ITEM FOR PUBLIC WORKS SUBCOMMITTEE OF FINANCE COMMITTEE

HEAD 708 – CAPITAL SUBVENTIONS AND MAJOR SYSTEMS AND EQUIPMENT
Subventions – Miscellaneous
3QR – Hong Kong-Zhuhai-Macao Bridge – funding support for Main Bridge

Members are invited to recommend to the Finance Committee (FC) to increase the approved project estimate (APE) of **3QR** by $1,514.7 million from $9,046.5 million to $10,561.2 million in money-of-the-day (MOD) prices.

PROBLEM

The APE of **3QR** is not sufficient to cover the cost of the works required for the detailed design and construction of the Hong Kong-Zhuhai-Macao Bridge (HZMB) Main Bridge jointly constructed by the governments of Guangdong Province, Macao Special Administrative Region (Macao SAR) and Hong Kong Special Administrative Region (HKSAR).

PROPOSAL

2. The Director of Highways, with the support of the Secretary for Transport and Housing, proposes to increase the APE of **3QR** by $1,514.7 million from $9,046.5 million to $10,561.2 million in MOD prices.

/**PROJECT** …..

PROJECT SCOPE AND NATURE

3. In May 2009, the FC of the Legislative Council (LegCo) approved the upgrading of **3QR** to Category A at an estimated cost of $9,046.5 million in MOD prices. The approved project scope of **3QR** comprises –

(a) detailed design and construction of a 29.6 kilometres (km) dual three-lane carriageway in the form of bridge-cum-tunnel structure comprising a subsea tunnel of about 6.7 km;

(b) detailed design and construction of two artificial islands for the tunnel landings west of the HKSAR boundary;

(c) associated works including civil, structural, environmental mitigation measures, drainage, electrical and mechanical works, installation of traffic control surveillance system and signage, etc.;

(d) miscellaneous expenses including land provision for works area, conservation measures for Chinese White Dolphins, further topical studies, testing such as detailed geotechnical assessment, engagement of consultants to carry out site supervision, bank loan interests accrued during construction, etc.; and

(e) operating cost of the management body of the HZMB Main Bridge (i.e. the Hong-Kong-Zhuhai-Macao Bridge Authority, hereinafter referred to as "HZMB Authority") [1] from commencement of the detailed design until the commissioning of the Main Bridge.

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[1] The HZMB Authority is a legal and non-profit-marking person organisation set up under relevant Mainland laws in 2010. It is responsible for taking forward the construction, operation, maintenance and management of the Main Bridge project under the supervision of the three governments. The HZMB Authority oversees the implementation of the Main Bridge project, including preparing the design and construction plan, carrying out tendering and assessment, managing site supervision, conducting quality assurance and material testing as well as managing, operating and maintaining the Main Bridge upon its commissioning. The HZMB Authority has also entered into contracts with various agents/contractors carrying out the above works.

—— A plan showing the alignment of the HZMB Main Bridge is at Enclosure.

WORKS PROGRESS

4. With the concerted efforts of the three governments and the HZMB Authority, the HZMB, including the Main Bridge, Hong Kong Section, Zhuhai Section and Macao Section, has been officially commissioned in full on 24 October 2018. Since the commissioning of the HZMB, there is significant reduction in the costs and travelling time between Hong Kong and western Pearl River Delta for people and goods. According to the information provided by the HZMB Authority, account finalisation of the main construction contracts is expected to complete in three years after the commissioning of the HZMB and has entered the final stage.

PROJECT COST OF THE HZMB MAIN BRIDGE

5. In February 2010, the three governments of Guangdong, HKSAR and Macao SAR signed the "Inter-Governmental Agreement in respect of the Construction, Operation, Maintenance and Management of the HZMB" ("Inter-Governmental Agreement") and confirmed that issues associated with the construction, operation, maintenance and management of the HZMB Main Bridge, the link roads and boundary crossing facilities of the three places would be dealt with according to respective local laws of the three places (the territoriality principle). As the HZMB Main Bridge locates within the Mainland waters, the project has to be implemented in compliance with and according to the works implementation procedures of the Mainland, including its methodology for estimation and approval of project cost, etc.

6. The HZMB is a mega scale transport infrastructure project across Guangdong, Hong Kong and Macao. Its scope, technical and engineering schemes, estimated sum of project investment and financing ratio were approved by the State Council in the project approval stage. In the subsequent preliminary design stage, the Ministry of Transport reviewed and approved the project estimate (similar to the "Approved Project Estimate" of public works in Hong Kong) having

regard to parameters such as the technical standards, wage rates, unit costs of materials and equipment, etc. of the Mainland with a view to controlling the total sum of project investment.

7. In 2008, the three governments agreed to share the responsibility for construction of the Main Bridge. Of the total sum of project investment contributed by the three governments which amounted to RMB¥15.73 billion, RMB¥7 billion (44.5%) was contributed by the Mainland Government, RMB¥6.75 billion (42.9%) by the HKSAR Government, RMB¥1.98 billion (12.6%) by the Macao SAR Government, with the remaining amount financed by syndicated bank loans of which repayment would be covered by the income generated from the operation of the HZMB.

8. When the funding application for **3QR** project was submitted to the LegCo in May 2009, the estimated project cost of HZMB Main Bridge based on the engineering feasibility study report was about RMB¥37.6 billion of which about 42%, amounting to RMB¥15.73 billion, would be contributed by the three governments. Subsequently, RMB¥34.72 billion was approved as the estimated project cost by the State Council in November 2009 and it was decided that the amount of contribution by the three governments be remained unchanged at RMB¥15.73 billion, amounting to around 45.3% of the project cost. Upon completion of the preliminary design, the Ministry of Transport approved the preliminary design and revised the project estimate of the HZMB Main Bridge to RMB¥ 38.118 billion. As approved by the State Council, the amount of contribution by the three governments still remained unchanged at RMB¥15.73 billion while the remaining RMB¥22.388 billion would be financed by syndicated bank loan.

9. According to the workflow of project implementation in the Mainland, the project estimate of the HZMB Main Bridge project was compiled based on its preliminary design in 2010. However, owing to the enormous scale of the project and its complexity, various engineering challenges and variations encountered during the detailed design and construction stages could not be fully foreseen back then. Given that the construction took place in the open sea where works conditions were extremely complicated, some of the design and construction schemes had to be refined in view of the greater-than-expected construction

difficulties, resulting in a longer construction period than expected. Coupled with factors such as increases in the labour and material costs, construction costs escalated during the later stage of the works and hence the approved project estimate has to be adjusted for payment of additional costs anticipated in the account finalisation of the project. In accordance with the relevant requirements in the Mainland, the HZMB Authority has conducted a comprehensive assessment of the project estimate and submitted a report on the adjustment of the approved project estimate for review by the Joint Works Committee of the Three Governments[2] (JWC). The JWC has engaged an independent consultant to review the proposed adjustment and offer comments to the HZMB Authority. The HZMB Authority then submitted the proposed adjustment to the approved estimate to the Ministry of Transport.

10. In 2017, the State Council approved an increase of RMB¥10.35 billion in project estimate for the Main Bridge project to be financed by contribution from the three governments and syndicated bank loan. Regarding the additional contribution by the three governments, it would be of the same ratio as adopted in the project approval stage (45.3%), i.e. RMB¥4.688 billion (RMB¥10.35 billion X 45.3%). Contribution from the three governments would also be calculated according to the prescribed sharing ratio, namely 44.5% for the Mainland Government (i.e. RMB¥2.086 billion), 42.9% for the HKSAR Government (i.e. RMB¥2.012 billion) and 12.6% for the Macao SAR Government (i.e. RMB¥0.59 billion). The remaining RMB¥5.662 billion would be financed by a syndicated bank loan by the HZMB Authority. Therefore, the contribution required from the HKSAR Government would be RMB¥2.012 billion (approximately HK$2.4224 billion). In end 2017, as per the State Council's request for minimising the project investment to the furthest extent possible without compromising the quality of works, the Ministry of Transport carried out a detailed review and lowered the increase in project estimate to RMB¥9.95 billion. The total project estimate of the Main Bridge was revised to RMB¥48.068 with the additional contribution from the three governments maintained at RMB¥4.688 billion and the syndicated bank loan to be sought by the HZMB Authority reduced to approximately RMB¥5.262 billion.

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[2] The Joint Works Committee of the Three Governments was established in accordance with "Inter-Governmental Agreement". It aims to facilitate coordination and cooperation of the three governments on public administration issues concerning the HZMB project, and supervision of the legal person of the project (i.e. the HZMB Authority) during construction, operation, maintenance and management.

JUSTIFICATION

11. As at 31 December 2020, the actual expenditure of **3QR** is HK$7,896.6 million. Following a detailed review of the financial position of the project, we consider it necessary to increase the APE of **3QR** by HK$1,514.7 million from HK$9,046.5 million to HK$10,561.2 million (in MOD prices) to cover the additional costs arising mainly from the following –

(a) Adjustment to construction costs:

(i) update of resource input;

(ii) variations to the works;

(iii) adjustment to labour and material costs; and

(b) Adjustment to other associated costs.

Details of the proposed increase in APE are set out in paragraphs 12 to 26 below.

Adjustment to construction costs

12. Construction costs refer to costs directly incurred from the construction of bridge structures and associated facilities, including temporary and ancillary facilities required during the construction process. The adjustment to construction costs was mainly due to three factors: (i) update of resource input; (ii) variations to the works; and (iii) adjustments to labour and material costs. Cost adjustment caused by these three factors are detailed in paragraphs 13 to 24 below.

Update of resource input

13. Resource input required for each works procedure is one of the important elements in preparation of cost estimate of works projects in the Mainland. The relevant Mainland authorities would promulgate a set of standards for the resource input required for each works procedure, known as "Budget Norm Standards" (定額標準), to serve as basis for preparation of project cost estimate. The "Budget Norm Standards" cover the resource input requirements of the works procedures for constructing a particular quantity of works under normal circumstances, including labour, materials and machineries. In preparing the project estimate, the resources required will be calculated based on the "Budget Norm Standards". The original approved estimate HZMB Main Bridge project

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was prepared based on the preliminary design and the resource input requirements of different works procedures according to the prevailing "Budget Norm Standards" at that time, while works involved in the construction of the Main Bridge (including bridges, tunnels, road surfaces and subgrades) were mainly calculated according to "Public Road Works Budget Norm Standard" (《公路工程預算定額》), etc. When preparing the original estimate, works in the open sea environment were yet to be covered under the "Budget Norm Standards", though references were made to similar works projects in the Mainland as far as possible to factor in the resources required for carrying out works procedures in the open sea in the original approved project estimate.

14. However, the Main Bridge project was of such enormous scale and complexity that were unprecedented in the Mainland. It involved the construction of the world's longest immersed tunnel, about 23 km long sea-crossing bridges and two artificial islands of about 100 000 square metres (m^2) each under the very challenging works environment of the open sea. The works area of the Main Bridge spanned across a number of busy navigation channels with an average daily traffic volume up to some 4 000 vessels. This, together with the frequently changing wind and wave conditions as well as complex tidal flow in open sea where works were conducted, led to a higher level of resources deployed during construction than originally estimated.

15. In view of the above, the Department of Transportation of Guangdong Province has, with reference to the actual construction methods and resources required for the Main Bridge project, established new resource input standards for the different works procedures for constructing the offshore bridge, immersed tube tunnel and artificial island projects and promulgated the "Supplementary Budget Norm Standard for Offshore Bridge Project in Guangdong Province (Provisional)" (《廣東省沿海橋樑工程預算補充定額（試行）》) and the "Supplementary Budget Norm Standard of Offshore Subsea Tunnel and Artificial Island Projects in Guangdong Province (Provisional)" (《廣東省沿海沉管隧道、人工島工程預算補充定額（試行）》) in September 2016 and January 2017 respectively. The project estimate of the Main Bridge project has thus been adjusted according to the new standards.

16. For the bridge works, owing to the difficulties and challenges mentioned in paragraphs 13 and 14 above, the vessel and mechanical equipment were deployed for longer period of time and more large-size vessels and machines were needed, resulting in higher expenditure. There was a total increase of about RMB¥3.4 billion in the construction and preliminaries cost estimate for bridge works.

17. For the tunnel works, it was expected in the preliminary design that the precasting of most of the immersed tube tunnel segments would be carried out outdoors, which is prone to weather conditions. In view of the tight construction schedule of the HZMB Main Bridge project and to minimize the risk of project delay, it was decided at the detailed design stage that a large indoor precast yard with segregated works zones for segment fabrication would be built to minimize the impact of adverse weather conditions and to better manage the risks of project delay as well as the construction quality and safety control. In this connection, additional large-scale specialised equipment including the tunnel segment transfer system were deployed, resulting an increase in the cost for precasting of segments. Moreover, laying of gravel bed for the foundation works of the immersed tube tunnel had to be conducted at some 40 metres below sea level, and the construction works were more difficult than expected. To meet the requirement to lay the gravel bed with high precision, after studying the technology of oil drilling platform system, the engineering team manufactured a specialised vessel with integrated working platform to ensure the stability of the vessel at open sea for laying of gravel bed with precision. The cost estimate for the immersed tube tunnel foundation works was thus increased. Furthermore, connection of tunnel segments required high precision, and its transportation at sea and installation could be affected by environmental factors such as water current, waves and wind speed. To overcome these technical difficulties, a specialised system was developed during construction phase to attain the precision level necessary for carrying out the tunnel segment connection works in the deep water environment. Together with adjustment to resources required by other works procedures such as installation and removal of watertight bulkhead at tunnel segment joints, the construction and preliminaries cost estimate for tunnel works was increased by a total of approximately RMB¥1.825 billions.

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18. The updates to resource input mentioned in paragraphs 13 to 17 led to an increase of a total of approximately RMB¥5.225 billion in the construction and preliminaries cost estimate for bridge and tunnel works of the Main Bridge.

Variations to the works

19. The design and construction schemes of the bridge, tunnel and building works recommended in the preliminary design had to be revised in view of the analysis and investigation results during the detailed design stage, actual site conditions and the latest management and maintenance requirements, thus leading to works variations.

20. For variations to bridge works, during the detailed design stage, the wind tunnel test revealed that some sections of the Main Bridge would generate higher level of vibration[3] under low wind speed and thus addition of dampers was required. With reference to the asphalt pavement design experience of large-scale steel bridges in Hong Kong and findings of the topical study on bridge asphalt pavement, a more durable asphalt material was adopted for the bridge pavement. To save on-site construction time and reduce environmental impact during construction, the construction material of the main towers of one of the bridge of about 1 km long was changed from concrete in the preliminary design to steel. This led to an increase in the cost estimate. Although the HZMB Main Bridge was designed in compliance with the marine safety standards in the Mainland, the bridge was located at busy navigation channels, additional study was thus conducted which recommended provision of collision prevention measures in the Main Bridge to further minimise the risks of vessels collision with bridge towers and bridge pier. Furthermore, there were variations to the west landing cum toll plaza of the Main Bridge, including improvement to the design of the landing to reduce the height of wave in the nearby sea and minimize the impact on the vessels travelling in the nearby area; and in accordance with result of the ground investigation carried out in the detailed design stage, the pile design of the toll plaza structures needed to be improved. Taking into account the other variations, the construction and preliminaries cost estimate for bridge works was increased by

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[3] The wind tunnel test for the bridge carried out during the detailed design stage revealed that vortex induced vibration would occur at some sections of the Main Bridge under low wind speed and may affect the operation of the Bridge. Addition of damper was therefore required to reduce the amplitude of vortex induced vibration to meet the requirement of the relevant design standard.

RMB¥1.39 billion approximately.

21. During tunnel construction, it was necessary to maintain live operation of the navigation channels while ensuring smooth transportation and installation of tunnel segments. In the course of construction, some navigation channels had to be widened in view of the actual maritime situation and to cater for marine transportation arrangement of tunnel segments. Moreover, tunnel segments were mainly transported along existing navigation channels, tunnel segments therefore had to be transported from the precast yard via the navigation channels on the western side, then along the tunnel alignment, to the installation locations. When installing tunnel segments on the eastern side, the distance of transportation would be long and thus there is higher possibility of the transportation being affected by water current. Therefore, additional dredging works were carried out on the eastern side of the tunnel alignment to set up a temporary navigation channel, thus shortening the distance and time for transportation of tunnel segments to the eastern side to ensure their smooth transportation and installation. Furthermore, due to the complex water current and busy marine traffic at the Pearl River Delta estuary, siltation in the trench of the immersed tube tunnel was more serious than expected, which had increased the volume of silt to be cleared. For example, the volume of maintenance dredging increased drastically from about 580,000 cubic metres (m^3) as estimated in the preliminary design to 3 540 000 m^3. Taking into account other works variations, the construction and preliminaries cost estimate for tunnel works was increased by RMB¥1.633 billion approximately.

22. In the period between the completion of preliminary design and detailed design, there were major changes[4] to the design standards for building construction works in the Mainland. To meet the requirements of the new standards and operational need, the total floor area of buildings on the eastern and western artificial island had been increased from about 43 600 m^2 in the preliminary design to 73 300 m^2, additional spaces of which were allocated mainly for installation of fire services, mechanical and electrical equipment and associated ducting required for tunnel and traffic management. Meanwhile, the number of

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[4] For instance, outdoor fire hydrant design water supply rate was 30 litres per second in the preliminary design. Subsequently, the "Technical Specification for Fire Water Supply and Fire Hydrant Systems" (《消防給水及消防栓系統技術規範》) was promulgated in 2014. According to the latest standard, outdoor fire hydrants should have a water supply rate of 40 litres per second and be retrofitted with an outdoor fire cistern of about 435 m^2 in area.

pipeline hangers was also increased; for the outdoor rainwater drainage system on the artificial islands, the return period of design rainfall was increased from 120 years in preliminary design to 200 years to reduce the risk of rainwater entering into the tunnel; and the fire protection system was improved to meet the latest fire safety regulations. Together with other works variations, the construction and preliminaries cost estimate for building construction works was increased by RMB¥0.311 billion approximately.

23. Due to the variations to the works mentioned in paragraphs 19 to 22 above, it is necessary to increase the project construction and preliminaries estimate by RMB¥3.334 billion approximately.

Adjustments to labour and material costs

24. In the Mainland, relevant authorities would promulgate unified standards regarding the labour and material costs of the construction industry. During the construction period, the labour and material costs had escalated in the Mainland, leading to an increase in the construction costs. The labour wage was adjusted according to the updated labour wage standards issued by the Department of Transportation of Guangdong Province. Moreover, the material cost was adjusted according to the average of the monthly material price released by the Department of Transportation of Guangdong Province during the construction period. Owing to the adjustments to labour and material costs, the cost estimate was increased by RMB¥1.080 billion approximately.

Adjustment to other associated costs

25. Apart from the construction cost adjustment, there were adjustments to other costs such as monitoring and testing, research and experiment, design and project management, etc. and the cost estimate was increased by around RMB¥0.711 billion in total.

26. Owing to the factors mentioned in paragraphs 12 to 25 above, the estimate for the HZMB Main Bridge project was increased by approximately RMB¥10.35 billion in total. As mentioned in paragraph 10 above, the HKSAR Government would have to contribute RMB¥2.012 billion (approximately HK$2,422.4 million).

/**Use** …..

Use of Provision for Renminbi Fluctuation

27. As mentioned in the paper PWSC(2009-10)17 concerning **3QR** discussed at the Public Works Subcommittee in 2009, 10% of the project cost (i.e. HK$843 million) has been earmarked as a provision to cater for fluctuation in Renminbi exchange rate. Currently, the remaining sum of this provision is HK$402.2 million. With reference to the RMB exchange rate fluctuation in the past year, it is proposed to allow 10% of the additional contribution required by the HKSAR Government (i.e. HK$242.2 million) as a provision for fluctuation in Reminibi exchange rate whilst the remaining HK$160.0 million will be used for offsetting the increased project costs.

SUMMARY OF FINANCIAL POSITION

28. A breakdown of the proposed increase of HK$1,514.7 million is as follows –

Factors	**Increased cost estimate (RMB¥ million) (I)**	**Proposed increase /offset in MOD prices for 3QR (HK$ million) (II) = (I) X RMB/HKD exchange rate X the percentage of capital injection by the three governments X the percentage of Hong Kong's contribution[5]**	**% of the total increase/offset**
Increase due to –			
(a) Adjustment to construction costs			
(i) Update of resource input	5,225	1,222.9	50.5
(ii) Variations to the works	3,334	780.3	32.2
(iii) Adjustment to labour and material costs	1,080	252.8	10.4

/(b) …..

[5] The RMB/HKD exchange rate is 1.204 (according to RMB-offshore selling price as at 31 December 2020 by the Hong Kong Association of Banks); the percentage of capital injection by the three governments is 45.30% (paragraph 8 above); the percentage of Hong Kong's contribution is 42.91% (paragraph 10 above).

	Factors	Increased cost estimate (RMB¥ million) (I)	Proposed increase /offset in MOD prices for 3QR (HK$ million) (II) = (I) X RMB/HKD exchange rate X the percentage of capital injection by the three governments X the percentage of Hong Kong's contribution[5]	% of the total increase/offset
(b)	Adjustment to other associated costs	711	166.4	6.9
(c)	Increase in cost estimate (c)=(a)+(b)	10,350	2,422.4	100.0
(d)	Provision for fluctuation in RMB exchange rate (d)=(c)x10%		242.2	
(e)	Total increase of **3QR** (e) = (c)+(d)		2,664.6	
The total increase in (e) above is offset by –				
(f)	Remaining provision for contingencies[6]		(747.7)	65.0
(g)	Remaining provision for fluctuation in RMB exchange rate		(402.2)	35.0
(h)	Total savings of **3QR** (h)=(f)+(g)		(1,149.9)	100.0
(i)	Proposed increase of **3QR** (i)=(e)-(h)		1,514.7	

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6 As the construction of the HZMB Main Bridge has come to the project finalisation stage, we consider that no additional provision is needed for use as contingencies in the future. The remaining provision of $747.7 million for contingencies under the original APE will be used to offset the additional costs arising from factors mentioned above.

FINANCIAL IMPLICATIONS

29. Subject to funding approval, we anticipated that there will be a revision in the phased expenditure as follows –

Year	HK$ million (in MOD prices)
Up to 31 December 2020	7,896.6
2021 – 22	2,664.6
	10,561.2

30. The proposed increase in APE will not give rise to any additional recurrent expenditure.

31. Given the total contribution by the three governments remains unchanged, the final total project cost will affect the amount of financing by syndicated bank loan by the HZMB Authority in future.

PUBLIC CONSULTATION

32. The proposed increase in the APE of the project does not involve any change in the approved scope of the project. We consider public consultation for the increase in the APE unnecessary.

33. We consulted the Panel on Transport (the Panel) of LegCo on the proposed increase in APE of the project on 15 January 2021. Members generally supported the submission of the funding proposal to the PWSC for consideration. In response to Member's enquiry on the HZMB Hong Kong Link Road and Hong Kong Boundary Crossing Facilities projects, we will provide supplementary information to the Panel on Transport.

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ENVIRONMENTAL IMPLICATIONS

34. The proposed increase in APE of the project will not have any implication to the environment within the HKSAR.

HERITAGE IMPLICATIONS

35. The proposed increase in APE of the project will not affect any heritage sites within the HKSAR, i.e. all declared monuments, proposed monuments, graded historic sites/buildings, sites of archaeological interest and Government historic sites identified by the Antiquities and Monuments Office.

LAND ACQUISITION

36. The proposed increase in APE of the project will not require any land acquisition within the HKSAR.

BACKGROUND INFORMATION

37. The FC approved the upgrading of **3QR** to Category A at an estimated cost of $9,046.5 million in MOD prices in May 2009.

38. The proposed increase in APE of the project will not involve any tree removal within the HKSAR.

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39. The proposed increase in APE of the project will not involve the creation of any professional and technical post or job opportunity within the HKSAR.

Transport and Housing Bureau
January 2021

港珠澳大橋
Hong Kong-Zhuhai-Macao Bridge (HZMB)