BUILDING REGULATIONS

AND

MEMBRANE STRUCTURES

A CASE FOR

MUTUAL UNDERSTANDING

AUTHOR

B.T. DAVIS McWilliam Consulting Engineers
Brisbane

SYNOPSIS

As Membrane Structures have advanced to the stage where the Industry which designs and supplies them is now somewhat permanently sustainable, and, their fields of application continue to broaden, it is timely to review their relationship with Building Regulations, in particular, the new Building Code of Australia.

The Paper provides a background to the present situation together with some thoughts on what might be expected in the near future.

In the Beginning;

'To understand the present, think of the past!'

It was around the late 50's that the foundations of our industry were cast. It was a time of experimentation and an outgoing search for something different. The results in terms of physical structures displayed materials, forms and concepts with which the Establishment were not at all familiar.

As with lots of new ideas most opportunities were offered in such non-normal areas as exhibitions, defence, space exploration and the like.

Applications to what might be termed 'normal' building were tentative, limited in number and were not taken too seriously. The often short life span and occasional failure in either performance or structure were readily noted.

It was against this background and through this 50-60's era that those involved in formulating or administering our present Building Regulations were 'learning their trades' as it were. They can be forgiven therefore, for not perceiving membrane structures as a significant element in the overall building scene. With far less than one percent of all building activities being other than 'conventional' this situation was quite understandable and economically defensible.

During the 70's and 80's, with advancing ecumenism around the world we saw strong movement towards unifying, or at least removing many of the often glaring differences between established codes and regulations. Some genuine attempts were made to create uniform world standards, eg. in the design of concrete structures.

In Australia, the last two decades have produced, after several false starts, the nearest thing we have had to a uniform set of building rules, viz. the Building Code of Australia (BCA).

The problems of bringing together some 7 to 8 well established systems, under one more or less universally accepted document were difficult enough without trying to extend its sphere of reference by covering all possible construction systems and new generation materials.

The present situation is then that membrane structures have been around Australia for more than 30 years, during which time no formal regulations have been developed for them per se, and there is presently no strong moves to do so in the near future.

REGULATIONS AND STANDARDS

It is interesting to look back through some of the older local Building Codes, long since amended and now about to be replaced by BCA. They were more or less self-contained documents with occasional cross references to the relatively limited number of Standards then existing. Phrases such as 'materials suitable for their purpose' and 'design in accordance with accepted engineering principles' still tickle one's fantasy!

We are all now well aware of the explosive increase over the last decade in the number (and technical complexity) of standards relating to building materials, and utilisation, and their related design and testing processes. One need only compare the thickness of Standards Australia's annual listing for 1975 with that of 1990.

The effect of this is that a contemporary Building Regulation like BCA can now concentrate on presenting an understandable framework of rules and policies uncluttered by refinements and mathematics. For these, it refers to and often incorporates the more detailed and specific Australian (or Overseas) Standards.

Two comments on how this impinges on both Building Administrators and Designers alike come to mind:

. Because BCA and the standards it refers to are so specific, there is a potential problem where a building material or system is proposed for which no formal standard exists; or again,

. To the making of standards there is no end. That is to say, there will never be enough nor adequately complete current standards to cover all materials and processes let alone 'new' ones and those in a constant state of development.

Both of these are particularly relevant to Membrane Structures. Regarding the first, it is notable that over 500 engineered membrane projects have been approved and completed throughout Australia, New Zealand and the near Islands in the last 15 years with no formal material or design codes in place.

As for the second, there are some who would like to see a design standard prepared for membrane structures. The counter to this is that those opposed to such a move greatly out-number those for it. Attempts in USA to have membrane structures directly referred to in various building regulations proved counterproductive to both the Industry and the client base.

One of the unfortunate effects of 'standardisation' is that 'stagnation' often results, and this is hardly what the membrane structures industry wants, given its sustained interest in new applications, yet-unchallenged markets and constant variety of form.

That having been said however, we must still operate within 'the rules' which, for the foreseeable future will be BCA and the current Australian (and relevant overseas) Standards referred to therein.

WHAT STANDARDS?

We said earlier that there were no formal Australian Standards relating directly to membrane structures.

It is proposed that in the very near future the results of wind studies on certain membrane forms reported on elsewhere in this Conference will be submitted for inclusion in AS1170.

Indirectly, however, standards do exist for such 'secondary' elements in membrane structures as steelwork, connections, cables, footings, ground anchorages, etc.

The all-important membrane, its production, conversion, jointing, and design remain as yet 'foreign' to an Australian Standard.

All is not blank, however, because fabrics, like any other structural material, can and must be tested for various fire properties to AS1530. These material test results are used in a very specific manner in BCA to define where and to what extent a membrane structure as we know it can be incorporated into, or indeed, be a whole building.

Now, when we look overseas it is a somewhat different story. Authorities such as ASTM, DIN, ISO, JIS have extensive test methods for fabrics, and these are regularly referred to within the industry.

For the design process, however, there still remains no accepted standard or design code of practice for membrane structures in general.

One exception is the low pressure air-supported structure. For Australian projects useful reference can be made to BS 6661 or CAN3-S367-M81.

These define loading, inflation system parameters, safety measures, etc. for what are essentially fairly standardised fabric building forms.

Even so, none of these standards or Codes of Practice are called up in BCA. Use of them within the industry is usually via the technical specification or as inhouse reference material for any given project.

The local suppliers of the fabrics commonly employed in our structures provide extensive data on their materials tested to the national standards of their country of origin, eg. ASTM, DIN, etc. Notably, because of the importance of fire performances all structural fabrics either of local or overseas manufacture have been tested to AS 1530.

MEMBRANE STRUCTURES AND BCA

The BCA was produced under a joint Commonwealth, State and Territory initiative with the basic objective of ensuring acceptable standards of structural sufficiency, fire safety, health and amenity in the design and construction of building throughout Australia.

It is notable that is Preface recognises that 'a building code cannot cover every issue concerned with the design and construction of buildings. In the case of innovative ..... building proposals beyond the scope of BCA, legislation may provide for the application to be referred to a Board of Referees'.

A reading of the Code reveals no reference in any manner or form, however obscure, to fabric or membrane structures. Accordingly, these must fit into the 'innovative building proposals' definition.

To date BCA has been legislated for in two states only though it is in trial operation elsewhere, with a view to its formal acceptance nationwide in a year or so.

In case one should fear the worst from all the above, BCA does not close the door. For example, broad statements of intent are included at the beginning of each Section to identify the objectives that the provisions of the Section are intended to achieve.

The Objectives are the basic concepts which apply generally to all buildings and structures. The provisions of each Part of the BCA are accepted by the Authorities as meeting the Objectives.

In some cases the provisions are expressed in performance terms. Accreditation Certificates, test reports or other documentary evidence may be used as evidence that a particular material, design or construction method meets the performance requirements of the BCA.

Where a provision states that the use of a particular material, component, method of construction or design satisfies a performance requirement of the BCA, that provision does not 'require' its use. An equivalent material, component, method or design may be used if it meets the level of performance prescribed by the provision concerned.

As with any Building Code, it requires that every part of a building must be constructed in a proper and workmanlike manner to achieve the required level of performance, using materials that are not faulty or unsuitable for the purpose for which they are intended.

Submission of evidence to support the use of materials and systems not directly defined in BCA is provided for, eg:

- A certificate from a professional engineer or other appropriately qualified person which;

  (i) certifies that a material, design or form of construction complies with the requirements of the BCA; and

  (ii) sets out the basis on which it is given and the extent to which relevant specifications, rules, codes of practice or other publications have been relied upon;

- any other form of documentary evidence that correctly describes the properties and performance of the material or form of construction and adequately demonstrates its suitability for use in the building.

These notes more or less outline the approach to approvals which has been found satisfactory in the past with existing Regulations by both Designers and Authorities, and, clearly will continue for some time in the future with BCA.

Membrane structures as part or the whole of a building are designed in the same rational way applicable to any other structural material and system.

This is in line with the principal elements in BCA, viz.;

- Building Classification
- Structure
- Fire Resistance
- Access and Egress
- Services and Equipment
- Health and Amenity

It has been found in the past, and there is no indication that in the near future, none of these other than fire resistance will require special attention when approvals are sought.

In this regard it is interesting to note the following objectives of BCA's Fire Resistance section;

Part C1 Fire Resistance And Stability

(a) A building must be constructed so that it is protected from fire in any other building.

(b) Materials used in the construction must be such that if there is a fire in the building;

i) the spread of fire and the generation of smoke and toxic gases will be minimised;

ii) stability will be maintained for a period at least sufficient for the occupants to escape and to ensure the safety of fire-fighters; and

iii) there will be little risk of collapse onto adjoining property.

Part C2 Compartmentation and Separation

Building compartment size and separating construction must have such that the potential size of a fire and the spread of fire and smoke are limited in order to ;

(a) protect the occupants of one part of a building from the effects of fire elsewhere in the building.

(b) control the spread of fire to adjoining building; and

(c) facilitate access to the building by fire-fighters.

These form a sound basis on which to consider the suitability of a membrane structure at design stage prior to submission for approval.

Reference ii) could offer some useful background information on the matter of fabrics and fire in buildings.

CONCLUSION

With hundreds of successful and oftentimes significant projects designed, approved and constructed the local Membrane Structures Industry has much to be proud of.

That this has been achieved with not one formally accepted design or material standard in place reveals a strong influence of co-operative effort and developed understanding on the part of Designers and Approval Authorities alike.

While cross reference to existing projects now eases the approval process by removing some of the mystique and providing recourse to tentative precedent it is strongly held by the Industry that a further period of historical assessment and ongoing development is needed rather than to join the headlong race to produce standards for materials, systems and design.

The new BCA has adopted the best elements of the many existing regulatory documents, and, as presently drafted, offers continued opportunity for membrane structures to be designed, approved and constructed in a desirable professional manner, ie. unfettered by rigid rules and standards.

In doing so, however, it demands the maintenance of a proper professional order from the Industry in general and a clear understanding of first principles from Designers in particular.

The successes to date, properly interpreted, will assist greatly in easing the approval path in the coming years.

REFERENCES

i) The Building Code of Australia, 1990.

ii) Davis B.T., Perceptions of Fire of Membrane Structures in Buildings, MSAA Convention, Canberra, 1990.