BRISBANE INTERNATIONAL TERMINAL

Part 3 – Structural Engineering

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INTRODUCTION

The architectural concept of the terminal was for a light, open building with a subtropical feel about it – lots of natural light and an absence of bulky elements.

With a floor plan size of 100 m x 150 m, it would have been easy to end up with a forest of columns supporting the roof using conventional framing approaches, or if not a forest of columns, then very large beams.

The external walls are up to 10.8 m high and structural support for the glazing could have been very bulky, approaching the appearance of a solid wall when viewed obliquely.

Structural solutions were therefore sought which would achieve the aesthetic objectives without compromising budgetary considerations.

ROOF SUPPORT

Typical column spacing in the subdivided areas of the building (office areas, arrivals areas, etc.) is 10.2 x 11.4 m.

By doubling the column spacing in each direction at the open departures level a column grid of 20.4 x 22.8 m resulted.

This removed 79 of the 99 interior columns but created very long roof spans. Carrying gravity loads using flexural members is not a very efficient method – utilising tension or compression is more economical. A solution was therefore sought which would reduce the beams spans without increasing the number of columns.

Tension is the most material–efficient method of resisting load and the first scheme investigated utilised cable stays (or rods, etc.). (See Figure 1). Because the roof is subject to significant upwards wind loads, the stays needed to have compression resistance capability, otherwise a second set of stays were required acting in tension below the roof. This proved to be a very economical solution in terms of weight of steel.

A second scheme was studied which utilised raking compression members to resist gravity loads. This had the advantages that the one set of members could resist the upwards wind loads as well as gravity loads and that all members were within the enclosed shell of the building. In terms of weight of steel, it was little different from the first scheme as the much greater column length of the first scheme required almost as much steel as the raking struts.

Weight of steel is not the sole criterion in evaluating a structure – buildability is an important factor. In this instance the builder foresaw significant difficulties in creating long beams with tension stays 6 m and more above the concrete floor. Safety aspects were also a major consideration. It was therefore decided to adopt the second (maybe less exciting) alternative. The result is what we see in the completed terminal.

The columns all terminate some 3.4 m above the floor – well above eye level so that the requirement for a wide spacing is maintained. The struts connect to the column via steel pins with similar connection to the roof beam.

All struts slope upwards and outwards creating an exciting visual effect rather than a clutter of closely spaced elements. Because one can never look through a series of struts, they never give a forest–like appearance.

Columns cantilever from the floor to where the raking struts are connected and the roof beams are continuos in both directions to provide a means of achieving stability as it is supported on members pinned at both ends.

Architectural engineering was employed all of the way through this project. The wide spread use of pinned connections is an example of this as is the use of steel cable bracing members. Both were employed in the mullions which provide vertical and lateral support to the glazed curtain walls and metal clad walls.

The usually tall mullions are in the form of what we termed 'bowstring–vicrendecl' trusses. One chord is straight, the other is curved and they are connected together by flat plate web members at 1.2 m centres. When spanning between floors, the mullions have a vertically slotted connection at the top so they do not act as a column transferring gravity load but for the uppermost storey they are fixed at both ends against vertical movement in order to avoid difficult wall to roof flashings and the like which would have been needed to accommodate roof movements. The resulting roof loads did not cause any increase in overall member size as bending stiffness had determined sizes originally.

The style of mullions was a response to the desire for transparency of the glazed facade. Solid members of the required stiffness would have been visually imposing.

To keep the members small, their effective length also had to be small. This was achieved by virtually unnoticeable 6mm stainless steel strand bracing at 2.4 m centres. The bracing was provided with rigid support at the columns. Standard rigging connections were specified but the fabricator manufactured his own at a cheaper price.

In these examples, lightweight is a relative expression in terms of the span. They are lightweight, rigid structures resulting from a search for economical solutions for long spans.