BRIDGE 101 - Bruce Judd

The need for a bridge is usually driven by community / commercial pressures.

The designer's objective is then to select the best materials and structural configuration to achieve the most effective Whole-of-Life structure.

Commonly used materials are steel and concrete. Steel is relatively light and is very strong in both tension and compression, whereas concrete is relatively heavy and has good compressive strength, but has virtually no tensile strength. For "Whole-of-Life" costings, concrete has good durability under most environmental conditions, whereas steel needs routine maintenance unless it is cast in concrete.

When a beam carries load and deflects downwards, the top of the beam effectively shortens and is in compression, while the bottom lengthens and is in tension. These tensions and compressions are known as "flexural stresses" and in Reinforced Concrete the compression is resisted by the concrete and tension by the steel.

Concrete can be pre-compressed with high tensile strength steel to enhance its capacity. This is known as pre-stressed concrete and is commonly used in bridge structures.

The main types of bridge structures are:

- Beams and trusses
- Arch
- Cables (Suspension and Cable Stayed)

Beams are either steel, reinforced concrete or pre-stressed concrete. Trusses are effectively skeleton beams with the top and bottom chords resisting flexure, and the diagonals and verticals transmitting forces between the chords.

Site conditions influence the selection of the type of bridge to be built. The site conditions include geological information and functional requirements such as navigational clearances and prominence of the location.

The designer's objective is then to select the best structural configuration and materials. Poor geological conditions require a light-weight structure supported on piles. As long-term settlement of pier supports is likely, the deck should allow movement, with joints at each support. This is known as "Simply Supported".

Good ground conditions permit longer and heavier spans to be investigated, and the rigidity of the supports permit fewer deck joints and a more efficient structure. These spans are known as "Continuous".

In both Simply Supported and Continuous decks, allowance must be made for expansion and contraction due to changes in temperature. In arch structures such as the Sydney Harbour Bridge and Gladesville Bridge, changes in temperature cause the arch to rise and fall.

Arches such as The Sydney Harbour Bridge and Gladesville Bridge resist loads as axial compressions in the arch. It should be noted that during construction the SHB was a cantilever truss until it was connected at the centre.

Cable stayed structures such as the Anzac Bridge anchor each cable into the deck, and resist load by tension in the cables and compression forces in the deck. Suspension bridges hang the deck from the cables and derive their stiffness from the mass of the cables, and distribution of load by stiffness of the deck. This form of construction is relatively flexible, especially for short span structures (less than 500m).