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London's Tower Bridge is an example of the compromises made to balance the needs between river and bridge traffic.

BRIDGES ARE MUCH MORE THAN JUST A CROSSING

Of the many man-made structures in the world, bridges are definitely the most fascinating of all.

The earliest bridges known to mankind were tree trunks straddling streams, which allowed humans and animals to cross streams to help farming and fishing activities, opening up useful opportunities to use fertile land.

As population grows, bridges allow more efficient use of land on both sides of a river.

Civilization would not have progressed so quickly and effectively without bridges.

Tree trunk bridges developed into rope bridges as the need for longer crossings arose, but to cross rivers, stone bridges were used for the next generation.

Applying mechanical forces to beneficial use, arches were built to take the strength of the bridge deck on top.

But there is a limit to this, as the strength of the arches, bearing compressive forces transferred from the weight of the bridge deck and its payload, reached their limits of the stresses imposed on the stone faces, causing them to fail eventually.

The invention of steel for construction opened up new opportunities for longer bridges.

Instead of using the compressive strength of rock, the tensile strength of steel, which is many times stronger, allowed for much longer bridge spans.

Most modern bridges use steel, facilitating a much more slender design for better aesthetics, and to economize on the use of materials.

Indeed, the first limit on bridge design is in the length of the span, defined as the length of bridge deck between adjacent columns.

The seventeen-arch bridge in the Summer Palace in Beijing was designed to limit the compressive forces on the stones used to construct the arches.

The engineers of that era devised a structure with numerous arches to span the length of only 150 metres, but that became a world-famous scenic spot.

The second limit of bridges are the depth of water in the crossing.

The deeper the water, the larger the height of the arch or columns and again this limits the span.

The third limit is navigation. Building a bridge for access is important, but we cannot neglect the need for the river to be used for navigation by boats. The height beneath the arches limits the size of the boats that can navigate.

There are, of course, solutions to this problem.

The smart engineers soon designed bridges with facilities to raise and lower the middle spans, to allow sea vessels to pass at certain times, but this affects bridge traffic at times of river navigation.

The famous Tower Bridge in London is a classic example.

For hundreds of years, when river traffic was not excessive, this may have been an acceptable compromise, but obviously not for a busy modern city.

To allow uninterrupted traffic for river navigation, the bridge deck must be built to a far higher level to give enough clearance for sea vessels.

Taller bridge columns need to be built, at much higher costs, and may affect air traffic in cities.

Tall decks also require a lot of land on both sides of the bridge bank to allow vehicle traffic to climb the gradient, making it even more costly to build and run.

There are a lot of technologies and engineering theories behind building bridges, and I shall try and describe them in my next article.

Veteran engineer Edmund Leung Kwong-ho casts an expert eye over Hong Kong's iconic infrastructure