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| | The Structural Engineer and Curtain Wall Design | | | |

1. INTRODUCTION

There are a number of different roles which structural engineers can be asked to undertake in the design of curtain walls and each role will entail varying levels of involvement and responsibility. Some of these roles fall outside the traditional scope of work and fee structure of the consulting structural engineer responsible for the design of the building structure to which the curtain wall is attached.

This practice note is intended as a starting point for ACSE members to understand the various possible roles for structural engineers in curtain wall design and to clarify the extent of responsibility, liability and exchange of information advisable in the various circumstances, which might apply.

2. CURTAIN WALL DESIGN

The design of curtain walls entails numerous inputs, including the following –


- architectural (appearance, aesthetics)
- structural
- energy transfer (internal climate, effect on services)
- materials selection and performance
- weatherproofing
- ease of method of construction
- cost

The design of curtain walls can be undertaken in a number of ways. The most common method of documentation at present is the so-called “performance brief” method. The performance brief gives the design intent (both structural and architectural), but leaves the detailed design of the curtain wall to the curtain wall fabricator. The level of detail in the performance brief may vary substantially depending on the nature of the project and the experience of the parties preparing the performance brief.

Alternatively, documentation packages can comprise a performance brief and some prescriptive details, while another approach is for full documentation of all elements to be provided. These latter two methods would usually entail specialist input from a façade consultant or engineer experienced in curtain wall design.

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The long-term behaviour of some elements of curtain walls is not well understood and there are no appropriate codes of practice for the design of curtain walls. There are Australian Standards for the design of some elements (eg. AS1288 Glass in Building), for the determination of loads (AS1170.2 SAA Wind Loading Code) and for curtain wall testing (AS4284 Testing of Building Facades). Performance briefs may also include a requirement for prototype testing of the curtain wall, usually in accordance with AS4284. Such a requirement is usually restricted to special situations or large buildings.

Due to the lack of a specific code of practice, work in the field of curtain wall design entails a higher level of risk than many other structural engineering activities. Curtain wall structures can impose significant forces on supporting structures and structure/wall interaction may be of design concern, especially where curtain wall support members are tensioned back to the supporting structure.

It is important that the consulting structural engineer responsible for the building structure defines his role in the curtain wall design process carefully in order that he clearly understands what work he agrees to undertake, and what responsibilities are incurred by virtue of doing that work. Issues which should be kept in mind when considering a particular Client brief are those of a level of competence in the specific field of curtain wall design and the potential liability that might be assumed unless the areas of responsibility are clearly defined.

3. THE STRUCTURAL ENGINEER

There are a number of roles which a structural engineer may be requested to undertake in relation to the design of curtain walls. Generally these may be described as follows –

- building structural engineer
- curtain wall structural engineer
- independent review engineer
- façade consultant

The scope of services relating to the design of the curtain wall which may be involved in each of these roles is outlined in the following sections (3.1 to 3.4).

3.1 Building Structural Engineer


The structural engineer responsible for the design of the building will have an involvement with the curtain wall falling into one of two categories –

a) Preparation of a Brief

In this case, the structural engineer has no direct involvement in the design of the curtain wall and his involvement is limited to the preparation of a loading brief and the exchange of information in relation to the interactions between the building structure

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and the curtain wall. The information which he should be prepared to provide in any brief includes the following –

- a) structural principles of the building in narrative form
- b) wind load information (either wind directional terrain categories and shielding) or
- c) calculated wind pressures or the results of relevant wind tunnel tests
- d) earthquake loading parameters
- e) assumed loading from curtain wall onto the building structure
- f) edge beam or slab reinforcement details
- g) long-term edge beam absolute and differential deflections between floors likely to
- h) occur after curtain wall installation
- i) column shortening due to DL, LL, thermal movements, creep and wind loads
- j) differential footing movements
- k) any unusual building movements to be allowed for

The information the building structural engineer should expect to receive back from the curtain wall structural engineer should include –

- loading pattern of curtain wall as designed
- connection details to building structures
- details of movements allowed for within the curtain wall design

Although the responsibility for the structural adequacy of the fixings and inserts themselves lies with the curtain wall structural engineer, it is prudent for the building structural engineer to be satisfied that the proposed design of the fixings and connection details do not impact adversely upon the integrity of the building structure.

b) Review of Structural Adequacy of Curtain Wall

This would usually occur in addition to (a) above.

The structural engineer may be requested by his client to undertake a review of the structural adequacy of the curtain wall design provided by the curtain wall fabricator. This engagement falls outside the usual scope of structural engineering works and should be the basis of a separate commission. The usual extent and responsibilities involved in this type of work are similar to those outlined in Section 3.3 for the Independent Review situation. This type of work should only be undertaken by a structural engineer with experience in the structural design of curtain walls and thin framing elements.

3.2 Curtain Wall Structural Engineer

A structural engineer may be requested to provide engineering support to a curtain wall

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manufacturer. Although detailed design of a curtain wall system is occasionally performed at the documentation stage, the curtain wall system will usually be designed by the curtain wall manufacturer. The structural engineer employed by the curtain wall manufacturer (either a staff engineer or specialist consulting engineer) will be required to provide structural calculations to verify the adequacy of the proposed system. The structural design will always involve sizing the framing system and fixings to the structure and is likely to also include the determination of the infill glazing and cladding panels.

The curtain wall structural engineer should, in conjunction with the curtain wall manufacturer, review the documentation provided by the building design team so that a curtain wall can be designed to meet the requirements of the building designer. He should also be satisfied that the information about the building structure and movements provided by the building structural engineer is adequate for this purpose (see Section 3.1a for summary of information usually required).

The following tasks would generally be included in the curtain wall structural engineer's brief:


- confirmation or specification of load data for design purposes, including wind, earthquake, thermal etc,
- co-ordination of wind tunnel testing if required specifically for the curtain wall design, or interaction with the building structural engineer and architect if an integrated wind tunnel test is proposed
- structural design of curtain wall framing members, fixing components and infill panels
- structural design of curtain wall fixings to the structure, including connection details, such that these do not deleteriously affect the performance of the building structure
- determine joint sizes to take account of all building and façade movements
- review materials selection where this may influence the structural integrity of the curtain wall
- determine minimum glass thickness for strength

Any structural testing of a prototype which might be undertaken should be reviewed by the curtain wall structural engineer and the results assessed by comparison with the original calculations and design predictions.

The curtain wall structural engineer should also be satisfied that his calculations are suitable for submission for review by an independent review engineer (whether appointed by the client or a Principal Certifying Authority) if required.

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If agreed with the curtain wall manufacturer, the curtain wall structural engineer could also review quality assurance procedures during manufacture and installation and undertake random inspections as required. If certification of these phases is required, then the curtain wall structural engineer should undertake sufficient inspections to satisfy himself that the structural requirements of the design are being achieved.

Typical areas of work which would normally be undertaken by a curtain wall structural engineer also include –

- weatherproofing
- sealants
- durability, other than its effect on the structural performance

This type of work should only be undertaken by a structural engineer with experience in the structural design of curtain walls and thin framing elements.

3.3 Independent Review Engineer

A structural engineer may be appointed to undertake an independent review of the structural design of a curtain wall. The scope of such a review should generally be limited to the structural adequacy and performance of the curtain wall, unless a broader façade consulting role is accepted by, and within the expertise of, the structural engineer.

Structural reviews may be performed either on behalf of the client or a building authority. In either case, it is likely that much of the work will be reliant on documentation provided by the curtain wall structural engineer, usually via the curtain wall manufacturer. The independent review engineer should be provided with all information made available to the curtain wall structural engineer by the building engineer (see Section 3.1a), and all information produced by the curtain wall structural engineer.

A review of the structural adequacy of the curtain wall should generally include the following activities:

- Review the submission and comment on the presentation quality. It should not be necessary for an independent review engineer to repeat the calculations due to poor setting out by the curtain wall structural engineer.
- Review the design assumptions and the determination of the applicable design loads.
- Review all structural calculations for framing members, fixing (including connection details to the structure) and infill panels

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- Comment on suitability of joint sizes determined to accommodate building and façade movements
- Review structural test results and conformance with design predictions and assumptions
- Review of materials selections appropriate to structural integrity of the curtain wall design

If independent certification of the curtain wall design is required as a result of the review, the independent review engineer should require that his brief is sufficient to permit him to satisfy himself that both the design calculations and probable performance of the design are in accordance with accepted good practice and relevant Australian Standards.

Structural reviews should only be performed by a structural engineer who has experience in the structural design of curtain walls and thin framing members. It is important to carefully define the limits of responsibility accepted with such commissions. Areas which could be excluded from a review of the structural adequacy of a curtain wall design might include:

- weatherproofing
- sealants
- selection of materials other than influence on structural integrity
- manufacture and installation of the curtain wall

3.4 Façade Consultant

In some cases, a façade consultant may be appointed by the client. The role of any façade consultant will generally vary from project to project, but façade consultants normally provide advice on a substantially broader range of topics related to the design of the façade than merely the structural adequacy.

The topics on which a façade consultant might provide advice may include the following:

- weatherproofing philosophy, including design of joints, panels and members to maximise the performance of the curtain wall
- structural design and behaviour of the curtain wall
- selection of materials, including consideration of physical and mechanical properties, durability of individual materials or components, and chemical and mechanical compatibility of different materials
- cost-benefit analysis of alternative systems or proposals

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- assessment of the ease of manufacture and/or construction of alternative details
- review of quality control and assurance procedures during manufacture and installation
- provision of an inspection/maintenance program during the life of the facade

This work will often include substantial requirements for co-ordination, monitoring and evaluation of testing, both of components and of any prototype.

A façade consultant may be appointed at the design stage by the client, in which case he may assume some of the roles assigned to the curtain wall structural engineer. Alternatively, a façade consultant may be appointed to undertake a review of the design proposed by the curtain wall structural engineer, in which case the façade consultant may be acting in the role of an independent review engineer on behalf of the client.

This type of work should only be performed by engineers who have developed or acquired specialist skills in these fields through extensive design and testing experience. However, it is of substantial importance that the scope of works for façade consultancies be clearly defined so as to ensure that work which requires skills or expertise not held by the particular consultant is not included in the consultant brief.

4. CERTIFICATION

An engineer's certificate for the design of curtain walls and their fixings would normally be supplied by the engineer responsible for the structural design of the curtain wall. Certification may also be required to include the manufacture and installation of the facade. Where such certification is required, this should be indicated in the original brief.


A Principal Certifying Authority may require this certification to be provided by an independent structural engineer other than the qualified engineer who prepared the design. Provision of such independent certification does not relieve the curtain wall manufacturer or his engineer(s) of their responsibilities for the design, manufacture and installation of the curtain wall.

Similarly, any independent reviews requested by the building owner do not relieve the curtain wall manufacturer or his engineer(s) of these responsibilities.

Where a structural engineer (whether the curtain wall structural engineer or an independent review engineer) is requested to certify the structural adequacy of the curtain wall, his involvement should be carefully considered. He must ascertain the level of certification required and ensure that his certificate is specific to this level of responsibility. Vaguely worded certificates may unwittingly imply tacit approval of the

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following matters, even if there has been no involvement by the certifying engineer in these processes:

- manufacture and installation of the curtain wall
- prototype test program and results
- quality assurance program

Where certification is specifically required to include these areas of involvement, then the certifying engineer should review his program and provide sufficient periodic inspections of manufacture, installation and testing to satisfy himself that the structural requirements of the design are achieved.

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