

Tunnelling Project in Hong Kong – Alternative Design Tenders

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1. Introduction

The Hong Kong Special Administrative Region of the People's Republic of China (Hong Kong) with a current population of 6.8 million in its 1,100km² territory, experienced a rapid population growth in 1950's and 60's and an efficient transportation network was desperately needed. Since the 1960's, trunk roads and underground railways have been continuously built and many new major projects are now under construction. As the majority of the terrain is steep hillsides and very little flat land is available, the expansion of the transportation network could not avoid adopting tunnelling and underground excavation solutions. This paper describes alternative proposals made by a contractor in winning these tunnelling contracts, taking some project as examples. The contractor developed a different concept of design from those initially studied by the clients and the cost effectiveness of the proposals made led to their acceptance.

2. Design and Build Contracts in Hong Kong

Civil engineering projects in Hong Kong are normally procured on a traditional style contract where clients employ consulting engineers who undertake the design and also the construction supervision roles. Since late 1980's, when Build Operate & Transfer (BOT) projects started being introduced by the Government for toll tunnels, and were successfully completed, the majority of tunnel projects were let to contractors on a design & build basis.

The implementation process normally starts with the clients employing consulting engineer(s) for a project feasibility study. Once its feasibility is confirmed, a conceptual scheme is developed and necessary statutory procedures, including gazetting to the public and preliminary land acquisition procedures, are completed. When the scheme has been given statutory approval, a design & build tender is called and contractors, who also employ consulting engineer(s) as a designer, submit their bids.

This process implies that when a design & build contract tender is called, various physical constraints have already been imposed and, subsequently, only relatively minor flexibility in detail design stage may be possible.

3. Alternative Design Tender

The client normally issues technical requirements to the tenderer for compliance. The technical requirements include land availability, conceptual design information (such as indicative alignment, number of tracks/lanes) and design manuals/technical specifications. The detailed development of the client's design is done by the contractor.

Tenderers are required to submit a conforming bid which meets all the above criteria. If they decide to deviate their design from those specified by the client, they have to submit Alternative Tender(s). For example, if the proposed facilities lie outside the gazetted land, the contractor's proposal shall be categorized as an alternative proposal.

Three project examples, in which a contractor's alternative tender design proposals were accepted by the clients, including brief description and the difference between the original concept and the proposed design, are explained below together with schematic illustrations.

Tate's Cairn Tunnel

Construction of 3.9km long dual 2 lane expressway tunnel and approach roads was completed in 1991 under a BOT a scheme. Gammon-Nishimatsu Joint Venture's alternative design proposal was significantly different from the one originally planned by the Government in terms of both approach road layout and tunnel ventilation arrangement. The original scheme had two very deep vertical shafts (in excess of 100m) as intake and extract points for a semi-transverse ventilation system for the tunnels and they were located on steep hill slopes.

After its own investigation of suitable and readily available lands, the Joint Venture proposed two inclined adits instead. Immediate commencement of adit excavation enabled early access to road tunnel excavation at quarter points. This resulted in a substantial reduction of both construction cost and time which enabled the concessionaire to obtain the franchise license from the Government. The alternative proposal achieve considerable improvement in the rate of tunnel boring progress by working simultaneously on an increased number of working faces. The key issue for success was the Government's co-operation to acquire the land required for the alternative adits. FIG 1 indicates the difference between the original and accepted schemes.

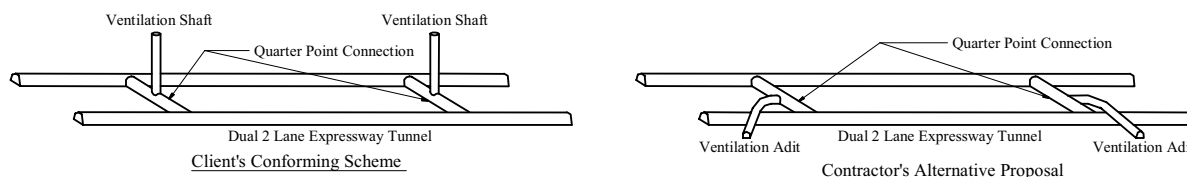


Fig. 1 Tate's Cairn Tunnel Schematic Diagram

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Route 3 Country Park Section – Tai Lam Road Tunnel

This B.O.T project (3.8km, dual 3 lane expressway tunnel) was completed in 1998 together with its 11km approach roads. In this tender the technical requirements by the Government were not clearly defined and the contractor (Nishimatsu-Dragages Joint Venture) investigated the optimum solution within the “conforming” framework. The Joint Venture’s target was to minimize the physical works and thus reduce time and cost.

By adopting a steeper vertical alignment the tunnel length was shortened and the volume of earth works in the adjacent approach road area, especially the rock cut, was reduced by 20% (i.e. 1 million m³). Of course, an alignment study was done, taking account of adverse impact on the tunnel ventilation system, but the benefit in civil works overwhelmed the negative ventilation impact. Another proposal offered by the Joint Venture was to eliminate the separate ventilation adits and relocate a third ventilation tunnel between the road tunnels.

Unlike Tate’s Cairn Tunnel, as mentioned above, the length of adits was long and they were not considered to contribute to any efficiency in construction. The Joint Venture decided to re-locate the adits and as a result, the site formation works became much simpler. The comparison of the schemes and illustrated in FIG 2 below.

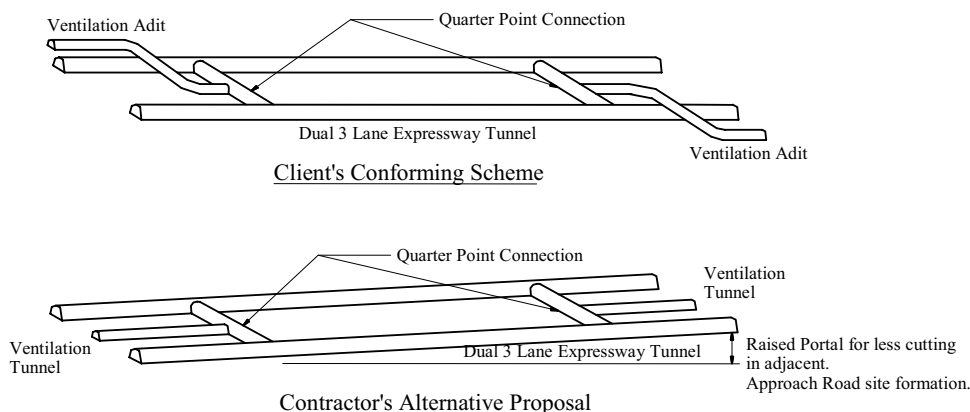


Fig. 2 Route 3 Tai Lam Tunnel Schematic Diagram

Kowloon Canton Railway Corporation – Contract DB350 Tai Lam Rail Tunnel

The client’s conceptual design indicated two separate tubes for 5.5km dual express railway tunnel with transverse connection adits for passenger escape at 100m intervals and one cross over rail tunnel between the two rail tubes. The separation of the two tubes was the critical requirement from Fire Services Department and fundamental to the acceptance of the bid.

The Nishimatsu-Dragages Joint Venture offered a large single tube solution with a separation wall at the centre. Cross passage doors replaced the passenger escape adits by an opening and a fire proof door provided in the separation wall. The cross-over tunnel was also replaced by huge opening and movable doors (5m high, 50m long) for trains to pass from one track to the other. The technical proposal was accepted by the client and the whole alternative scheme was adopted for the permanent works. FIG 3 below shows the comparison.

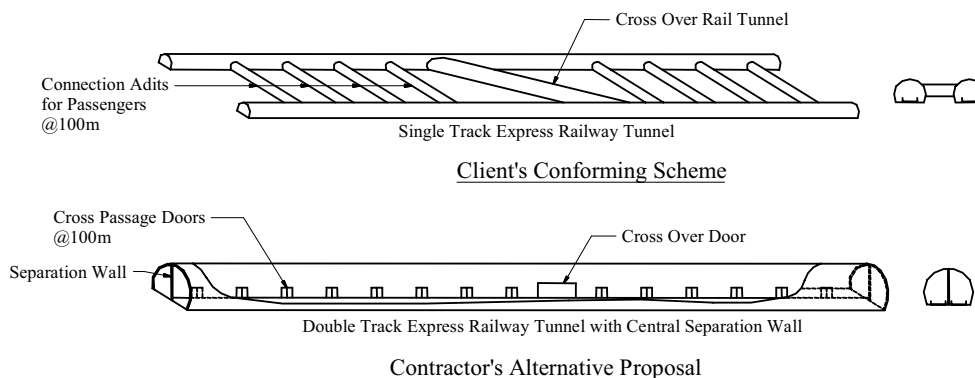


Fig. 3 KCRC DB350 Tai Lam Tunnel Schematic Diagram

4. Conclusion

The tenderers are given, normally, a two to three month period to prepare a design & build proposal. Investigation and selection of the best alternative design within such a short period is a very condensed exercise. Although design consulting engineers are employed as contractor’s designer, the lead party is the contractor who uses his experience to achieve buildability at the minimum cost and time. This ensure that an acceptable design alternative is proposed coupled with a reduction in the overall project cost.