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MANAGEMENT OF THE CLADDING/SERVICES INTERFACE:  
A CASE STUDY

Alistair G F Gibb  
BSc, CEng, MICE, MCIOB  
Department of Civil and Building Engineering  
Loughborough University

ABSTRACT

Two of the most complex areas of modern buildings are the cladding and the building services. Both involve considerable specialist contractor input into the design development phase, and both require considerable coordination in their own right. Furthermore, historically, both have been the cause of project failure, recrimination and litigation (e.g. Anon 1996).

This paper describes an aspect of the author's research into interface management of complex cladding projects. It concentrates on the interface between the main wall cladding and the building services, drawing conclusions from a two year study considering fifteen major building projects. One of these projects, namely the Central Science Laboratory for the Ministry of Agriculture, Food and Fisheries (MAFF) near York (Figure 1) is presented as a case study example (Russell 1995).

INTRODUCTION

The interfaces between components and elements of a building continue to cause problems on major construction projects. This is particularly the case for complex elements such as external cladding and building services. Effective management of these interfaces will improve the outcomes of the project. Most designers try to separate the cladding from the services to avoid difficulties. However, on some projects this is not possible and a deliberate and systematic interface strategy must be developed to manage the interface between the designers, specialist contractors, installers and the physical works themselves.

The author has recently completed a two-year research programme funded by the UK's EPSRC and entitled "Testing Methods for Construction Interfaces." This programme forms part of the author's research into the interface management of large complex construction projects. This paper describes the research, concentrating on the interface between the external cladding and building services elements of the new MAFF Central Science Laboratory. Other facets of this research have been published elsewhere (Gibb 1994, 1995, 1996). Further work on the subject is underway (IMI 1997).

Figure 1 MAFF Laboratory Block Elevation  
Showing completed rainscreen cladding and service riser pods
RESEARCH CONTEXT

Hypothesis of the research programme

The hypothesis of this research programme is that the key to improvements in the efficiency of building design and construction lies in the area of interface management. By concentrating on interfaces, weaknesses in design and construction should be identified, leading to improved standards of detailing and workmanship. In this context, the term 'interface' defines the junction between two or more elements or components of a building. The research centres on the design development and testing of high performance, bespoke cladding for major building projects, as this is one of the more complex aspects of construction.

Research methodology

Case studies of 15 construction projects listed below were completed:

1 Camomile Street, London 2 ICC, Edinburgh 3 Embankment Place, London
4 Compass Centre, Heathrow 5 IFF, New York 6 10 Ludgate Place, London
7 100 Ludgate Hill, London 8 100 New Bridge St, London 9 Inland Revenue, Nottingham
13 UOB Plaza, Singapore 14 Vinners Place, London 15 MAFF, York

All projects involved complex external cladding of bespoke design. 59 key project personnel were interviewed. In addition, the views of others involved in the cladding design development and testing process were obtained through postal questionnaires and structured discussions.

MAFF CENTRAL SCIENCE LABORATORY, YORK

Project Description

The 44 000m² MAFF Central Science Laboratory comprises laboratories, offices, a conference facility, restaurant and small fitness centre, located at Rydale just outside the City of York. Construction ran from 1993 to 1996 at a cost of around £60M.

The focus of this paper is the standard laboratory block (45m x 17m) which was developed based on client requirements, laboratory sizes, fire escape routes and so forth. The structure is a steel frame with profiled metal decking and concrete flooring enabling a rapid onsite programme. The two storey buildings have a very simple layout with laboratories on one side of the block offices on the other with a spine corridor in between (Spring 1993).

The project procurement method was develop and construct, rather than design and build. The basic difference is that the design is very much controlled from the outset in the form of drawings and specification which determine the quality and the appearance to a greater extent than would be the case for design and build. Also the concept architect (RMJM) was retained via the Client's Project Manager (Symonds) to advise on the design development throughout the project. Laing Haden Joint Venture were the develop and construct contractor subletting the main cladding to Crittall Windows and the services work to various package contractors. Cladding consultant CladTech advised RMJM on cladding matters. A detailed discussion on procurement aspects is outside the scope of this paper.
Cladding Design

The initial concept design comprised a cladding system which had an inner wall then a zone of services vertically down the outside of the building. Then there would be a transparent outer wall. This lead to the development of the rain screen principle but with an opaque outer skin.

The rain screen incorporates an inner cassette panel, a void and then an aluminium rainscreen on an aluminium frame. The inner wall was on the project critical path, releasing both the internal works and the external service run installation prior to the fixing of the rainscreen panels. The inner wall cassette panel has a mineral wool core laminated so that it is cut at 90° to the panel. The cassette panel terminology originated with RMJM as the panels were fully enclosed at the ends and sealed into the frames, with the two faces and the four edges being wrapped in aluminium to form a completely sealed system (Anon 1993).

The final system, which was developed by Crittall and the Laing Haden team, does not follow quite the same principle - the aluminium on the edges was replaced with a thin reinforced silver tape - reasonably strong but not as robust as the aluminium. RMJM were concerned that the compression at the edges of the panel would not be withstood by the panel as there is no stiffness other than in the mineral wood itself and the edges are not reinforced - there is no mechanical fixing between the two sheets of aluminium. However, the system exceeded the specification requirements for the air penetration test at Crittall's works and Taywood Engineering. Window panels incorporate Crittall's Luminaire 2000 windows. The Crittall cladding, covering almost 10,000 m², cost around £5.6M.

Acoustics, possible infestation and demountability were the key design issues. All the cladding is demountable from the outside to enable future maintenance. This is an unusual requirement and involved new gasket design development. Also the open jointed aesthetic of the rain screen was important ensuring continuity and lining up between the different blocks. The project policy was to ensure that there was a second line of defence against the weather (e.g., if the gutter leaks it is outside the building - it will drain eventually into a sump which is itself separately drained).

Services Design

The building services concept design comprised a plant loft where services run at high level to facilitate future access for maintenance, relocation or enlargement. Also, it was decided to serve the laboratories from the perimeter on one side of the block. The original intent was that the laboratories could expand into the opposite side and by serving down one side of the block the ductwork and pipework could be routed through the ceiling void right the way across. This was different to the Nuffield principle which locks you into penetrations through the slab. Also it was decided that no wet services would penetrate the slab but rather be distributed along the perimeter of the building, accessing through the cladding where required. It is this aspect that is the unusual feature of this project. These service runs were then covered by pods in the rainscreen cladding (See Figure 1)

KEY INTERFACE ISSUES

The interface between the building services and the cladding was considered by all interviewees as the major interface on MAFF. This contrasts with other case studies where the services had generally been designed to avoid the cladding altogether.
Ductwork penetrations through the cladding

This interface comprises the insulated airhandling ductwork, drainage outlets and service supply pipes and ducts that penetrate the cladding on the laboratory elevation, and pass down between the insulated panels and the outer rain screen in a specially designed, removable pod (Figures 1 & 2). The office elevations also incorporate services within the cladding zone, but to a lesser extent than for the laboratories. This was rated as a very significant interface mainly due to the complexities of weatherproofing the penetrations and coordination of services within the area available in the rainscreen pods.

Design implications

The interface was indicated on the original scope drawings, although obviously at that stage the extent of the ductwork and other services, and in particular their sizes and positions, had not been determined. Therefore, the actual design of the penetrations had to follow the detailed design of the building services. This meant that the other aspects of the cladding design had to proceed, leaving the interface until a later stage.

Design coordination of the ductwork and pipework in the riser pods was critical, as the size of the pods had to be decided at a very early stage as it affected the aesthetic concept design of the buildings. It was not possible to design greatly oversized pods to cater for later design development of the services, since such pods would have affected the appearance of the building detrimentally.

Design coordination was centred on Laing Haden, who distributed appropriate information between the various interfacing specialists. There were no specific multi-trade interface meetings.

Weathertightness

The detail of the weather seal at the services penetrations was developed as the services and cladding design progressed. The final solution was to use a Sarnafil membrane, heat bonded and secured using a screwed steel band clamp (See Figure 2).

Concept architect RMJM would have preferred a more engineered solution possibly with a purpose made gasket. One of the difficulties was that there were so many variables that a standard solution was a problem and it would have been too expensive to produce a moulded gasket. One of the solutions RMJM suggested was to look at standardising the opening size by standardising the overall dimensions of the insulated ductwork (i.e. by varying the thickness of the insulation).

Weathertightness and buildability prototypes

A two-storey, two-bay prototype hybrid of the cladding system was tested for weathertightness at Taywood Engineering in London. The sample incorporated both
office and laboratory elevations as these were the main representative types on the project. A full review of the cladding testing is outside the scope of this paper.

The testing programme enabled the final design of the weather seal around the services to be developed. The advantage of a full-scale test is that complex areas of projects are built in advance of the main production run. This enables three dimensional spatial problems to be addressed, providing the tests are programmed early enough in the project to enable this evaluation. One of the difficulties on this project was that the ductwork sizing was not complete at the time of the main cladding test. This was solved by arranging additional tests at Crittall's cladding works.

This smaller scale test was very effective. In fact, it is likely that the large scale test would not have considered this interface adequately as the test is not sensitive enough to pick up the effects of the relatively small interface area involved.

The drainage penetrations were not included in the test regime. The design solution for them was similar to that for the ductwork. The cladding mock-up did not involve the services contractors. Crittall were asked to install the ductwork into their sample based on information provided by Laing Haden. In terms of the technical test this did not present any problem. However, other projects considered in the author's research have identified the additional benefit of involving interfacing contractors, in particular in resolving installation issues of sequence, access or protection (Gibb 1996).

The specification also includes an on-site spray test of one bay per elevation chosen at random. This test, of course, also tested the services / cladding interface.

Installation sequence

The installation sequence for the service pods was as follows:
1. Crittall install the internal cassette panels, providing box-outs based on information from Laing Haden
2. Haden install ductwork and insulation
3. Crittall apply a weather seal to ducts / pipes etc. (As in Figure 2).
4. Crittall complete the rainscreen.
5. Internal wall linings installed by the internal fit-out contractor.

Secondary steel work support for services in riser pods

At tender stage the support for the services pods was to be secondary steel by others. However, during design development an additional mullion against the main steel frame has been added with Crittall supplying the support work.

Cladding / internal services interface

The interface between the cladding and the internal fit-out items such as laboratory benches, small services and so forth also had to be resolved. There is the potential for movement between the centre point of the rainscreen and the fixed benching inside. Therefore, they are connected to a Unistrut frame supported off a piece of steelwork spanning between the bays, independent of the cladding.

Also, as the main heating was via radiators rather than air-conditioning, the method of fixing the radiators to the wall cladding had to be resolved. The final solution was again to provide an independent Unistrut support frame to avoid fixing into the cassette panels.
CONCLUDING THOUGHTS

The following are the key conclusions from the overall research:

• Problems on complex construction projects become concentrated around the interfaces.
• Tolerance issues at the interface, particularly with the building structure, cause major problems.
• Different trades have different cultures, with different attitudes to tolerances, damage and interface responsibility.
• Proper interface consideration is essential for effective management of the design development, testing and construction phases. Failure will lead to poor coordination on site, contractual conflicts and future problems with the works.
• Effort invested at the early stages of the project, particularly early design development, will reduce the problems encountered later.
• A positive, proactive and open attitude to interfaces from the whole project team improves constructability and productivity on site.

The cladding/services interface on the MAFF Research Park Project has presented the project team with a considerable challenge. Separation of these two trades remains the preferred approach. However, this case study has demonstrated that project success can still be achieved where services are integrated with the cladding works providing the project team addresses the issues concerned and considers interfaces at the design, testing and installation phases.

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