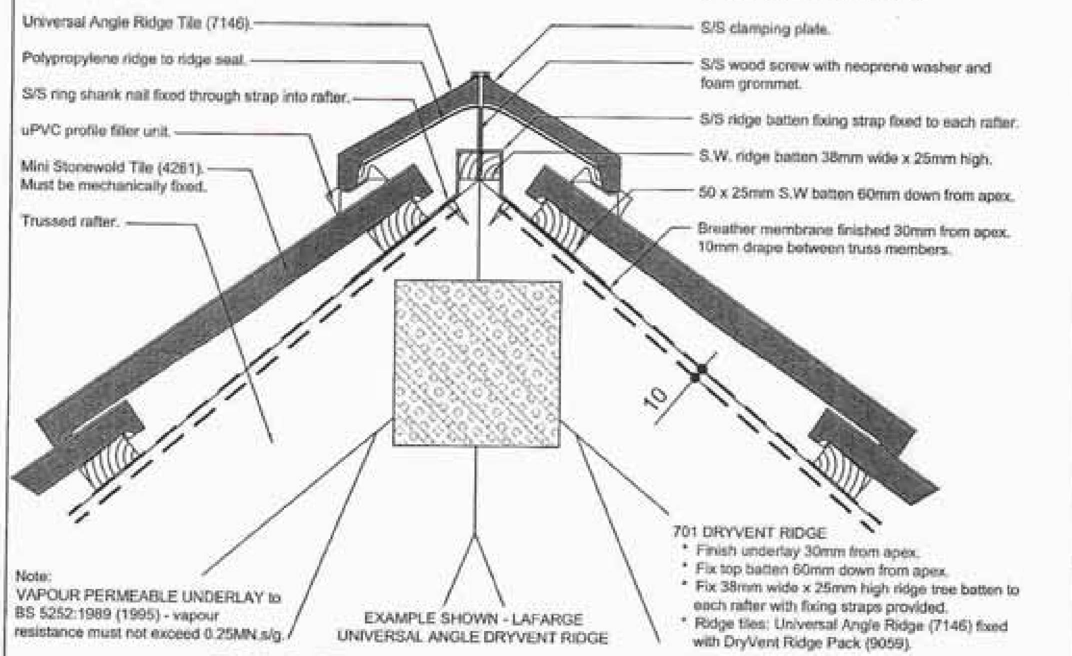


COLD "Breathing" ROOF: Eaves window head

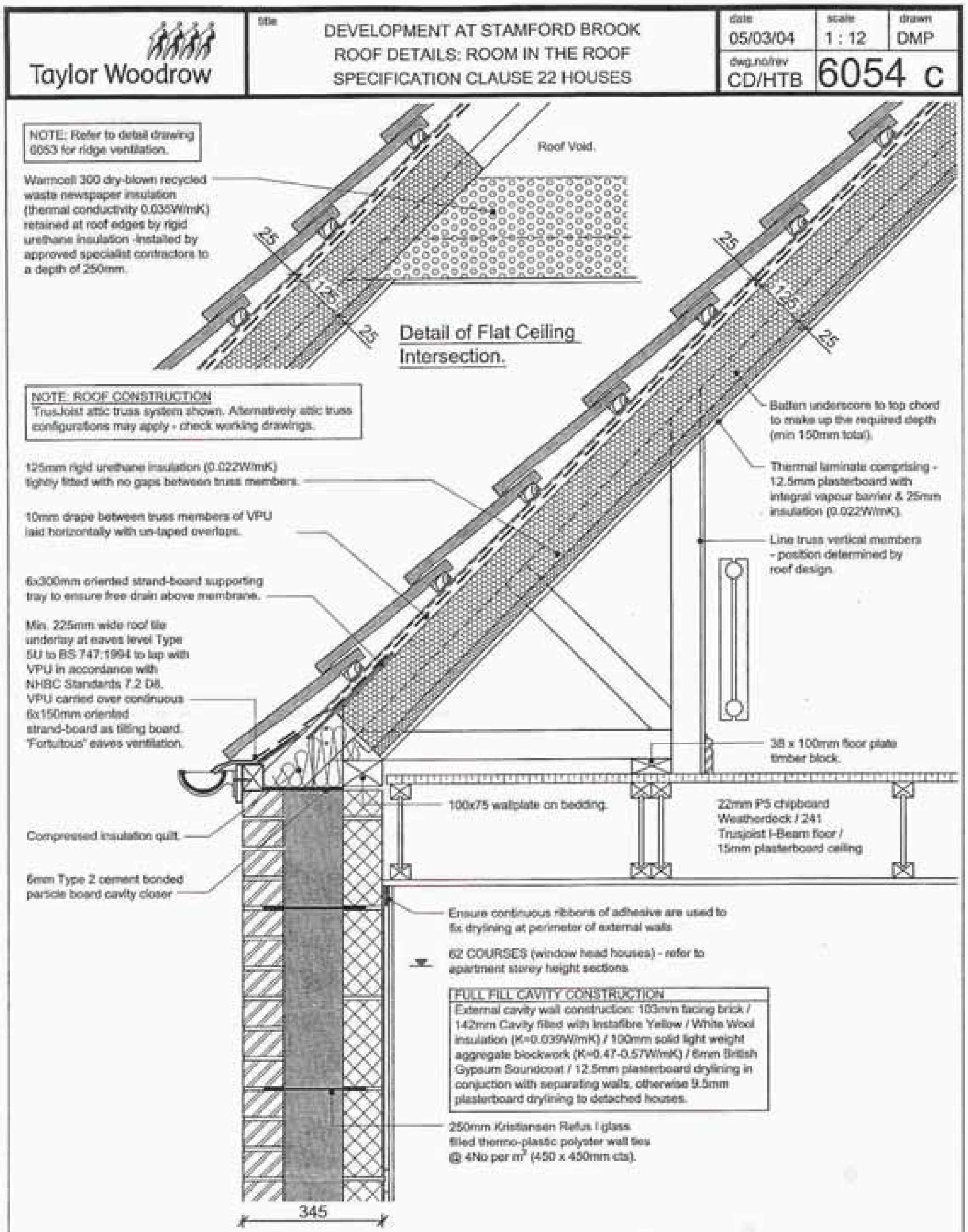

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
ROOF DETAILS: ATTIC TRUSS VERGE
SPECIFICATION CLAUSE 22 HOUSES
date 05/03/04
scale 1 : 5
drawn DMP
dwg.no/rev CD/HTB 6052 b
200mm compressed insulation quilt (0.044W/mK) laid over wall
Roof tiles laid & fixed in accordance with manufacturers recommendations to suit site exposure
50x25mm Type A imported S.W. battens.
Min 65mm wide mortar bedding.
38-50mm overhang formed by 150mm wide undercloak.
Indicative verge detail - check with external features sheet.
Blockwork kept 2 courses below finished outer leaf & cavity closed with 6mm cement bonded particle board.
DRY-LINER
3-6mm British Gypsum parging coat to blockwork face including reveals. Additionally ensure continuous ribbons of adhesive around all room perimeters.
Trusjoist attic truss (see house type roof design) laid in accordance with manufacturers instructions - alternatively other attic truss configurations may apply - check working drawings.
Note: BREATHABLE SARKING MEMBRANE to BS 5252 - vapour resistance must not exeed 0.25MN.s/g laid with open horizontal overlap joints & 10mm drape.
125mm rigid urethane insulation (0.022W/mK) tightly fitted with no gaps between truss members.
Galv. m/s horizontal restraint straps - 30 x 5 c.s.a. fixed to noggins with min 4no. 50mm no.10 woodscrews or round wire nails.
Batten underscore to top chord to make up the required depth (min 150mm total).
Thermal laminate comprising - 12.5mm plasterboard with integral vapour barrier & 25mm insulation (0.022W/mK).
12.5mm Gyproc Fireline plasterboard.
Additional layer 12.5mm plasterboard where ceiling abuts a separating wall.
Packer.
25
125
25
GABLE END VERGE DETAIL - "ROOM IN THE ROOF"
BS5250 : Pitched Roof - small void above insulation and a type L.R. underlay.

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK ROOF DETAILS: RIDGE SPECIFICATION CLAUSE 22 HOUSES & APARTMENTS	date: 05/03/04	scale: 1 : 5	drawn: DMP
		dwg.no/rev: CD/HTB	6053 b	



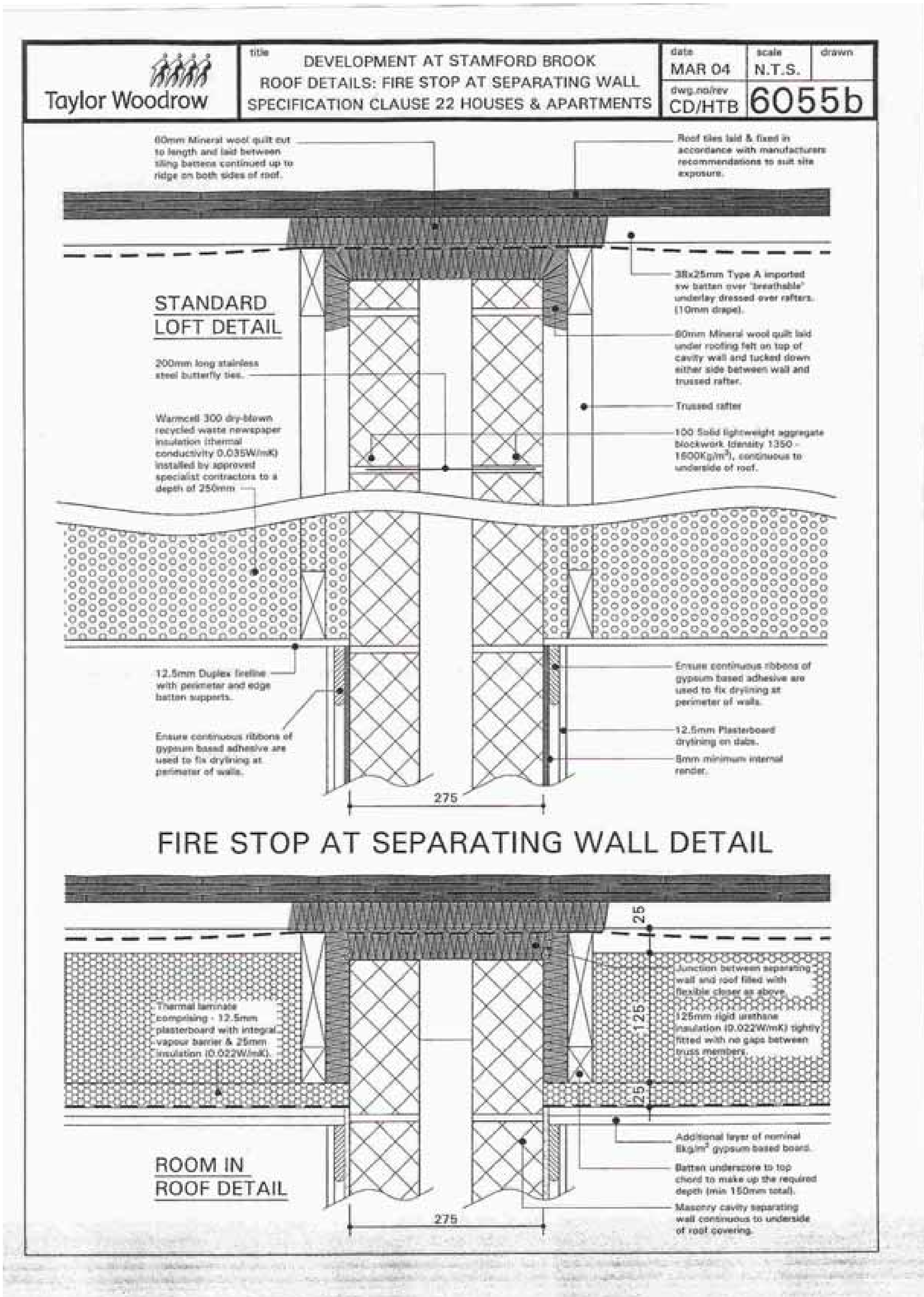


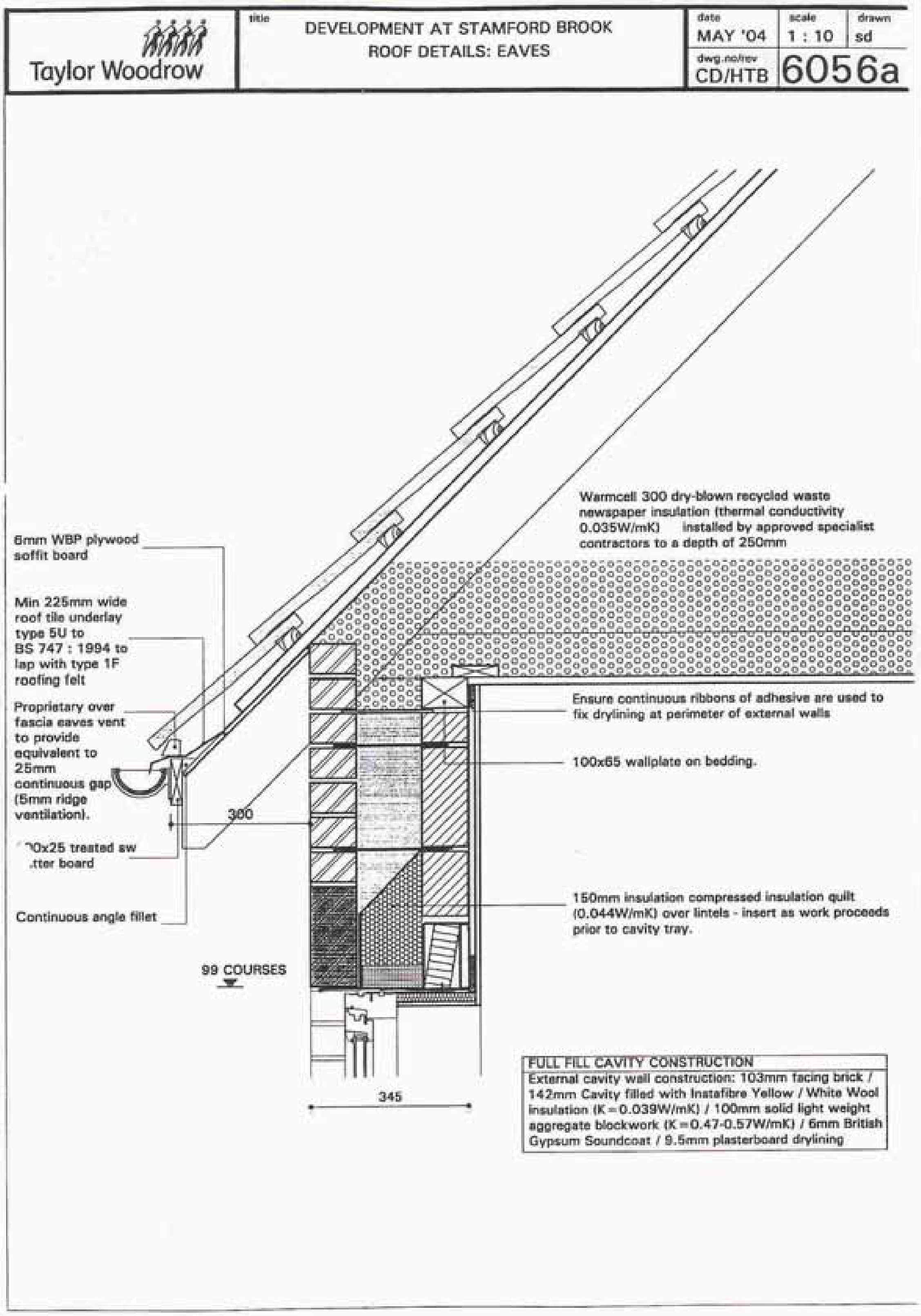
COLD "Breathing" ROOF: Ridge.
(Ridge Ventilation also applicable to 'Room in the Roof').

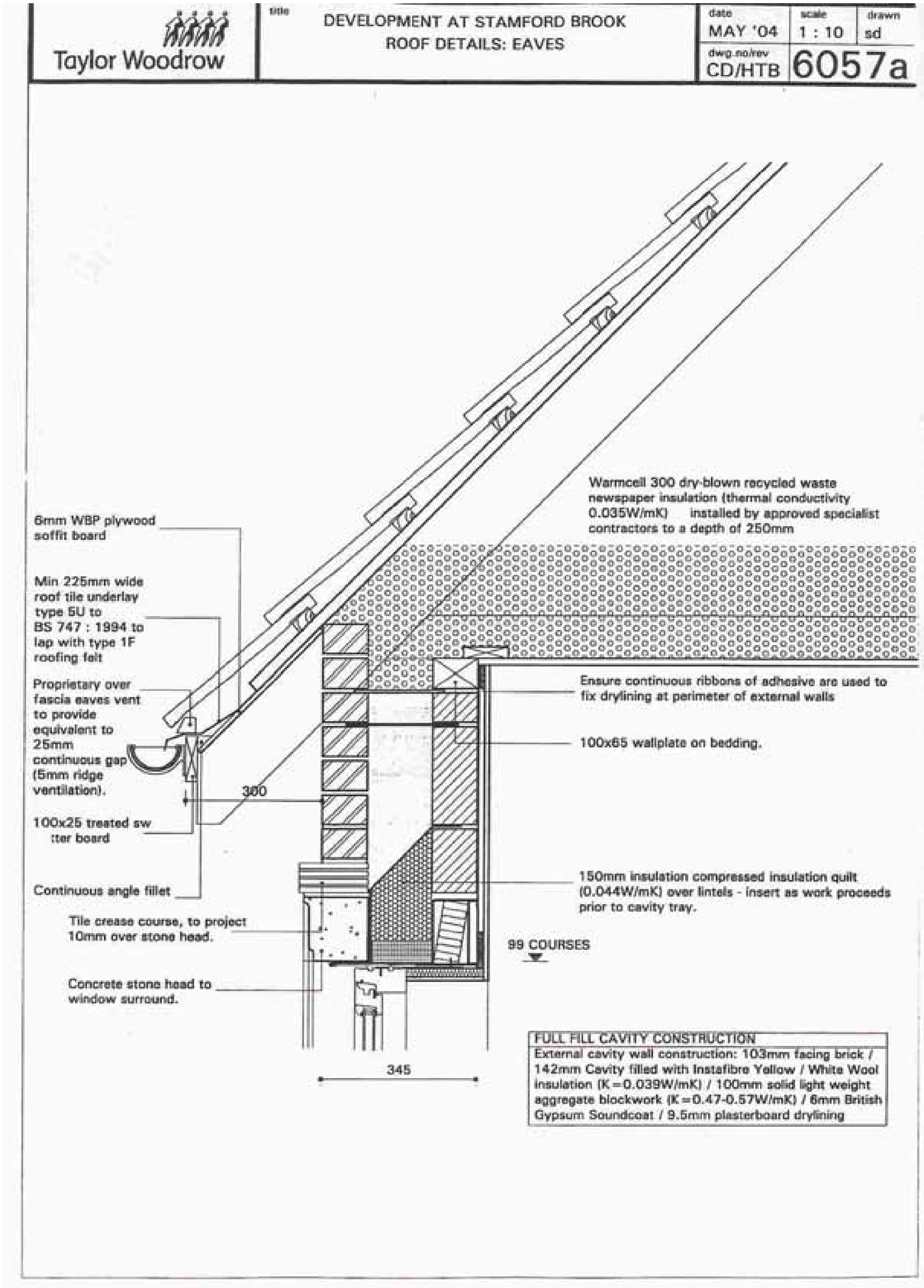


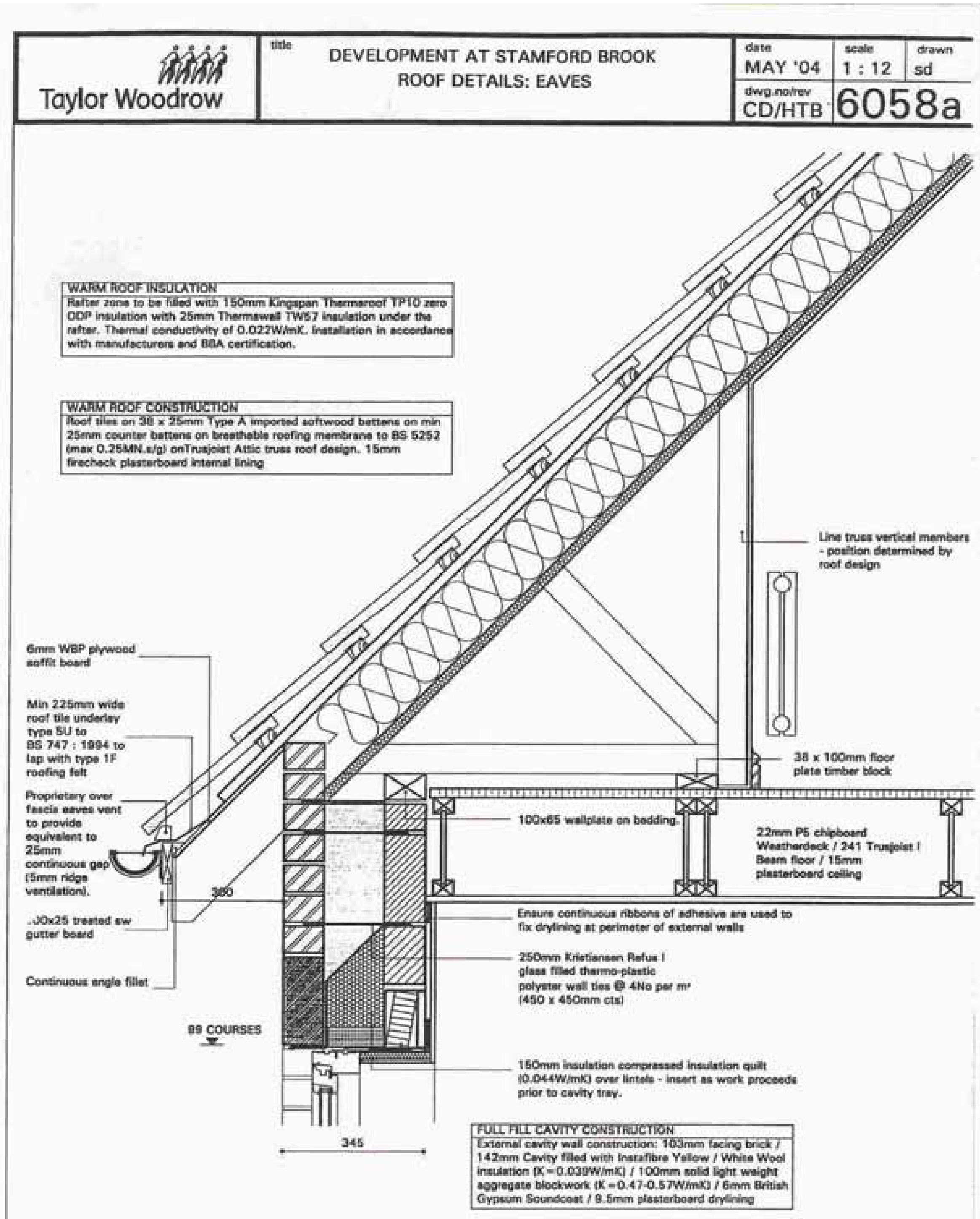
ROOM IN ROOF EAVES DETAIL
(Trusjoist I-Beam design)

BS5250 : Pitched Roof - small void above insulation and a type L.R. underlay.

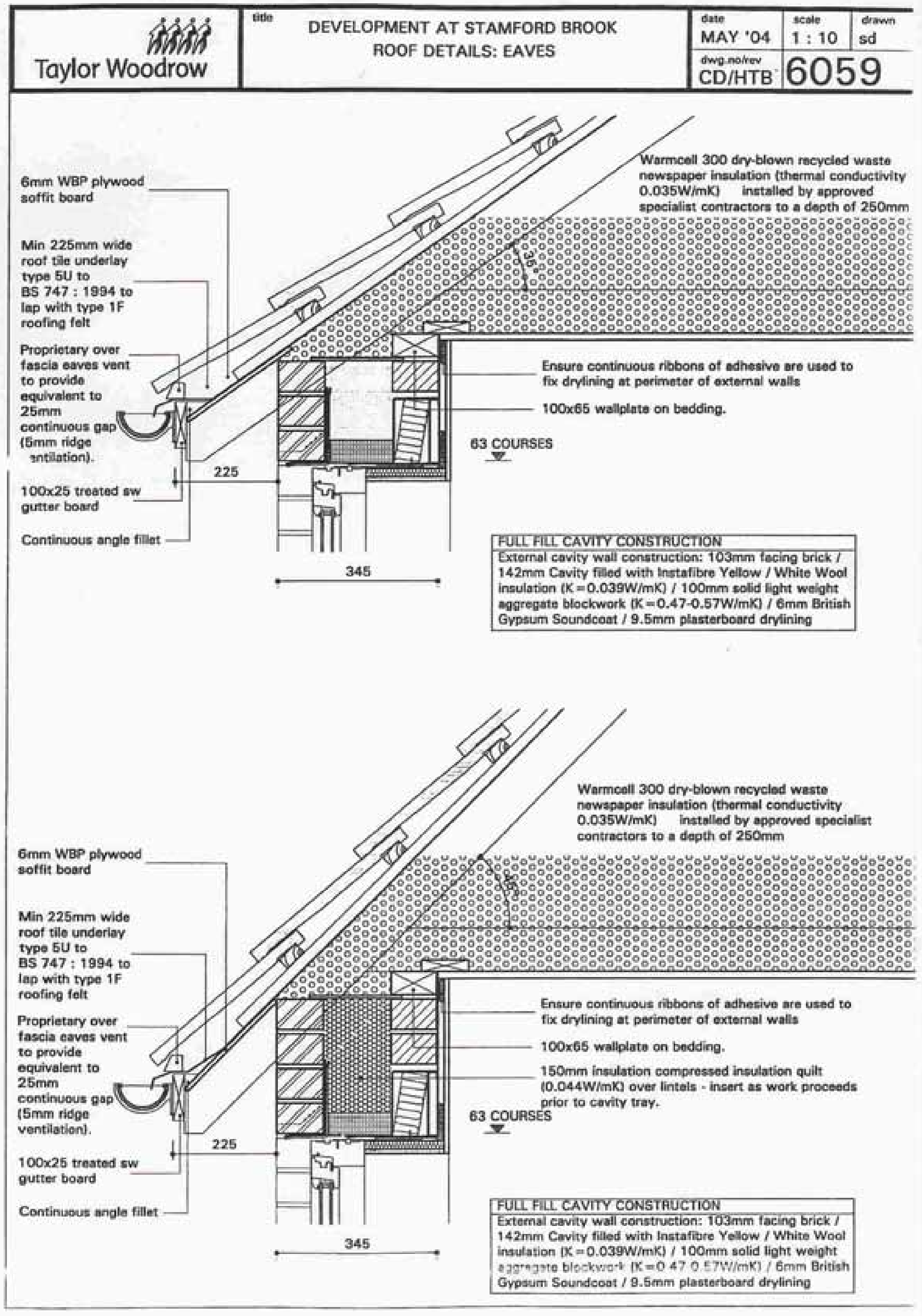

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
ROOF DETAILS: FIRE STOP AT SEPARATING WALL
SPECIFICATION CLAUSE 22 HOUSES & APARTMENTS
date
MAR 04
scale
N.T.S.
drawn
dwg.no/rev
CD/HTB
6055b
60mm Mineral wool quilt cut to length and laid between tiling battens continued up to ridge on both sides of roof.
Roof tiles laid & fixed in accordance with manufacturers recommendations to suit site exposure.
STANDARD LOFT DETAIL
38x25mm Type A imported sw batten over 'breathable' underlay dressed over rafters. (10mm drape).
60mm Mineral wool quilt laid under roofing felt on top of cavity wall and tucked down either side between wall and trussed rafter.
200mm long stainless steel butterfly ties.
Trussed rafter
Warmcell 300 dry-blown recycled waste newspaper insulation (thermal conductivity 0.035W/mK) installed by approved specialist contractors to a depth of 250mm
100 Solid lightweight aggregate blockwork (density 1350 - 1600Kg/m³), continuous to underside of roof.
12.5mm Duplex fireline with perimeter and edge batten supports.
Ensure continuous ribbons of gypsum based adhesive are used to fix drylining at perimeter of walls.
Ensure continuous ribbons of gypsum based adhesive are used to fix drylining at perimeter of walls.
12.5mm Plasterboard drylining on dabs.
5mm minimum internal render.
275
FIRE STOP AT SEPARATING WALL DETAIL
25
125
25
Junction between separating wall and roof filled with flexible closer as above.
Thermal laminate comprising - 12.5mm plasterboard with integral vapour barrier & 25mm insulation (0.022W/mK).
125mm rigid urethane insulation (0.022W/mK) tightly fitted with no gaps between truss members.
Additional layer of nominal 8kg/m² gypsum based board.
ROOM IN ROOF DETAIL
Batten underscore to top chord to make up the required depth (min 150mm total).
Masonry cavity separating wall continuous to underside of roof covering.
275

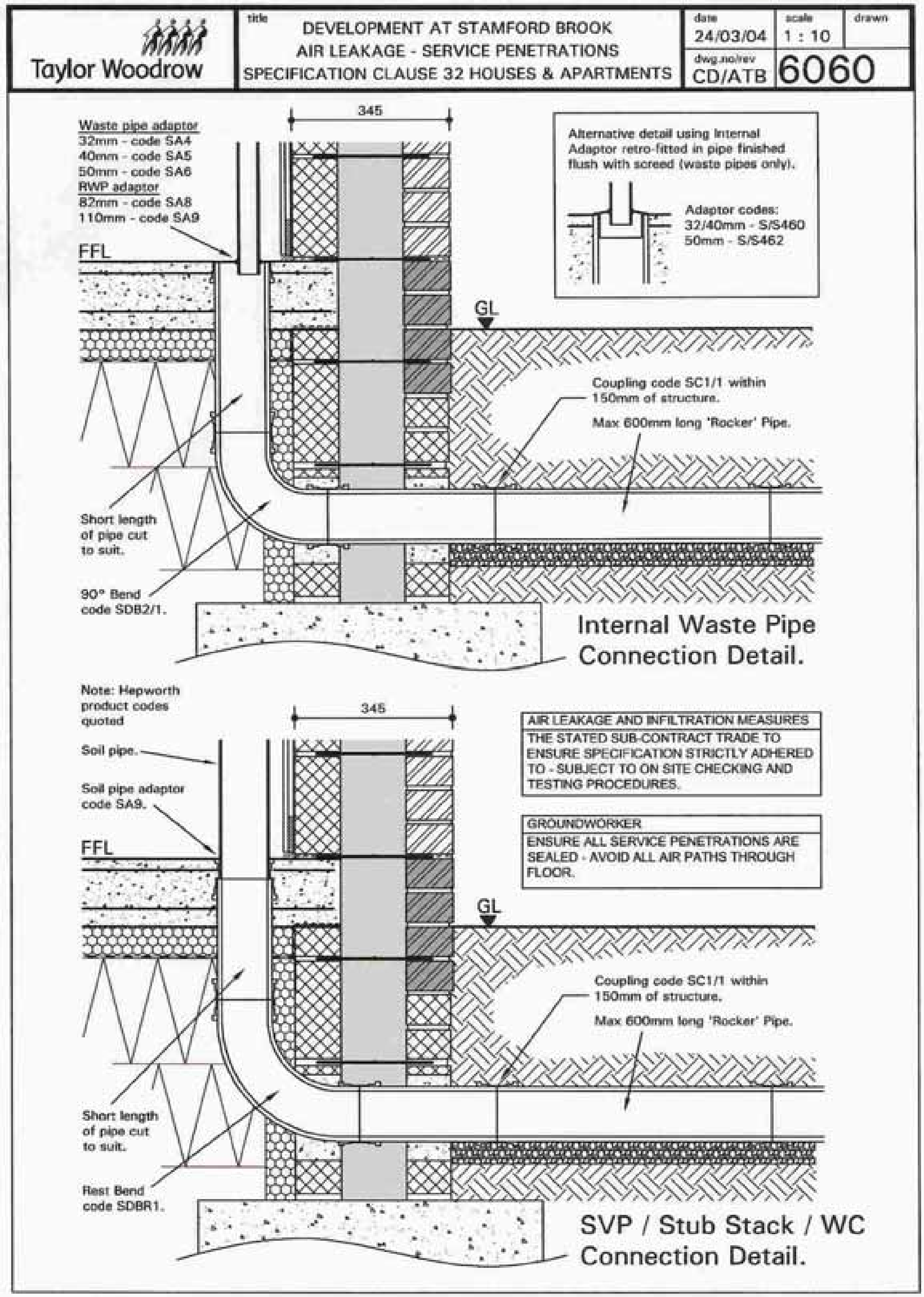

Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
ROOF DETAILS: EAVES
date
MAY '04
scale
1 : 10
drawn
sd
dwg.no/rev
CD/HTB
6056a
Warmcell 300 dry-blown recycled waste newspaper insulation (thermal conductivity 0.035W/mK) installed by approved specialist contractors to a depth of 250mm
6mm WBP plywood soffit board
Min 225mm wide roof tile underlay type 5U to BS 747 : 1994 to lap with type 1F roofing felt
Proprietary over fascia eaves vent to provide equivalent to 25mm continuous gap (5mm ridge ventilation).
Ensure continuous ribbons of adhesive are used to fix drylining at perimeter of external walls
100x65 wallplate on bedding.
300
Continuous angle fillet
150mm insulation compressed insulation quilt (0.044W/mK) over lintels - insert as work proceeds prior to cavity tray.
99 COURSES
345
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Instafibre Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 6mm British Gypsum Soundcoat / 9.5mm plasterboard drylining


Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
ROOF DETAILS: EAVES
date
MAY '04
scale
1 : 10
drawn
sd
dwg.no/rev
CD/HTB
6057a
Warmcell 300 dry-blown recycled waste newspaper insulation (thermal conductivity 0.035W/mK) installed by approved specialist contractors to a depth of 250mm
6mm WBP plywood soffit board
Min 225mm wide roof tile underlay type 5U to BS 747 : 1994 to lap with type 1F roofing felt
Proprietary over fascia eaves vent to provide equivalent to 25mm continuous gap (5mm ridge ventilation).
Ensure continuous ribbons of adhesive are used to fix drylining at perimeter of external walls
100x65 wallplate on bedding.
300
100x25 treated sw tter board
Continuous angle fillet
150mm insulation compressed insulation quilt (0.044W/mK) over lintels - insert as work proceeds prior to cavity tray.
Tile crease course, to project 10mm over stone head.
99 COURSES
Concrete stone head to window surround.
345
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Instafibre Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 6mm British Gypsum Soundcoat / 9.5mm plasterboard drylining

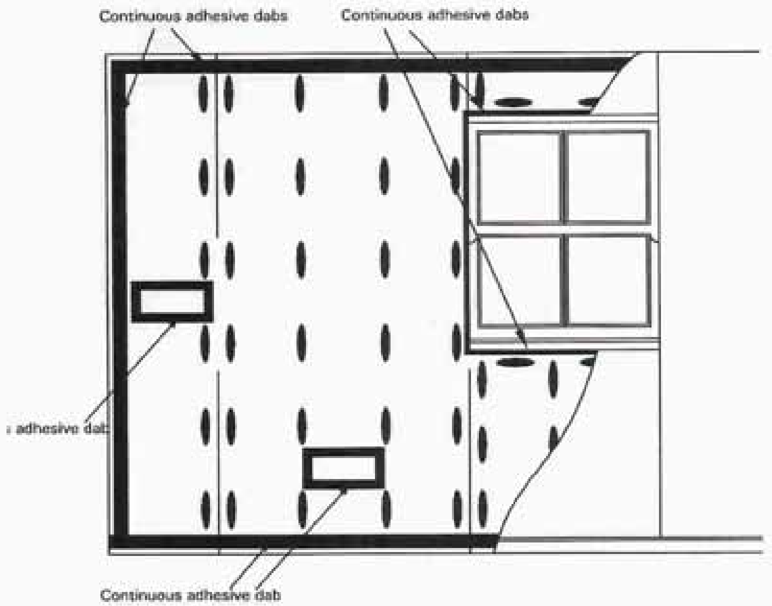


ROOM IN ROOF EAVES DETAIL
(Trusjoist I Beam design)


Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
ROOF DETAILS: EAVES
date
MAY '04
scale
1 : 10
drawn
sd
dwg.no/rev
CD/HTB 6059
Warmcell 300 dry-blown recycled waste newspaper insulation (thermal conductivity 0.035W/mK) installed by approved specialist contractors to a depth of 250mm
6mm WBP plywood soffit board
Min 225mm wide roof tile underlay type 5U to BS 747 : 1994 to lap with type 1F roofing felt
Proprietary over fascia eaves vent to provide equivalent to 25mm continuous gap (5mm ridge ventilation).
100x25 treated sw gutter board
Continuous angle fillet
225
345
35°
Ensure continuous ribbons of adhesive are used to fix drylining at perimeter of external walls
100x65 wallplate on bedding.
63 COURSES
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Instafibre Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 6mm British Gypsum Soundcoat / 9.5mm plasterboard drylining
Warmcell 300 dry-blown recycled waste newspaper insulation (thermal conductivity 0.035W/mK) installed by approved specialist contractors to a depth of 250mm
6mm WBP plywood soffit board
Min 225mm wide roof tile underlay type 5U to BS 747 : 1994 to lap with type 1F roofing felt
Proprietary over fascia eaves vent to provide equivalent to 25mm continuous gap (5mm ridge ventilation).
100x25 treated sw gutter board
Continuous angle fillet
225
345
Ensure continuous ribbons of adhesive are used to fix drylining at perimeter of external walls
100x65 wallplate on bedding.
150mm insulation compressed insulation quilt (0.044W/mK) over lintels - insert as work proceeds prior to cavity tray.
63 COURSES
FULL FILL CAVITY CONSTRUCTION
External cavity wall construction: 103mm facing brick / 142mm Cavity filled with Instafibre Yellow / White Wool insulation (K=0.039W/mK) / 100mm solid light weight aggregate blockwork (K=0.47-0.57W/mK) / 6mm British Gypsum Soundcoat / 9.5mm plasterboard drylining


Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
AIR LEAKAGE - SERVICE PENETRATIONS
SPECIFICATION CLAUSE 32 HOUSES & APARTMENTS
date
24/03/04
scale
1 : 10
drawn
dwg.no/rev
CD/ATB 6060
Waste pipe adaptor
32mm - code SA4
40mm - code SA5
50mm - code SA6
RWP adaptor
82mm - code SA8
110mm - code SA9
FFL
345
Alternative detail using Internal Adaptor retro-fitted in pipe finished flush with screed (waste pipes only).
Adaptor codes:
32/40mm - S/S460
50mm - S/S462
GL
Coupling code SC1/1 within 150mm of structure.
Max 600mm long 'Rocker' Pipe.
Short length of pipe cut to suit.
90° Bend code SDB2/1.
Internal Waste Pipe Connection Detail.
Note: Hepworth product codes quoted
Soil pipe.
Soil pipe adaptor code SA9.
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES.
GROUNDWORKER
ENSURE ALL SERVICE PENETRATIONS ARE SEALED - AVOID ALL AIR PATHS THROUGH FLOOR.
Rest Bend code SDBR1.
SVP / Stub Stack / WC Connection Detail.

	title	date	scale	drawn
Taylor Woodrow	DEVELOPMENT AT STAMFORD BROOK FLOOR AND EXTERNAL WALL JUNCTION SPEC. CLAUSES 4 to 9 / 32 HOUSES & APARTMENTS	24/03/04	1 : 10	DMP
		dwg.no/rev CD/ATB	6061	

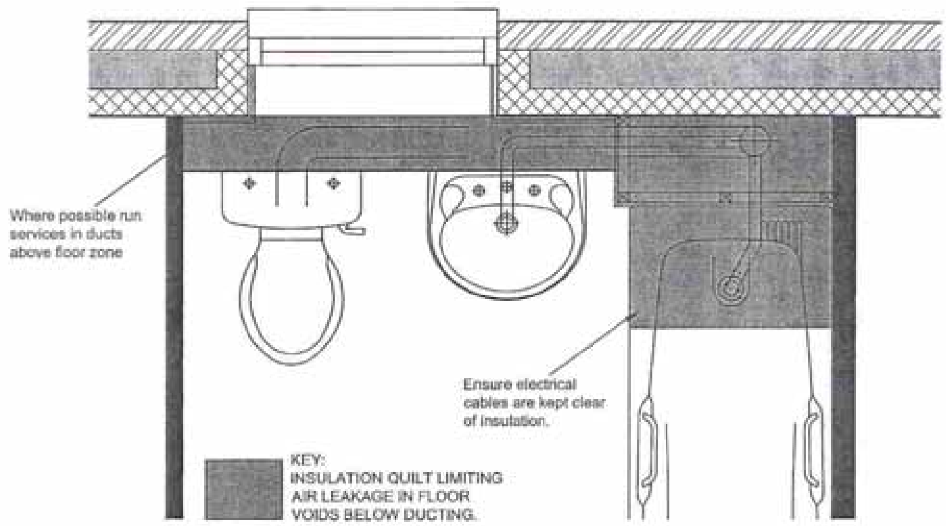


Typical wall elevation -
9.5mm plasterboard, 1200 wide

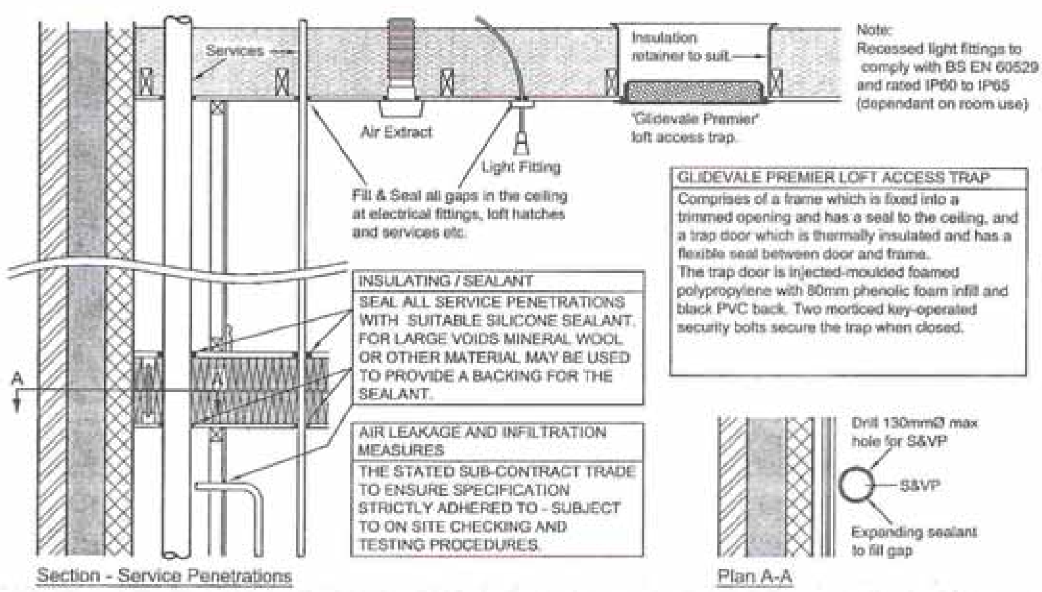
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES.

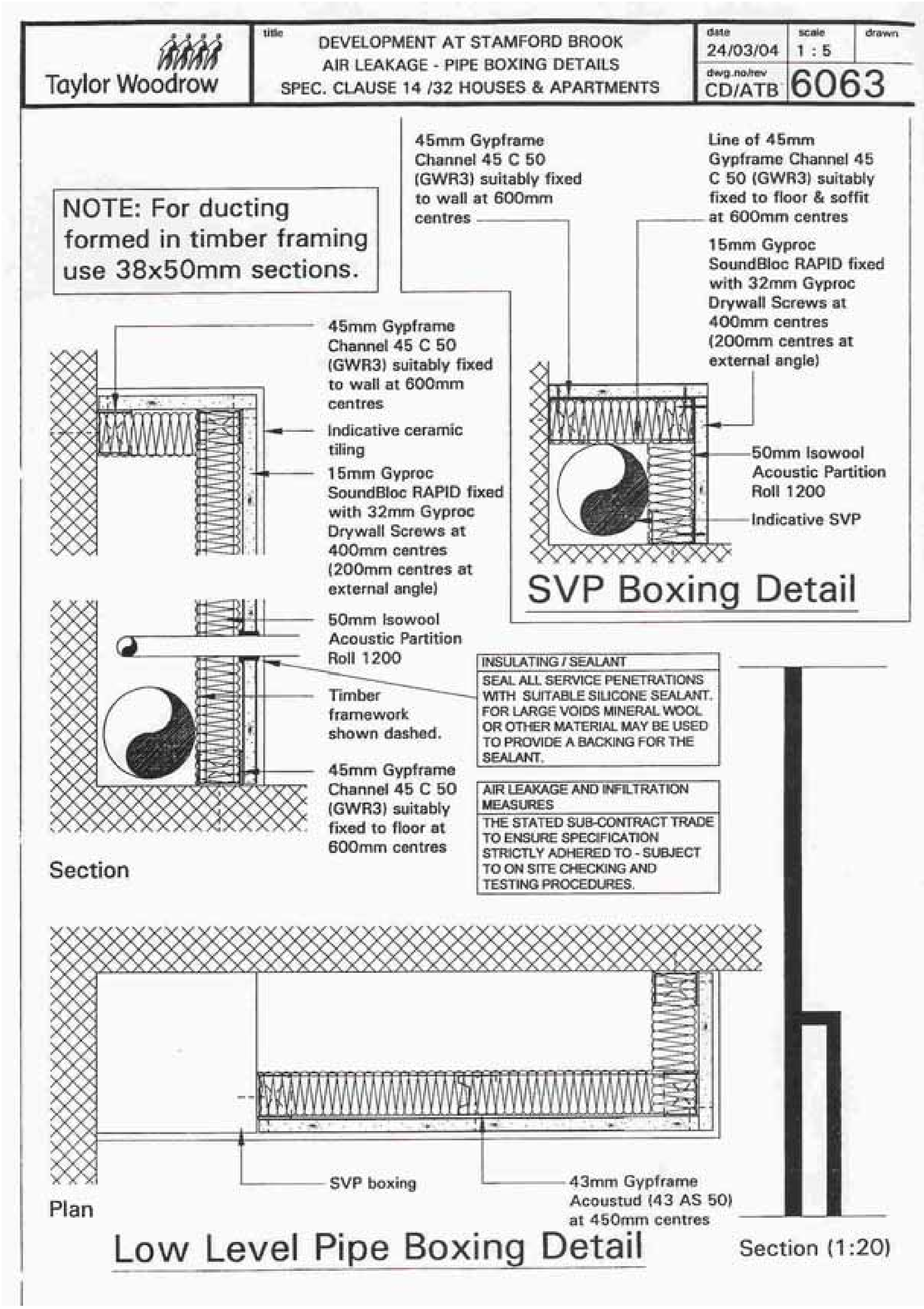
DRYLINER
A CONTINUOUS DAB OF ADHESIVE IS TO BE APPLIED TO THE PERIMETERS AT THE CEILING LINE, VERTICAL WALL JUNCTIONS, FLOOR LEVEL & AT DOOR / WINDOW OPENINGS & SERVICES ON EXTERNAL WALL. THE ADHESIVE SHOULD BE APPLIED PROGRESSIVELY AS BOARDING PROCEEDS, ENSURING THAT SUFFICIENT ADHESIVE IS APPLIED TO MAKE CONTACT WITH THE BOARD EDGES.

Taylor Woodrow	title: DEVELOPMENT AT STAMFORD BROOK AIR LEAKAGE - FLOOR & CEILING PENETRATIONS SPEC. CLAUSES 1/18/24/32 HOUSES & APARTMENTS	date: 24/03/04	scale: 1 : 20	drawn
		dwg.no/rev: CD/ATB	6062 b	



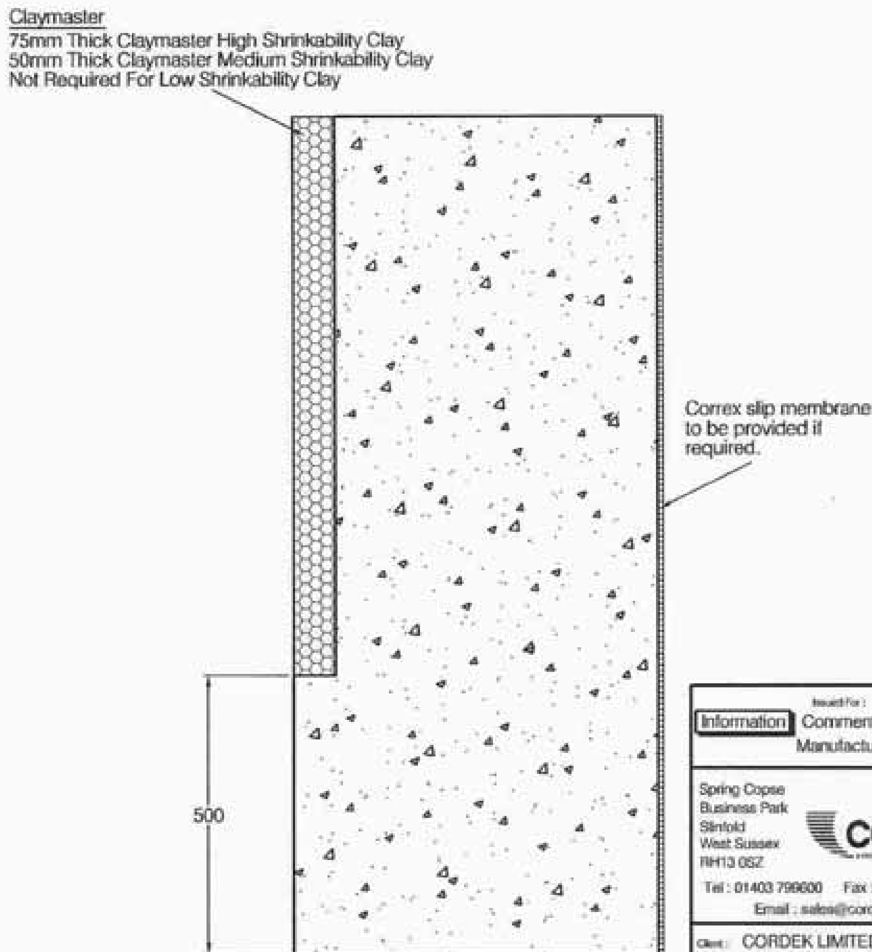
PIPEWORK THROUGH PLASTERBOARD - RADIATOR FEED & RETURN / HOT & COLD SUPPLY ETC. PENDANT & BATTEN HOLDER LIGHT FITTINGS.	GYPOC OR OTHER SUITABLE ACRYLIC SEALANT.
SHOWER DOWNLIGHTERS.	CHECK SPECIFIED ITEM IS SELF SEALING.
FLOOR VOIDS WHICH INCORPORATE PLUMING DUCTS AND FLOOR VOID BELOW BATHS / SHOWER TRAYS / SANITARY WARE (AROUND PIPEWORK).	FILL WITH INSULATION QUILT.
S&VP DUCT ON EXTERNAL WALLS.	FILL WITH INSULATION QUILT.




Taylor Woodrow
title
DEVELOPMENT AT STAMFORD BROOK
AIR LEAKAGE - PIPE BOXING DETAILS
SPEC. CLAUSE 14 /32 HOUSES & APARTMENTS
date
24/03/04
scale
1 : 5
drawn
dwg.no/rev
CD/ATB
6063
NOTE: For ducting formed in timber framing use 38x50mm sections.
45mm Gypframe Channel 45 C 50 (GWR3) suitably fixed to wall at 600mm centres
Line of 45mm Gypframe Channel 45 C 50 (GWR3) suitably fixed to floor & soffit at 600mm centres
15mm Gyproc SoundBloc RAPID fixed with 32mm Gyproc Drywall Screws at 400mm centres (200mm centres at external angle)
50mm Isowool Acoustic Partition Roll 1200
Indicative SVP
SVP Boxing Detail
45mm Gypframe Channel 45 C 50 (GWR3) suitably fixed to wall at 600mm centres
Indicative ceramic tiling
15mm Gyproc SoundBloc RAPID fixed with 32mm Gyproc Drywall Screws at 400mm centres (200mm centres at external angle)
50mm Isowool Acoustic Partition Roll 1200
Timber framework shown dashed.
45mm Gypframe Channel 45 C 50 (GWR3) suitably fixed to floor at 600mm centres
Section
INSULATING / SEALANT
SEAL ALL SERVICE PENETRATIONS WITH SUITABLE SILICONE SEALANT. FOR LARGE VOIDS MINERAL WOOL OR OTHER MATERIAL MAY BE USED TO PROVIDE A BACKING FOR THE SEALANT.
AIR LEAKAGE AND INFILTRATION MEASURES
THE STATED SUB-CONTRACT TRADE TO ENSURE SPECIFICATION STRICTLY ADHERED TO - SUBJECT TO ON SITE CHECKING AND TESTING PROCEDURES.
SVP boxing
43mm Gypframe Acoustud (43 AS 50) at 450mm centres
Plan
Low Level Pipe Boxing Detail
Section (1:20)

2

Typical Deep Trench Fill Detail For Foundations Greater Than 1500mm In Depth



Issued For :
Information Comment Approval Manufacture

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Email : sales@cordek.com

Client : CORDEK LIMITED

Contract :

Notes :-

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3. The above detail complies with the requirements of NHBC standards Chapter 4.2 Building Near Trees.

Dwg. Title : TYPICAL DEEP TRENCH FILL DETAIL

Drawn : TREVOR LARKIN

Date : JAN 2003 Scales : 1:10 @ A4

Dwg. No. COR/STD/002 Rev. --

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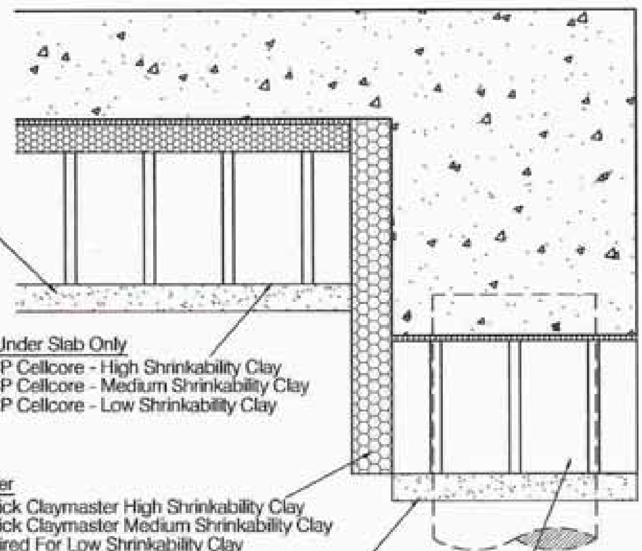
Typical Cellcore And Claymaster Detail For Groundbeam & Slab

L3



Concrete Blinding

Cellcore Under Slab Only
300mm CP Cellcore - High Shrinkability Clay
225mm CP Cellcore - Medium Shrinkability Clay
150mm CP Cellcore - Low Shrinkability Clay

Claymaster
75mm Thick Claymaster High Shrinkability Clay
50mm Thick Claymaster Medium Shrinkability Clay
Not Required For Low Shrinkability Clay

Concrete Blinding

Cellcore Under Beams Only
250mm CC Cellcore - High Shrinkability Clay
175mm CC Cellcore - Medium Shrinkability Clay
100mm CC Cellcore - Low Shrinkability Clay

Cellcore Types and Grades
For depth and grades refer to Ground Movement Brochure or CordekTechnical Deptartment. Tel: 01403 799600.

Issued For: **Information** Comment Approval Manufacture

Spring Copse
Business Park
Slinfold
West Sussex
RH13 0SZ
cordek
Tel : 01403 799600 Fax : 01403 791718
Email : sales@cordek.com

Client: CORDEK LIMITED

Contact:

Notes :-

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3. The Cellcore should be placed on a firm level surface which will ensure uniform loading on the legs. A layer of sand/cement or concrete blinding will usually be necessary to achieve this.
4. Cellcore can be supplied to beam widths as required. (Min. width 300mm)
5. Seal joints between panels with a suitable formwork tape.
6. Place reinforcement in position and use either Cordek galvanised steel spreader plates or Cordek bigfoot spacers.
7. The above detail complies with the requirements of NHBC standards Chapter 4.2 Building Near Trees.
8. Cellform a permanent formwork system for groundbeams which incorporates Cellcore is also available from Cordek.

Drg. Title: TYPICAL GROUNDBEAM AND SLAB DETAIL

Drawn: TREVOR LARKIN

Date: JAN 2003 Scale: 1:10 @ A4

Drg. No: COR/STD/003 Rev. --

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Appendix 5: Key Performance Indicators

Key Performance Indicators

Measure	Standard Build	Best Practice	Stamford Brook current	Future Phases
Energy : Ventilation : Heating				
1.Air Permeability	Unrestricted Av 11.5 m3/h/m2		Less than 5 m3/h/m2	
2. CO2 Emission	Less than 60kg/m2/yr		Less than 20kg/m2/yr	
3. Ventilation Rates				
4. Boilers SEDBUK			Condensing Boilers 90.4% SEDBUK	
5 Solar Orientation			Simplified window geometry	
6 Solar Shading			Less than 15% of properties at noon in midwinter	
7 Window Position	Unrestricted		Optimum position to minimise thermal bridge	
8 Low Energy Lighting			Low Energy Fittings through out	
9.Minimum Air Supply Requirements			Double bedroom 8 l/s Single bedroom 4 l/s Living room 8 l/s Dining room 4/s Kitchen 10 l/s Bathroom 6 l/s	
10. Renewable Energy				Heat pumps Solar Panels Photovoltaics
Building Envelope				
1.U Values Walls Windows Ground Floors Roof	Elemental 0.35 3.3 0.25 0.16	2005 ADL Trade off 0.35 2.2 0.25 0.25	Actual Trade off 0.229 0.30 1.300 1.56 0.188 0.26 0.141 0.19	
2.Building Envelope Performance	2002 Part L		Greater than 15% improvement on current Part L	
3. SAP rating	90 SAP		105 SAP	
4. Wall Ties	Stainless steel Conductivity= adds 10% to U value		Polyester glass wall ties Conductivity= zero	
5. Cavity wall insulation	75mm mineral fibre		142mm mineral fibre with insulated formers at reveals	

6.Lintels	Single lintel spanning both inner and outer leaves		Thermal bridge removed. Separate lintels with insulation between	
7 Thermal bridge around ground floor	Insulation - None		Thermal bridge minimised by extending insulation below dpc, using edge insulation, using thermal blocks where structure crosses insulation layer	
8 Additional airtight layer	No		Parging on all outer walls to reduce air permeability	
9 Domestic Window Energy Rating	No		DWER 70	
Environmental Standards of the Internal Building				
1 Sustainable Timber	Unrestricted		60% FSC building elements 75% FSC finishing elements	
2 Loft Hatch	Unrestricted		Insulated airtight hatch	
3.Paint - Zero VOC	Unrestricted		Water based system	
4 Wiring	PVC		Non PVC wiring - LSF	
5 PVC Ducting			Non PVC ducting for ventilation	
6 Worktops	Unrestricted		Low Formaldehyde	
7 White Goods	Unrestricted		Eco Labelled A Rated Goods	
8. Floor Finish	Unrestricted		Non PVC Marmoleum	
9 Waste Fittings	Unrestricted		ABS pipework	
10. Insulation Materials			Zero ODP	
Water Usage				
1. WC's	Unrestricted		WRAS Approved Siphon 4.5 l Flush	
2 Handbasins	Unrestricted		max. 6 litres/min	
3 Showers	Unrestricted		max. 6-9 litres/min	
4 Baths	Unrestricted		Standard 150 litre	
Waste Minimisation				
1 Construction Waste Management	Unrestricted		Compaction, recycling and monitoring of waste	
2 Recycling in kitchen	Unrestricted		3 Built in Containers	
3. Local Authority Recycling Scheme	Yes		Yes	
Pollution				
1. HCFC Emissions	Unrestricted		No ozone depleting substances	
Transport				
1 80% of development within 500m of well served public transport	Not required		Yes	
2 Provision of cycle	Not required		50%of dwellings	90% of dwellings

storage				
3 Local Amenities – food store	Not required		Within 500m	
4 Other amenities	Not required		5 within 1000m	
5 Safe routes to amenities	Not required		Provided	
Landscape and Biodiversity				
1. Biodiversity	Not required		Enhanced biodiversity	
2 Landscaping			Preference to local species.	
3. Wildlife corridors			Enhanced environment	
Health and Well Being				
1 Daylighting to BS 8206			To BS in kitchen, habitable rooms	
2 Private Space			Provision of private out door space	
Design				
1 Provision of secure drying space	Not required		Yes	
2 External Lighting	Unrestricted		Low Energy CFL's	
3 Security Lighting	Unrestricted		PIR, Max. 150 Watts	
4 Home Office	Not provided		Space for home office	
Community Woodlands				
1. Woodlands	Non standard		Provide a valuable natural habitat for wildlife	
Sustainable Urban Drainage				

River Restoration

Public Participation

Community Provision

Other Materials

Other Environmental Standards

Training

Appendix 6: Site training Powerpoint presentation


Leeds Metropolitan University
Dr David Roberts
Prof Bob Lowe
Prof Malcolm Bell


LeedsMet involvement 1
funded by the Office of the Deputy Prime Minister
asking the whole construction industry what they think about building to high environmental standards - designers, construction staff, sales teams, building control and suppliers
we will also physically monitor 10 dwellings during a year of occupation and interview home owners
findings will directly inform next revision of regulations


LeedsMet involvement 2
LeedsMet would like to chat to construction staff
everyone can contribute
record and pass on ideas and opinions
offer guidance and feedback on the construction process
LeedsMet does not have a supervisory or checking role


Documentation
construction specification
site training plan
robust construction details


Thermal comfort
high levels of insulation
high performance windows
low carbon emissions
designed to avoid cold spots


Thermal bridging
wherever possible, the insulation thickness will be maintained where a construction junction occurs
infra-red camera can show where insulation is missing
boroscope can photograph inside the structure

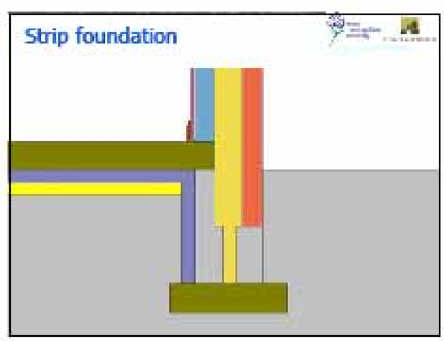

Thermal bridging

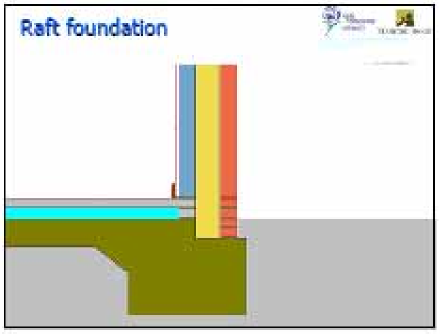

Good indoor air quality
airtight construction (tested on completion)
no draughts or loss of heated air
all dwellings will have continuous mechanical ventilation

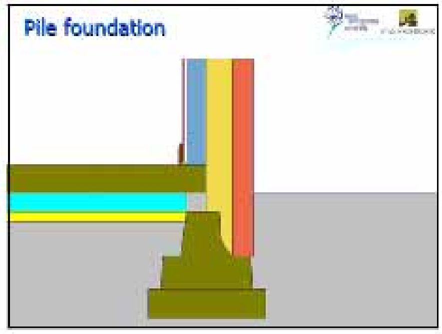

Air pressurisation testing

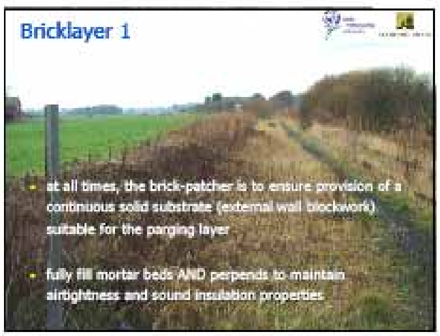

Airtight construction
a parging layer will act as the primary airtight barrier
seal all service penetrations
take extra care with known leakage routes
feedback into a developing site training programme
additional site supervision
(note: sealing the plasterboard layer does not improve leakage through the airtight barrier)


Eco-friendly materials
FSC timber
no PVC materials (includes wiring, ducting, etc)
no substances that harm the ozone layer
low formaldehyde & low volatile organic chemicals
recycled materials where applicable

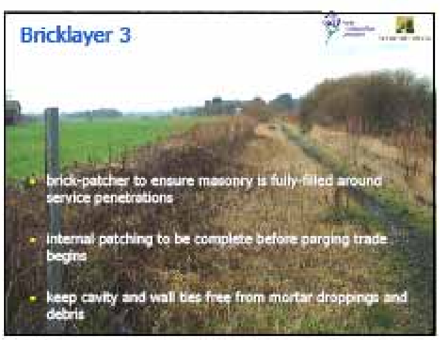

Strip foundation


Raft foundation


Pile foundation


Bricklayer 1
at all times, the brick-patcher is to ensure provision of a continuous solid substrate (external wall blockwork) suitable for the parging layer
fully fill mortar beds AND perpends to maintain airtightness and sound insulation properties

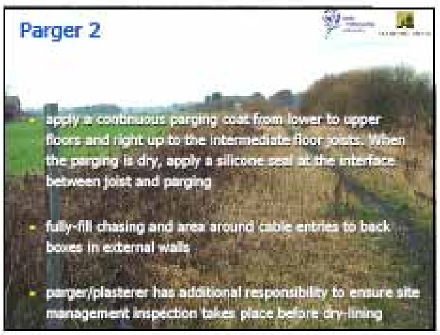

Bricklayer 2
intermediate floor joists to be built in at both ends. Blocks between joists to be cut to size – large mortar joints are not acceptable. The infill and pointing should be neat enough to allow a (later) parging coat to continue right up to the joists. Later still, a silicone bead will be placed at the interface between the joist and the parging coat


Bricklayer 3
brick-patcher to ensure masonry is fully-filled around service penetrations
internal patching to be complete before parging trade begins
keep cavity and wall ties free from mortar droppings and debris

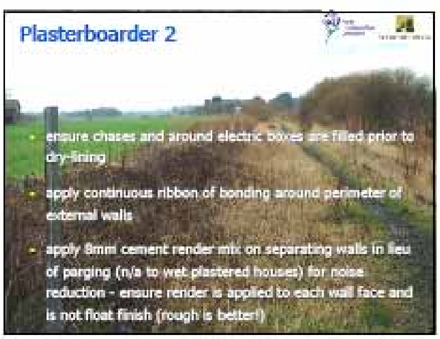

Wall insulation installer 1
ensure area under lintel is filled with insulation
ensure cavity is filled right down to the footing
ensure some drill holes are as high as possible to the eaves to fully fill right up to underside of cement bonded particle board cavity closer


Wall insulation installer 2
take measures to avoid settlement of insulation that could leave spaces at the top of walls – eaves in particular
fully-fill gable with insulation right up to the verge
fully-fill all drill holes after insulation has been installed leaving a solid resilient substrate for (later) application of the parging coat

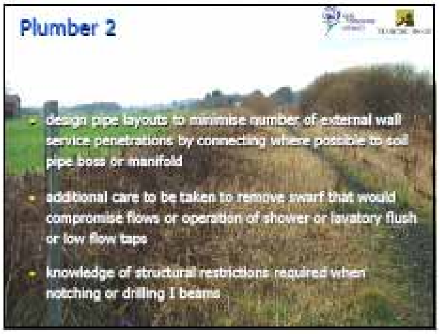

Parger 1
parging provides the primary airtight layer on the external walls (except where the dwelling is wet plastered – here the wet plaster provides the primary airtight layer)
the parger to take reasonable steps to fill small holes in blockwork prior to parging - unreasonably large or numerous holes or service penetrations may be reported to the site manager for other trades to patch


Parger 2
apply a continuous parging coat from lower to upper floors and right up to the intermediate floor joists. When the parging is dry, apply a silicone seal at the interface between joist and parging
fully-fill chasing and area around cable entries to back boxes in external walls
parger/plasterer has additional responsibility to ensure site management inspection takes place before dry-lining

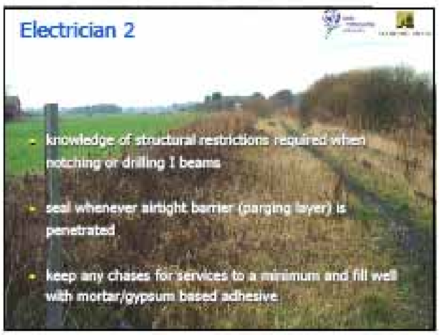

Plasterboarder 1
plasterer has to check that all service penetrations are sealed prior to fixing plasterboard
check that all cavity insulation drill holes are fully-filled before plasterboarding
the plasterer has the additional duty to ensure an inspection is made by site management after parging and before dry-lining


Plasterboarder 2
ensure chases and around electric boxes are filled prior to dry-lining
apply continuous ribbon of bonding around perimeter of external walls
apply 8mm cement render mix on separating walls in lieu of parging (n/a to wet plastered houses) for noise reduction - ensure render is applied to each wall face and is not float finish (rough is better!)


Plumber 1
any holes cut in floors to be circular and of minimum size to suit diameter of pipe
all service penetrations through floors to be sealed with mastic
all service penetrations through brick/blockwork to be sealed neatly and resiliently, internally and externally
plasterboard will not provide the air barrier – penetrations must be sealed before plasterboarding


Plumber 2
design pipe layouts to minimise number of external wall service penetrations by connecting where possible to soil pipe boss or manifold
additional care to be taken to remove swarf that would compromise flows or operation of shower or lavatory flush or low flow taps
knowledge of structural restrictions required when notching or drilling I beams


Electrician 1
seal top floor ceilings around cable entries to light fittings, sensors and fan grilles or use proprietary airtight fittings
fix airtight grommets to back boxes or use proprietary airtight boxes
seal mains cable service entry through hockey stick


Electrician 2
knowledge of structural restrictions required when notching or drilling I beams
seal whenever airtight barrier (parging layer) is penetrated
keep any chases for services to a minimum and fill well with mortar/gypsum based adhesive


Silicone man
areas where sealing is required for airtightness
mastic seal around soil pipe whether tiled or not


Ceramic tiler
all tiles are to be laid to surfaces (prepared by others) and you are to satisfy yourselves that the sub base is suitable for the laying of your materials - this includes making sure any gaps around service penetrations are fully filled prior to tiling


This is not an experiment
the houses have been designed to use trusted technology from the UK and other countries
this is an opportunity to contribute to help shape the future of the house building industry

STAMFORD BROOK

INDUCTION to SITE TRAINING PROGRAMME
CERTIFICATE OF ATTENDANCE

This is to certify that .... *attended the induction to the site training programme*

Awarded by .... *Date:* ....

Research project

- LeedsMet is asking the whole construction industry what they think about building to high environmental standards - designers, construction staff, sales teams, building control and suppliers
- findings will directly inform next revision of building regulations
- LeedsMet want to chat to construction staff and photograph construction details and will record and pass on ideas and opinions
- LeedsMet will offer guidance and feedback on the construction process but does not have a supervisory or checking role

Documentation referred to

- construction specification; site training plan; robust construction details

Thermal bridging

- wherever possible, the insulation thickness will be maintained where a construction junction occurs

Airtight construction will be achieved by:

- applying a parging layer to act as the primary airtight barrier
- sealing all service penetrations
- taking extra care with known leakage routes
- feeding back into a continually developing site training programme
- additional site supervision
- (note: sealing the plasterboard layer may not improve leakage through the airtight barrier)

Bryant Homes THE NATIONAL TRUST REDROW leeds metropolitan university

Appendix 7: Modifications to raft detail

Modifications to raft foundation detail

David Roberts 30th September 2004

Introduction

Since the report dated 15th September 2004, there have been three reasons to continue the analysis of raft thermal performance.

- In the report dated 15th September 2004, it was recommended to increase the underscreed insulation thickness from 65mm to 85mm. The Project Director and the Contracts Manager have since gone further and decided to use 100mm, mainly to assist the coursing. This additional insulation obviously gives us more headroom to play with.
- Concerns have been expressed on site that the as-built slab meets the outer leaf creating a thermal bridge.
- Another recommendation was to use an insulating block (λ=0.1 W/mK) between the slab and the blockwork inner leaf. However, the QS has since asked if it is now possible to use medium density block in this position since there is some headroom provided by the extra thickness of underscreed slab. This change was thought desirable to avoid having two types of block on site and to streamline deliveries.

Cavity between outer leaf and slab

Two models are shown in Figure 1, one with the originally suggested insulated cavity between the outer leaf and the slab, and the proposed detail where the slab is cast so that it meets the outer leaf. Since only few of the isolines occur below the top of the slab, casting the slab to meet the outer leaf only marginally increases the psi value, by around 6 %. The performance through the wall section is largely unchanged.

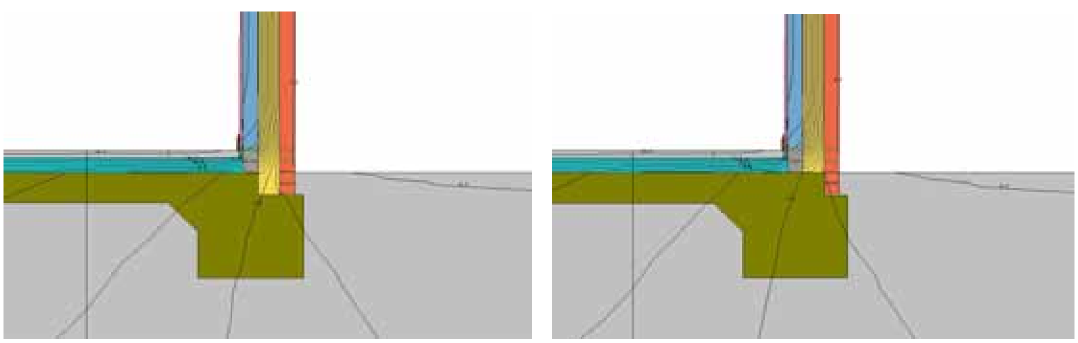


Figure 1: Effect of replacing cavity insulation below dpc with concrete.

Thermal blocks or medium dense concrete blocks

Two models are shown in Figure 2, one with thermal blocks (where the inner masonry leaf crosses the insulation layer) and one with medium density blocks in the same position. Again, there are only four isolines below the insulation layer indicating very little heat movement there. This is probably because the construction now has a substantial underscreed insulation layer and this contains most of the isolines. There is a 21% increase in floor psi value when medium dense blocks are used to bridge the insulation layer. Consequently, the choice of thermal block or medium dense block makes a significant difference to edge heat loss, especially in detached houses. The cumulative effect of losing the insulated cavity below dpc and losing the insulated block is a 29% rise in psi value. Interestingly, this large change in psi value only corresponds to a small change in whole floor U value, from 0.16 to 0.17 W/m^{2}K. This is partly because the 100mm underslab insulation gives a nominal floor U value much better than that of the wall. However, there is also additional heat loss through the wall, as indicated by the change in isoline spacing through the wall section (RHS, Figure 2).

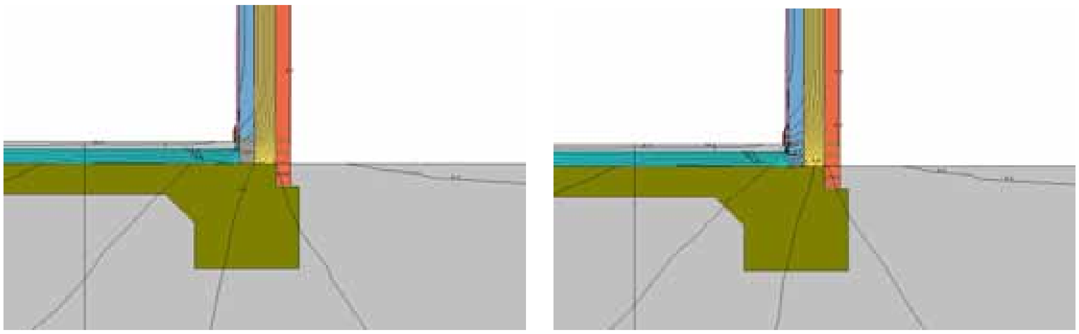


Figure 2: Effect of replacing thermal block (left) with medium density block (right) between slab and inner leaf.

The magnitude of this heat loss through the wall is shown by heat flow vectors in Figure 3. Strong concentrations of vectors flow into the coursing block (bypassing the edge strip) on their way to outside. Consequently, the wall psi value is increased in addition to the floor psi value. As the whole wall U value is already approaching its trade-off limit, the use of the thermal block is therefore recommended despite the additional buildability problems such as extra deliveries and the handling of two types of block on site. As a general rule, the weak point in a floor/wall junction detail is the coursing block that interrupts the wall and floor insulation layers. It should have as low a thermal conductivity as possible.

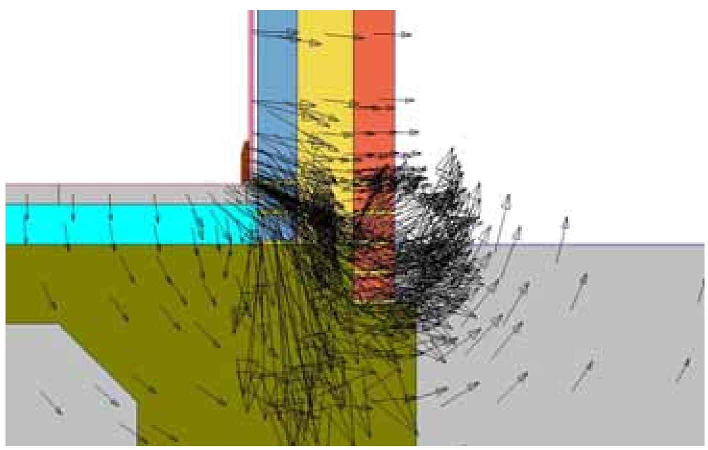


Figure 3: Heat vectors through wall with medium dense coursing blocks between slab and inner leaf.

Revised (30-09-04) recommendations for raft foundation design

- 100mm rigid urethane insulation under the screed.
- Insulating block (λ=0.11W/mK) between slab and inner leaf.
- 2 brick courses from dpc to toe of slab (unless sloping ground levels dictate otherwise).
- Slab can meet external leaf (subject to dpm) without creating a thermal bridge
- Edge strip insulation not needed.
- Leave out occasional bricks at low level to allow later cleaning of cavity droppings.
- No insulation required underneath the raft.

Appendix 8: Raft pile & strip foundations

Raft, pile and strip foundation details for Stamford Brook

David Roberts 15th September 2004

Introduction

A foundation detail was developed by the design team and drawn by the Details Designer in the early stages of the design stage. The detail addressed thermal bridging, airtightness and buildability issues and consisted of a strip footing with 65mm rigid urethane insulation under the reinforced concrete slab and perimeter insulation. This detail was signed off as part of the contract documentation that formed the agreement between the Trust and the developers, see Figure 1.

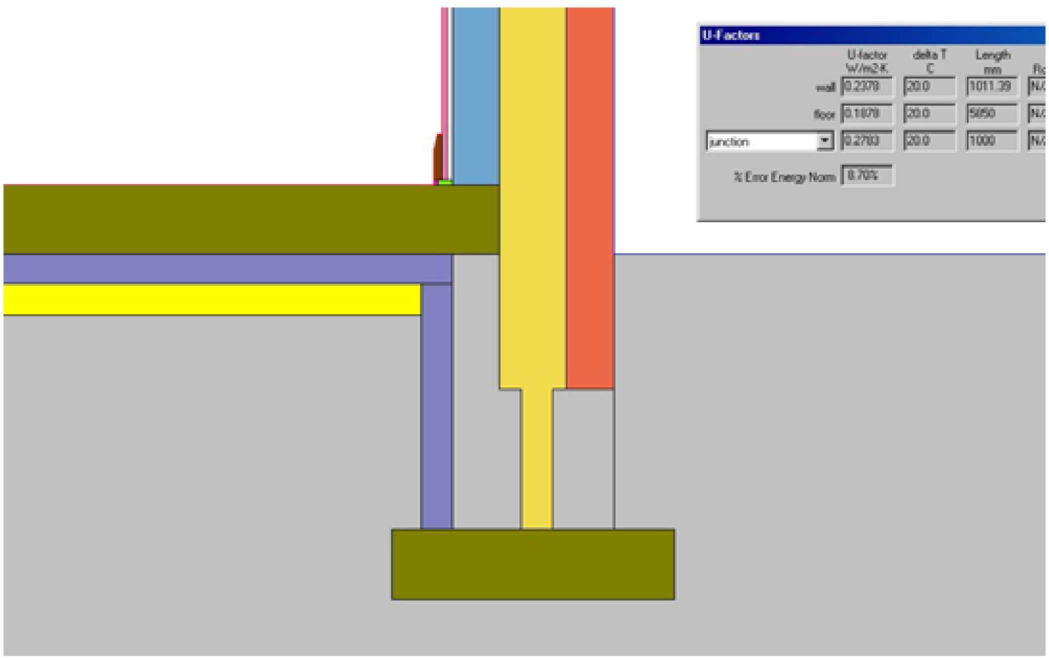


Figure 1: Original foundation design – strip footing with 65mm under-slab insulation, perimeter insulation, thermal blocks between slab and footing and cavity insulation extended below ground level.

However, ground conditions at Stamford Brook necessitated other foundation designs: a piled and a raft foundation on vibro-compaction for areas 3 and 6, respectively, in Phase A. The foundations were started in July 2004 and it was not until September that the research team realised that the new designs may not fully comply with the EPS. The foundations had been designed by the External Groundworks Consultant, who had been involved in the river restoration and other ground works. Unfortunately, they were never involved in the EPS meetings relating to the dwelling construction and were unaware of the thermal bridging requirements of the energy standard. Their drawings for the pile foundation, for example, showed components suitable for cavity widths in common use currently (ADL2002).

In September 2004, foundation construction on site was halted briefly while the research team was asked to model the raft and pile details to identify packages of measures that would allow all foundations to conform to the EPS requirements. Some adjustment was thought necessary to the foundations that had already been constructed. The research ream made initial studies using Therm and showed that both these foundation types suffered from greater thermal bridging than the strip type. In the strip footing, good performance was achieved by using thermal blocks below ground (λ=0.11W/mK, Thermalite Turbo or similar) and by extending cavity insulation some distance below ground level (Figure 1). These measures were not applicable to the raft and pile so, to compensate, deeper thicknesses of insulation were considered as well as the use of edge insulation and thermal blocks (λ=0.11 W/mK) to support the inner leaf under the slab.

Whole ground floor U value

Ground floor whole U value is highly dependant on perimeter to area ratio. The Derwent house type is used as an illustrative example here because that house type is available in mid, semi and detached variants. As mentioned, the original foundation detail developed by the design team was a strip footing with 65mm insulation under the slab. This detail achieved whole U values of 0.23, 0.24 and 0.25W/m^{2}K for the Derwent mid, semi and detached variants, respectively. Although none of these exceeded the maximum trade-off value 0.26, none reached the 'elemental' target of 0.22 W/m^{2}K, either. The difference in whole U value was a significant factor in the mid and semi Derwent variants attaining the carbon rating requirement (8.7) and the detached Derwent failing. The research team thought that, although the original floor design was adequate, it left very little headroom to achieve the whole house energy target, especially in the detached variants. In light of this, it seemed sensible to slightly increase the performance of the proposed ground floor details to allow detached variants to comply more easily.

Raft

The preliminary raft drawing showed seven brick courses from slab to dpc. The research team wanted to fully fill the cavity with insulation down to the slab but there were concerns about ground pressure and so the builder decided to fill part of the cavity (the lower three courses) with lean mix concrete. If this is the case, the builder could re-shape the slab to have a thicker 'toe' so that there are effectively four brick courses from slab to dpc without detriment to thermal performance.

Thermal performance improves by increasing insulation thickness from 65mm to 85mm. A further increase is found when thermal blocks are used at the side of the screed and the floor insulation - an insulating block improves the psi value of the junction by 29%. These measures are shown in Figure 2.

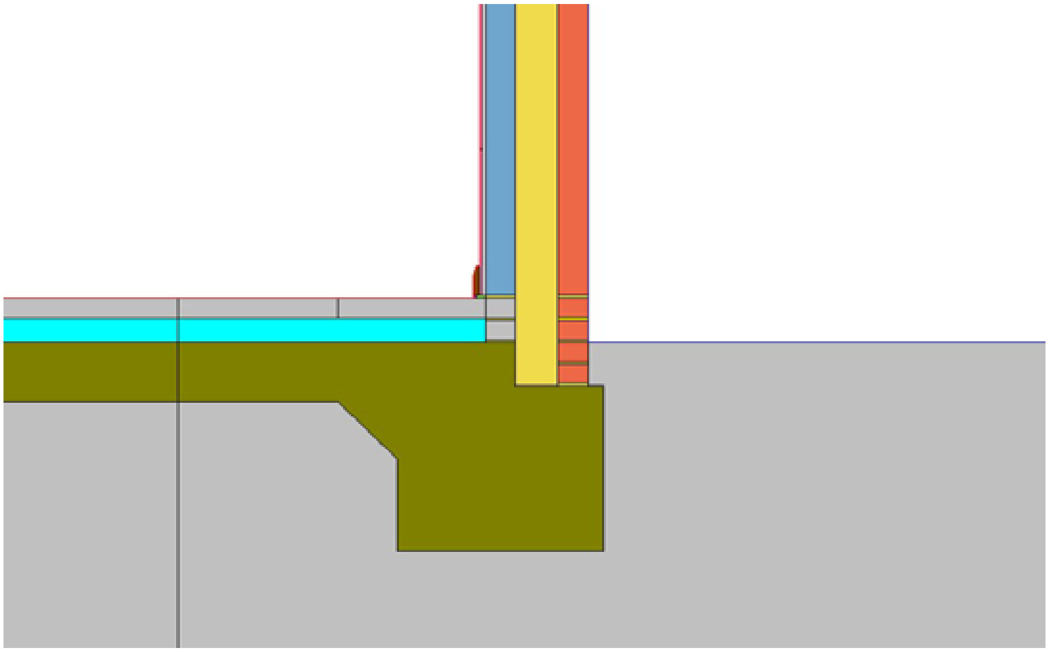


Figure 2: Raft with 85mm under-screed insulation, thermal blocks between slab and inner leaf (actual dimensions of raft dependant on structural considerations).

Using a raft that has four courses to dpc, thermal blocks and 85mm insulation raises the carbon rating of a Derwent detached from 8.64 (fail) to 8.72 (pass) compared with the original strip foundation design. SAP rating also rises one point to 105. The whole floor U value improves from 0.25 (strip) to 0.21 W/m^2K (raft) in the Derwent detached.

Pile

The pile foundation was constructed from driven piles, pile caps and a ring-beam. Some piles were already driven at the time of the study and so it was not possible to continue the cavity fill down to a sufficient depth to alleviate thermal bridging in these constructions. If later foundations are constructed deeper in the ground and extra (thermal block) courses placed between the ring-beam and floor level, then the cavity created could be filled with insulation at that point. Again, the ground pressure may limit the height of this cavity fill below dpc. However, this under-build construction option may be may be more expensive than simply adding extra insulation, the next option considered.

The preliminary pile foundation design (by Parkman) had 65mm insulation below the slab and no perimeter insulation. The site Project Manager first alerted the research team to the fact that piles would be used when he asked them about perimeter insulation. He realised that the pile foundation was different from the original strip design and had no edge insulation and wondered what difference it would make to the thermal performance. The research team instinctively replied that perimeter insulation should be used and that further investigation would be made using computer modelling. However, the effect of the edge insulation was not as pronounced as expected.

The complex shape of the ring-beam and the pile cap made it impractical to snugly place perimeter insulation anywhere but at the top 200mm. Even if it were practical, the ring-beam itself extends well into the cavity, allowing significant bridging through the structure.

To compensate the unavoidable thermal bridge through the ring-beam, the under-slab insulation was increased to 100mm with 100mm edge insulation on the inner side of the ring-beam and thermal blocks supporting the slab (λ=0.11W/mk), see Figure 3. It can be seen that the thermal block (many isolines) makes a **significant** contribution to the thermal performance while the perimeter insulation (only one isoline) does not.

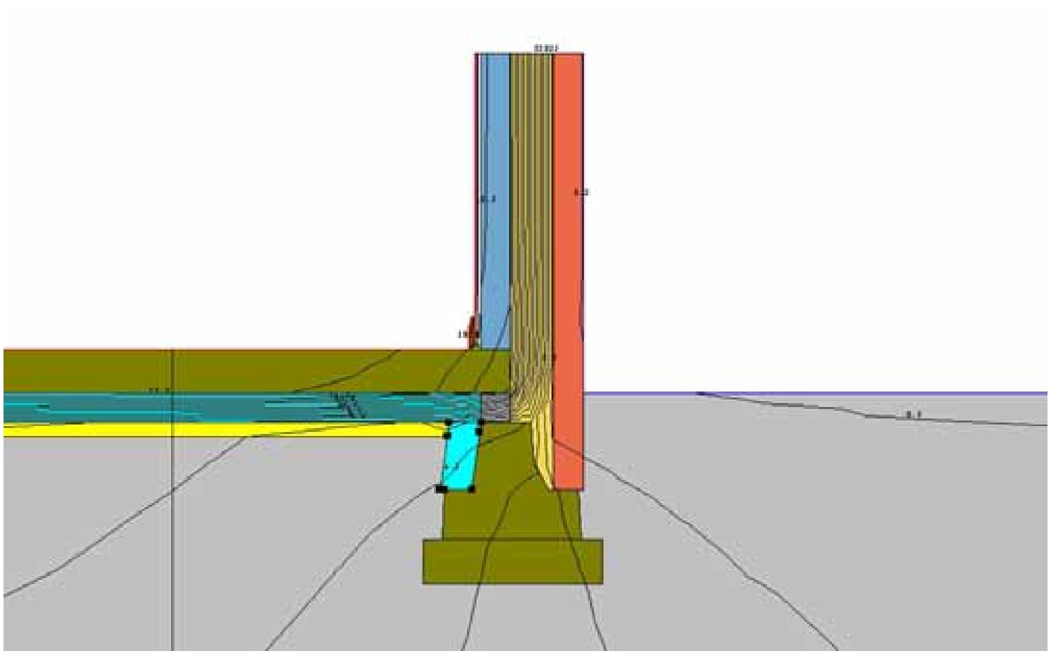


Figure 3: Pile foundation with edge insulation.

This interesting finding is confirmed in Figure 4 which shows the same model but with the perimeter insulation replaced by soil. In this particular instance, counter-intuitively, perimeter insulation does appear not offer any benefit. This material could therefore be OMITTED and the cost of supply and fit could offset the cost of the extra thickness (100mm)of under-slab insulation.

Figure 5 shows where material cost and labour savings can be made on site. All perimeter insulation in the pile foundations is not necessary PROVIDED a thermal block is used under between the slab and the ring-beam.

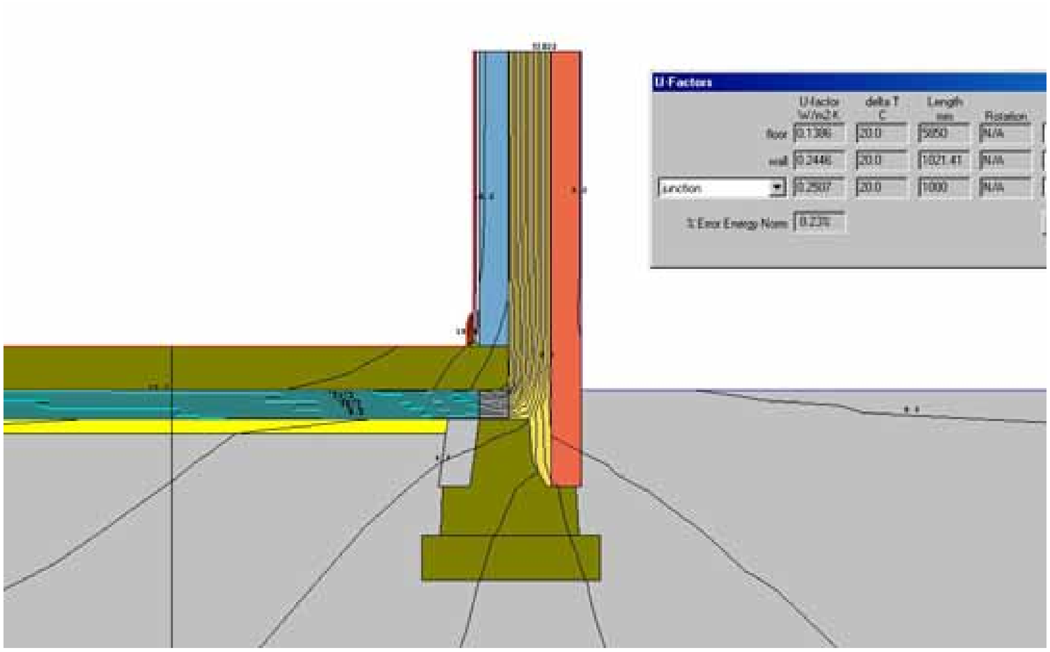


Figure 4: Pile foundation showing no difference when perimeter insulation removed.

Figure 5: Unnecessary insulation.

With these measures, the pile foundation gives a whole floor U values of between 0.18 to 0.21W/mK, all better than the elemental target of 0.22W/mK. This just about allows compliance with the carbon rating of 8.7 (pass) in the Derwent detached compared with 8.64 (fail) with the original strip foundation.

The pile foundation has more thermal bridging than the raft foundation. To compensate for this, the pile has a greater thickness of under-slab insulation (85mm for the raft, 100mm for the pile). The result is that the centre floor performance of the pile is better than the raft but this is balanced by the better edge performance of the raft.

Pile foundations already constructed

Some plots (7 – 14 inc, Area 3) have already been constructed. If the block between the ring-beam is replaced with a thermal block (λ=0.11) then these foundations will comply with the EPS. The perimeter insulation can be left in or taken out as required.

Domestic Performance Calculator results

The nominal ground floor U values and the psi values of the ground floor junctions were input to the Domestic Energy Performance calculator to calculate whole U values and carbon ratings. The summary of U values is shown in Table 1. The details were optimised with the detached variant of the Derwent in mind and both proposed details have a whole U value of 0.21W/m^{2}K which is slightly better than the elemental requirement. These values are for the Derwent type only – other house types may have other U values depending on form, perimeter to area ratio, etc.

Table 1: Ground floor whole U values (W/m^{2}K) obtained with three foundation types and three variants of the Derwent house type.

(Note: different U values may be obtained in other house types).

	Strip	Raft	Pile
Mid Derwent	0.22	0.17	0.18
Semi Derwent	0.23	0.18	0.19
Detached Derwent	0.25	0.21	0.21

Summary of recommendations

Raft foundations

- 85mm rigid urethane insulation under the screed.
- Insulating block (λ=0.11W/mK) between slab and inner leaf.
- 4 brick courses from dpc to toe of slab (unless sloping ground levels dictate otherwise).
- Leave out occasional bricks at low level to allow later cleaning of cavity droppings.
- No insulation required underneath the raft.

Pile foundations

- 100mm rigid urethane under-slab insulation.
- No perimeter insulation necessary.
- Thermal block between slab and ring-beam ESSENTIAL.
- Leave out occasional bricks at low level to allow later cleaning of cavity droppings.

Pile foundations already completed, plots 7 8 9 10 11 12 13 14

- These plots are all Derwent terraces and therefore achieve the energy standard easier than other variants. However, it is imperative that the block between the ring-beam and the slab is thermal block (λ=0.11W/mK, Thermalite Turbo or similar).

- Perimeter insulation already fitted can be left in without detriment but is not needed for future plots.

Strip

- The original detail should be revised by the design and research teams to achieve parity with the performance of the new raft and pile details proposed in this paper. Improving floor U values slightly will provide headroom and help some detached dwellings which struggle to comply with the energy standard.

Construction specification

If these proposed details are accepted, the design and research teams will incorporate these details into the Construction Specification and Stamford Brook Working Details.

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Appendix 9: Effect of windposts on wall thermal performance

Thermal bridging through windposts

David Roberts, 11-10-04

In answer to the query on windposts, the thermal bridging through them is quite small. One reason is that, although the windpost is stainless steel, the bulk of it is in the internal masonry leaf. The insulation layer is only bridged by the ties which are 2.5 x 20mm in section. Since they only appear every three brickcourses, the total amount of steel penetrating the insulation is small. Another reason is that the overall length of windposts is small compared with other junction details.

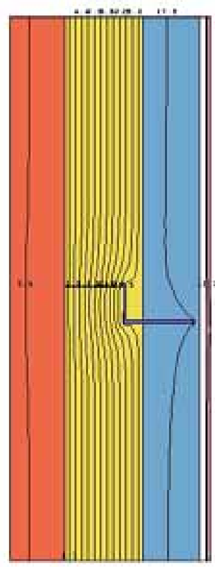


Figure 1. Section through wall showing L-shaped windpost in the inner leaf and the ties penetrating the insulation layer (see Appendix 1).

I calculated the psi value to be 0.0099 W/mK (see Appendix 2). This means that on a Calder which has 5 windposts at a storey height of 2.4m, the total extra heat loss will be 5 x 2.4 x 0.0099 = 0.1188W/mK, translating to a whole wall U value change from 0.253 to 0.256 W/m2K.

Conclusion

I think installing the windposts will have negligible effect on the dwelling thermal performance.

Appendix 1: Photo of windpost

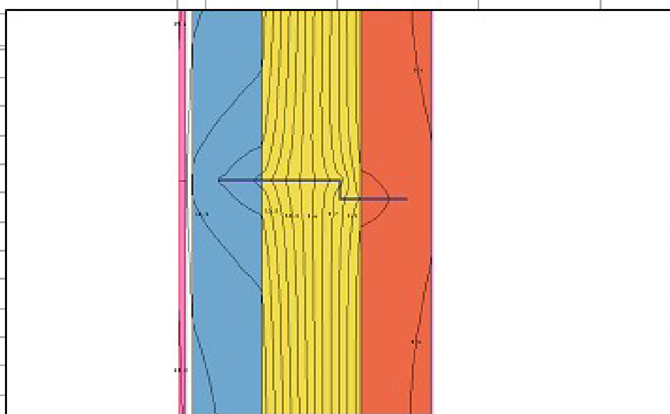
Appendix 2: Calculations

Psi value through windpost

David Roberts 11th October 2004.

Introduction

The windpost consists of a vertical angle built into the blockwork connected to stainless steel ties which bridge the insulation layer and into the brick outer leaf. There is a 25mm gap between the L of the angle and the cavity face of the blockwork, see plan.
The tie is 2.5mm X 20mm. The angle is 125 X 70 X 4.



Therm results

Two models were made, one showing the tie only and one showing the angle only. Heat loss through each was calculated and then added together to obtain a psi value for a metre length of windpost.

Windpost calcs						
Uwall	0.2300	W/m2K				
U tie only	0.2572					
U angle only	0.2375					
psi through ties						
Dimensions of the tie are 2.5 (y-axis) x 20mm (z-axis).						
In the z-axis, there are 1000/20 = 50 widths of tie in one meter length						
	0.0272	/	50	=	0.000544	
ties spaced at 225mm vertically,hence 4.5 ties per metre length.						
	0.0005	x	4.5	=	0.002448	W/mK
psi through angle						
Angle runs entire length of windpost.						
					0.0075	W/mK
total per metre length of windpost					0.0099	W/mK

Appendix 10: Thermal performance of eaves detail

Thermal performance of eaves detail

as designed and as constructed

David Roberts 1-11-04

Introduction

An eaves detail drawing 6050b has been issued recently (the research team received copies by post 7-10-04). The psi value through this newly-designed junction is not quite as good as the earlier eaves designs (e.g., drawing 020). In some ways the detail now more closely resembles current construction practice rather than an EPS08 robust detail.

In addition, the eaves detail actually constructed on plots 13/14 is different to the design in a way that further reduces the amount of insulation in the junction.

Eaves detail drawing 6050b

The psi value of the eaves junction is now 0.066 W/mK (originally 0.04 W/mK in drawing 020) which equates to a whole roof U value of 0.1908 W/m^{2}K for a Derwent detached. This is slightly outside the trade-off requirement of 0.19 W/m^{2}K. Semi and terraced variants may meet the requirement as they have less length of gable junction. The Therm drawing of this detail is shown in Figure 1.

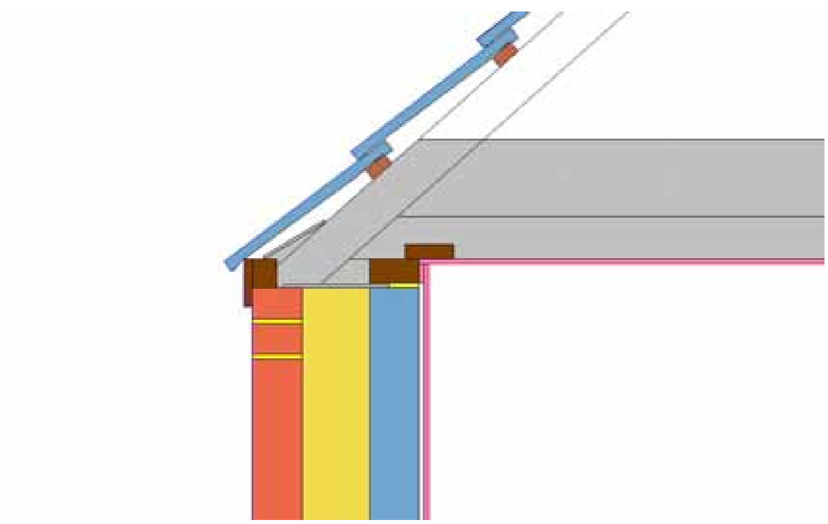


Figure 1: Therm drawing of detail 6050b.

The reason for the increase in psi value is due to the reduction in insulation thickness in the junction compared with earlier robust details drawings. The minimum distance across the insulation layer is from the top of the wall plate diagonally across to the top of the truss chord just underneath the centre of the first row of tiles as shown by red arrows in Figure 2.

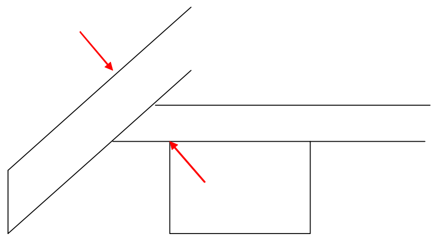


Fig 2 Truss birdsmouth 50mm into cavity (as drawing 6050b). Red arrows indicate minimum insulation thickness through the junction.

Eaves construction plots 13/14

On site, the minimum insulation distance across the insulation is even shorter than shown on drawing 6050b. This is because the truss birdmouth was constructed to fit snugly up to the wall plate (Figure 3) whereas in the drawing, the birdsmouth overhangs 50mm into the cavity (refer back to Figure 2).

Fitting the birdsmouth to the wall plate is the industry norm and so the truss manufacturer should be made aware of the requirements for this type of roof detail. Indications suggest that the truss manufacturer supplied trusses to a length taken from construction plans but not from the robust detail drawing which shows the overhang.

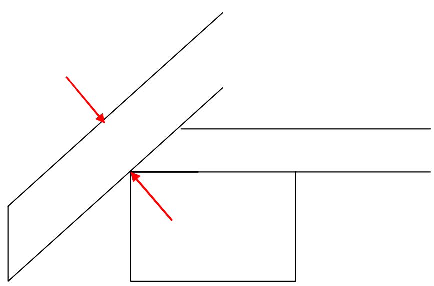


Figure 3: Roof as constructed with birdsmouth on wall plate.

When the insulation layer is reduced further by the space needed for the ventilation, the width of insulation at this narrowest point is only about 75mm. This compares with a distance of 105mm in the 6050b drawing and 150mm on an earlier robust detail (020).

Conclusion and recommendations

- Drawing 6050b is at the trade off limit for thermal performance in a cold roof (with 250mm insulation) and would benefit from further design iterations to improve thermal bridging through the junction.
- The actual construction of the eaves does not match drawing 6050b, resulting in additional thermal bridging.

The truss supplier should be made aware that the truss overhangs the wall plate and should and provide trusses with the necessary structural performance and/or connection plate.

Appendix 11: Homeowner information bullet list

STAMFORD BROOK

Homebuyer energy & environmental information

The low-energy dwellings at Stamford Brook have been designed to minimise greenhouse gas emissions and be environmentally friendly.

Environmentally friendly

- The dwellings achieve a predictive Eco Homes rating of "excellent".
- The dwellings are constructed where possible with environmentally-friendly products and materials.
- No materials affect the ozone layer.
- Sustainable timber is used throughout.
- Greenhouse gas emissions are a third lower than houses built to the 2002 building regulations and by more than one half compared with 1995. At this level of performance, the cost of space heating is less than the cost of domestic hot water.
- Water efficient taps, toilets, showers, pressure controllers save water and also energy and costs.
- Materials & paints have been selected to minimise odours/emissions in the home (low VOC, low formaldehyde etc).

Comfort through thermal insulation

- The dwellings have high levels of thermal insulation in walls, floors and roofs.
- Very high performance timber windows are fitted as standard.
- The dwellings require very little space heating to achieve thermal comfort.
- Low space heating means low greenhouse gas emissions from electricity and gas use.
- The insulation layer is designed to reduce cold spots and improve thermal comfort.

Free heat & light

- The layout of the entire site is designed to optimise free heat and light from the sun.
- Each dwelling has been positioned to minimise overshadowing from other dwellings.
- Houses have been orientated so that most windows face approximately south, again maximising free heat and light from the sun.

High quality construction

- Each dwelling has to pass a strict air pressure test.
- There are fewer micro-gaps and cracks in the structure which otherwise would allow costly heat to be lost from the building.
- There will be fewer uncomfortable cold draughts from doors, windows, loft hatches etc.
- The air pressure test also confirms high quality construction throughout.

Advanced ventilation systems

- Advanced ventilation systems will provide consistently fresh air in all rooms.
- The windows will still open as normal, if required.
- Condensation will be reduced.
- There will be a feeling of freshness in the air.

The Leeds Metropolitan University research project

A Research Team from Leeds Metropolitan University has been actively involved in the design and construction of the homes at Stamford Brook. Their research project is funded by the DTI and the Office of the Deputy Prime Minister. The main focus is the reduction of greenhouse gas emissions from dwellings in-use. Everyone involved in Stamford Brook, from architects to tradesmen, have been asked about their experiences in the design and construction of the homes. Now the team would like to ask the home owners what they think.

Everyone can contribute to the research project

Homeowners will be asked to contribute their ideas, experiences and opinions on living in a low energy home. This will involve short interviews about comfort conditions and energy use.

Ten special home owners

In addition, ten home owners will be invited to take part in a year-long study

where unobtrusive temperature and air quality sensors will be placed in their homes to measure actual performance over the twelve month period.

leeds metropolitan university

STAMFORD BROOK

Appendix 12: Householder ethics documentation:

1) Introductory letter

2) Information to householders

3) Householders agreement

1) Introductory letter

Dr David Roberts
Centre for the Built Environment
Leeds Metropolitan University
Brunswick Building
Leeds
LS2 8BU
d.roberts@leedsmet.ac.uk
0113-2831713

Dear

Stamford Brook Energy Efficiency Project

I am very pleased to hear that you have expressed an interest in taking part in the Stamford Brook Energy Efficiency project.

In order to take things further I need to arrange for you to meet me or one of my colleagues so that we can discuss what will be involved. To this end, I or one of my colleagues will be contacting you within the next few days to arrange a convenient time.

If in the meantime, if you have any queries or are no longer interested in being involved, please contact me. My contact details (phone, email, postal address) are at the top of this letter.

Yours sincerely

Dr David Roberts
Project Manager
Centre for the Built Environment
Leeds Metropolitan University

2) Information to householders

STAMFORD BROOK ENERGY EFFICIENCY PROJECT
HOUSEHOLDER MONITORING PROGRAMME
INFORMATION TO HOUSEHOLDERS

Thank you for expressing an interest in the Stamford Brook Energy Efficiency Research Project. In order to proceed, it is important that you are clear about what your participation will involve so that you are in a position to make an informed decision as to whether you wish to take part. This information sheet accompanies the householder consent form.

General Information

As you will know, all the houses on this estate have been built to much higher energy efficiency standards than most modern houses. In order to find out how much of a difference this advanced standard makes to occupiers as well as to the environment, researchers at Leeds Metropolitan University are carrying out a research project to monitor how the houses perform over the next year. The project is funded by the Government, the National Trust and the Developers and is part of a larger project that has looked at how the houses were designed and constructed.

Your involvement

Your house will be one of about 10 houses that we would like to monitor in detail for the next 12 months. Monitoring will be carried out by manual reading of your utility meters, and automatic sensing and data recording and will not require any action by you. Data from the sensors will be stored hourly in a small data logger placed nearby. The data will be downloaded to the University on a weekly basis via a special project mobile telephone connection. The following detailed measurements will be taken:

- **Temperature and humidity -** A small temperature/humidity sensor will be fixed in the main bedroom, kitchen, living room, bathroom, en-suite bath/shower (if present). This will help to assess how comfortable the house is.
- **Carbon dioxide** – A sensor will be placed in the main bedroom. Its purpose is to help to assess the effectiveness of the ventilation system.
- **Nitrous dioxide** – A sensor will be placed in the kitchen so that the effectiveness of ventilation in the kitchen can be assessed, particularly in relation to gas cooking.
- **Electricity consumption** – This will be measured by manual readings from the main electricity meter every month. In addition, a separate meter (next to the ventilation unit) will measure how much electricity the ventilation system uses and a small current meter will measure the electricity used by the electric oven. The additional meters will be read automatically and the data transmitted to the data logger.
- **Gas consumption** – As with electricity, manual readings will be taken every month from the main gas meter with further gas meters on the supply to the gas boiler and gas hob. These meters will be read automatically and the data transmitted to the data logger.
- **Heating for central heating and hot water** – One heat meter will be installed in the main hot water supply pipe and one in the main central heating flow pipe. This will show how much heat is being used for space heating and how much for water heating. In combination with the information on gas consumption it will enable the efficiency of the heating system to be established.

I am sure you appreciate that it is important not to move or obstruct the sensors, as this would affect the measurements. If you do need to move a sensor, for example if you are redecorating or moving some furniture, then please contact the research team who will be happy to move it for you.

In addition to the above we may wish to carry out an infrared survey of your home. This consists of a series of infrared photographs that show the main heat loss paths from your house. This will be discussed with you before it takes place and you will be asked again for your permission before it takes place.

Most of the sensors and meters are battery operated but two sensors (carbon dioxide and nitrous dioxide) will require access to a wall power socket. The location of this will be agreed with you when the equipment is installed and you will be reimbursed for the cost of the electricity consumed.

Interviews

At the beginning, during and at the end of the project, researchers will carry out interviews with you to get your views on your home and other aspects of energy efficiency. You may also be invited to participate in focus groups with other residents, researchers, the developers and the National Trust.

Contact

The monitoring arrangements have been designed so that we minimise the need to go in to your house. Once the system has been set up we will not require access unless a sensor or meter needs to be maintained or you request a visit. However we will need to gain access to the main utility meters. These are installed in boxes which are accessible from outside. We will visit your property once a month to read these meters. We will tell you approximately when visits are to take place and at each visit we will leave a card to inform you that we have taken readings, what the readings are and which member of the team took them. The card will have a contact number so that you can raise any queries you may have.

If for any reason we need to gain access to your house we will contact you to make an appointment.

All researchers will be employees of the University and will have passed all necessary security clearances. You will be provided with photographs and contact details of all the researchers. Researchers will carry University ID cards with them at times.

Anonymity

We will take all reasonable steps to preserve your anonymity and we will respect your privacy at all times. When producing project reports and other publications based on the research, the data that we collect from your home and from the interviews we conduct with you will be presented in an anonymous form. This means that we will not provide any information that would positively identify your home, you or any member of your household.

We are bound by the terms of the data protection act and, unless you give your permission, we will not disclose any information we hold about you or your household to any one outside the Leeds Metropolitan University research team. Your data will be held at the University and will be held securely.

At the end of the project we intend to preserve the data we collect in a data archive. However, in order to preserve your anonymity, all your personal details and information that identifies your home will be deleted.

Withdrawal

We fully understand that you may change your mind about being involved in the project and would reassure you that you are free to withdraw from the project at any time. If you feel it necessary to withdraw, all personal information will be deleted and if requested all research data relating to your house will be deleted also.

Your Property

Researchers will treat you, your household and your home with the greatest of respect and will take care to ensure that your property is not damaged in any way.

Further Information

Thank you for your interest in the project. If you have any queries please contact myself of one of the team at Leeds Metropolitan University.

Professor Bob Lowe, r.lowe@leedsmet.ac.uk, 0113-2831724

Leeds Metropolitan University

Centre for the Built Environment

Brunswick Building

Leeds

LS2 8BU

3) Householders agreement

STAMFORD BROOK ENERGY EFFICIENCY PROJECT

HOUSEHOLDERS AGREEMENT

I have read the householder information sheet and have been verbally briefed on the requirements and procedures of the project. I agree to participate as an:

(delete as appropriate)

a) intensively monitored household (fully monitored house and interviews)

or

b) Type 1 extensively monitored household (monitored meter readings and interviews)

or

c) Type 2 extensively monitored household (monitored meter reading, summertime temperature/humidity monitoring and interviews)

Signed………………………………………

Dated…………………………………………..

Address:

A