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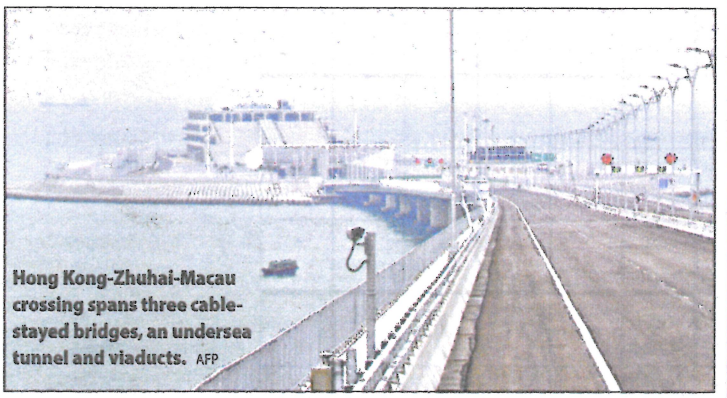

Hong Kong-Zhuhai-Macau crossing spans three cable-stayed bridges, an undersea tunnel and viaducts. AFP

THERE'S A LOT OF WATER UNDER THESE BRIDGES

Continuing with my theme on the technical limits of bridge lengths, let me explain how engineers build links across river estuaries, some of which may be over 20 kilometers.

For relatively shallow water, viaducts can be built across the bay, using a series of columns driven into the riverbed.

The problem comes when we need to allow large sea vessels to pass through.

A lifting bridge mid span may help, but it hinders continuous traffic for both road and water.

The topographies of riverbeds across estuaries often comprise lengths of shallow water and deep water.

Detailed surveying of them will provide data for engineers to design various components of the link to accommodate these different structures.

Armed with such information, a series of viaducts, cable-stayed bridges and tunnels can be built.

The limitations are again the length of the span of viaducts and cable-stayed bridges, with the former up to about 200 meters and the latter 1,000 meters.

Immersed tube tunnels can be built for lengths of up to seven kilometers, their limit being the ability to provide effective ventilation both for normal running conditions and for smoke extraction in times of a fire emergency.

But how do they connect bridges with tunnels in the middle of an estuary?

An ingenious solution is to build an artificial island to allow the road bridge to dip from its high elevation to below water level, meeting at a portal in the island.

The slope of the road, from bridge deck to tunnel, is limited to about one in 10, to ensure heavy vehicles can travel without too much difficulty.

With this limitation, it requires a long road to allow for the gentle slope.

A judicious choice of these three types of structures, connected by an artificial island, will allow a long link to be built, facilitating continuous traffic for both land and water transport.

The Hong Kong-Zhuhai-Macau Bridge is a glaring example of this new wonder of the world.

The total length of the crossing is 55 km, but it comprises three cable-stayed bridges, an immersed tube tunnel and viaducts for approach roads and along those sections of the route that have relatively shallow water.

It is made possible because engineers were smart enough to lay out these components along the link, applying their characteristics effectively to allow the bridge and river navigation traffic to flow freely at all times.

But if you think this is a unique invention, I hate to disappoint you as it is nothing new under the sun, especially with transport infrastructure.

It is believed that this was originally the brainwave of Gordon Wu Ying-sheung of Hopewell Holdings fame.

In the 1990s, his dream of this crossing was inspired by the Chesapeake Bay Bridge and Tunnel system in the US.

That 28.3 km link across the Chesapeake Bay linking Maryland with Virginia used a combination of tunnels and viaducts and served as a vital transport link for over half a century.

Engineers are applied scientists. Instead of new inventions, they continuously improve on ideas their forerunners had devised, improving and enhancing efficiency and effectiveness, while ensuring public safety, to better serve the community.

Bridges and tunnels are now common in many cities, but just imagine how we would have been able to use land across rivers and valleys if we did not have these ingenious components of the transport infrastructure.

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