City of Westminster

Cabinet Member Report

Date	**13 December 2016**
Classification	**For General Release**
Title of report	**Waterloo Bridge Articulation & Concrete Strength and Repairs to the parapets for the Golden Jubilee Footbridges**
Report of	**Stuart Love - Executive Director for City Management and Customer Services**
Decision maker	**Cabinet Member for City Management and Customer Services**
Wards involved	**St James**
Policy Context:	**The planned programmes support the City for All, objective in delivering a well-managed, high quality streetscape whilst protecting and enhancing Westminster's unique heritage**
Financial summary	**The estimated cost of the works to Waterloo Bridge and Golden Jubilee Bridge identified in this report is £1,100,000, including risk and contingencies.** **The Waterloo Bridge has an approved funding allocation of £100,000 from Transport for London. Council funding for the remaining £1,000,000 exists in the approved capital programme for 'Waterloo Bridge Improvements'.**
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1. Executive Summary

1.1 Waterloo Bridge over the River Thames is strategically important to London's road network. It is essential the bridge is kept in a good state of repair to extend its life.

1.2 The articulation of the bridge i.e. the way it expands and contracts under temperature effects has changed since it was originally built in the 1940's. This change has occurred as a result of two of the four bridge joints 'locking-up' (i.e. there is no longer free movement of the joints). The 2 'locked-up' joints are both in the central span of the bridge which has had the knock on effect of creating greater movements in the two joints at the ends of the bridge.

1.3 The extent to which the movements in the bridge has changed needs to be fully understood to determine what additional adverse stresses the bridge might be subjected to as a result of the change in articulation. Having this information will allow engineers to make decisions and develop design solutions to either return the bridge to its original design condition or accept the new articulation arrangements and make changes to the bridge to eliminate any adverse stresses in the bridge.

1.4 A load assessment has been carried out on the bridge to make sure it can still carry highway loading to modern standards. The load assessment made certain assumptions with regard to the concrete strength of the bridge. The results of the load assessment were sufficiently close to the factors of safety recommended for the assessment to warrant the need to test the concrete throughout the bridge. The concrete test results will determine whether or not the actual concrete strength is sufficiently close to the assumed strength used in the assessment so as to make no appreciable difference to the result of the load assessment.

1.5 A serious issue has arisen with respect to the parapets for the Golden Jubilee Footbridges. The bolts fixing the parapets to the bridge deck have corroded and are in poor condition. As the parapet railings are an essential safety feature of the footbridges it is imperative that the parapets remain in good condition and do not pose a risk to the public. The corrosion of the bolts is considered to be a design fault. Legal advice is being sought on whether or not a reasonable claim can be made against the original designers and constructors of the footbridges to recover the repair costs. Whilst legal options are being pursued, and in order to maintain public safety, approval is sought to use funding from the approved capital budget for the 'Waterloo Bridge Improvements' to undertake the necessary parapet repairs on the Golden Jubilee Footbridges.

2. Recommendations

2.1 It is recommended that approval be given for capital expenditure to carry out the work necessary to determine the actual articulation of Waterloo Bridge and also carry out extensive concrete strength tests on the critical areas of the bridge to confirm the load assessment results for the bridge. Funding to carry out this work is available in the City Management and Customer Services Capital Programme for Bridges & Structures.

2.2 It is recommended that approval be given for capital expenditure to carry out the urgent repairs to the parapets of the Golden Jubilee Footbridges using funding from the Waterloo Bridge Improvements capital programme line.

3. Reasons for Decision

3.1 The articulation of Waterloo Bridge i.e. the bridge movement due to temperature effects and traffic loading is no longer taking place as originally designed. This movement was originally designed to be distributed across four bridge joints. However, because of the age of the bridge and general deterioration, two of the joints have 'locked-up' causing greater than anticipated movements at the ends of the bridge. It is essential that these new movements in the bridge are fully understood in order to determine what measures should be put in place to mitigate any adverse effects from the change in articulation arrangements.

3.2 The holding down bolts for the Golden Jubilee Footbridges parapets must be replaced to maintain the integrity of the parapets. The parapets are an essential safety feature of the footbridges, if the bolts deteriorate further the bridge may have to be restricted or closed for public safety reasons.

4. Background information

4.1 Waterloo Bridge was constructed over the River Thames between 1938 and 1942 and is Grade II listed.

4.2 The bridge has seven spans and a total length of approximately 377 metres. The five central spans are across the river, whilst the two end spans are partly across the river and partly over land.

4.3 The bridge carries the A301 across the river, connecting Lancaster Place to the north and Waterloo Road to the south. Passing beneath the end spans of the bridge are Victoria Embankment and Queen's Walk to the north and south of the river respectively.

4.4 The bridge carries approximately 44,000 vehicles per day, including numerous local bus routes and taxis and also forms an important pedestrian link, particularly for commuters to and from Waterloo Station.

4.5 Recent routine inspections of the bridge raised concerns about certain defects on the bridge which could be indicative of the bridge not articulating (expanding and contracting) in the way it was originally designed to articulate. As a result of those concerns specialist consultants were engaged to carry out extensive investigations on the condition and behaviour of the bridge.

4.6 There were also concerns over metal components within the bridge which are in a poor corroded condition and what impact this might have on the load carrying capability of the bridge. The bridge has therefore been assessed for its load carrying capacity taking into account the current condition bridge condition. The recommendations from the further investigations and load assessments are detailed below.

5. Results of the detailed review

5.1 The results of the detailed review identified 3 main areas of concern for the bridge, these are:-

- Concrete deck slab in the centre span of the bridge
- The bridge Abutments & Piers
- Main bridge deck and the impact of a change of articulation

5.2 The centre span at the mid-point of the bridge comprises of a large concrete slab extending across the width of the bridge. The large slab extends across the width of the bridge and is 28.5 metres long. It is supported by specially formed joints in the bridge deck which means there are two joints across the bridge in the centre span. These two joints have complex metal components and restraints associated with them which control movement of the centre span slab whilst allowing for expansion and contraction of the bridge.

5.3 These metal components are severely corroded and have expanded which has resulted in the centre span joints ‘locking up’ allowing only minimal movement when the bridge expands and contracts. Because the two centre span joints are locked, all the bridge movement takes place at the ends of the bridge. The result of this is that the joints at the ends of the bridge expand and contract across a greater range than the original design allowed for which is causing the bridge bearings at the two ends of the bridge to struggle with the excessive movement placed upon them.

5.4 Waterloo Bridge is constructed from reinforced concrete. In order to fully appreciate the load carrying capacity and strength of the bridge it is important to understand the concrete strength. A load assessment carried out on the bridge has assumed the concrete strength to be the same as the design strength.

6. Remedial Action Strategy

6.1 Because two of the four expansion joints on the bridge have locked-up it is essential that the actual movement of the bridge is fully understood. The movement of the bridge will change with the seasons so it is essential to understand the full range of movement over a full 12 month period.

6.2 It is therefore essential that on-site real-time measurements are recorded for changes in temperature and horizontal, vertical and lateral movement across all four bridge joints and along the length of the structure. This can be achieved by installing a sophisticated monitoring system on the bridge and remotely receive data which can be analysed at regular intervals to build up a picture of the actual bridge movement.

6.3 Once the actual articulation of the bridge is known the following issues can be resolved:-

- Should the two centre span joints be unlocked and the bridge returned to its original designed articulation? Or should the bridge remain locked and the expansion joints and bearings at the ends of the bridge re-designed to accommodate the actual movement ranges?

- What additional undesirable stresses may be imparted into the structure (deck and piers) and whether or not these exceed acceptable limits? Once this information is known a decision can then be made on the best course of action to resolve the matter.

- The bridge bearings can be designed to accommodate the actual known movement of bridge rather than the theoretical movement of the structure.

6.4 When Waterloo Bridge was built in the 1940's concrete technology was in its infancy and over the years there is a possibility that the concrete has deteriorated. This may have been exacerbated by the salt water environment of the Thames. An accepted method of calculating the current concrete strength is to take concrete samples throughout the bridge, especially in critical high stress areas, and test these to determine actual strength. These results can be compared against the theoretical concrete strength used in the load assessment to see if they are broadly comparable.

6.5 Waterloo Bridge is a complicated structure. The work identified above is essential to inform the next steps for the bridge in terms of physical works to either return the bridge to its original design condition or accept the changed bridge articulation and redesign certain elements of the bridge to cope with the additional movements and stresses placed on it. Gathering the above information on the actual bridge movement and verifying the concrete strength will mean that the most appropriate decisions can be made about the maintenance of the bridge.

7.5 The installation of the remote monitoring system and undertaking the concrete testing will not require part or full closures of the bridge, it may however be necessary to install lane closures however these will be short periods and during off peak hours only.

7. Golden Jubilee Footbridges – Defective Parapets

7.1 An urgent issue has arisen with the parapets for the Golden Jubilee Footbridges for which capital funding approval is sought from the Waterloo Bridge Improvements programme line.

7.2 The defects in the parapets are considered to be as a result of an inadequate design when the bridges were constructed in 2002/03. Legal Advice is being sought on the possibility of pursuing a claim against the designers and constructors of the bridge, the claim will be for the costs to rectify the defects found on the parapets. If a claim for costs is not successful or is only partly successful, the London Borough of Lambeth will be responsible for 50 % of the residual costs under a maintenance agreement between the City Council and Lambeth.

Background

7.3 The parapets are the railings which run along the length of both footbridges; they are an essential safety feature providing edge protection for pedestrians to the River Thames below. The parapets are fixed in position at each vertical post position using 4 bolts drilled into the concrete bridge deck, each post has a stainless steel base plate with 4 slots in it through which the bolts pass which are then tightened to securely fix the parapets in position.

7.4 During recent routine inspections of the footbridges it was noted that the condition of one or two bolts (which are not easily visible) appeared to be poor condition with the recommendation these should be investigated further. Financial approval was granted in the Cabinet Member Report for 'Planned Preventative Maintenance (PPM) for 2015/16 in respect of Highways, Lighting and Bridges & Structures' to expose the bolts at various locations on both footbridges to understand the seriousness of any corrosion and how widespread it is.

7.5 Several parapet bolt anchorages were exposed and inspected at intervals along both bridges and on both sides of each footbridge. At each location the same problem was found. The bolts holding down the parapets had corroded severely including the nuts on the bolts. In some locations the exposed sections of the bolts and nut had disintegrated completely. The stainless base plates attached to the posts through which the bolts pass are however in perfect condition, it is only the bolts that are defective.

7.6 The investigation concluded that considering the bridges are less than 15 years old, the bolts should not be suffering from such severe and extensive corrosion. It also noted that the stainless steel base plate through which the

bolts passed was in perfect condition leading to the conclusion that the bolts have suffered from a condition known as ‘Bimetallic Corrosion’.

7.7 Bimetallic corrosion is the accelerated corrosion of one metal when it is placed in contact with a dissimilar metal which is a more noble (or less corroding) metal. The accelerated rate of corrosion of the less noble metal can occur relatively rapidly and even more so when damp salty conditions exist.

7.8 The bolts used to hold down the parapets are made from normal steel. These bolts and nuts are in close contact with the base plate of the posts which is made from stainless steel. Although both the bolts and base plates are made from steel, one is normal steel (the bolts) and the other stainless steel (the base plate) and therefore considered dissimilar and susceptible to bimetallic corrosion.

7.9 Having reviewed the As-built drawings for the footbridges, there is evidence to suggest that the original design of the bolt down connection for the parapets is flawed. Officers are seeking legal advice to determine if there is a case for compensation against the original bridge designers or constructors to rectify the problem.

7.10 In order to rectify the problem, the existing bolts need to be removed and replaced with stainless steel bolts i.e. the same material as the base plates. A method of working to replace the existing severely corroded bolts with new stainless steel bolts has been developed. It is estimated that for both footbridges approximately 2,600 bolts need replacing. A trial of the proposed method of working has been carried out successfully so there is confidence that the work can be undertaken and completed with minimal disruption to pedestrians and within budget.

7.11 The bolt down connections are deteriorating at a relatively rapid rate. If steps are not taken soon to rectify the problem, there is a possibility the footbridges will have to be restricted and possibly closed at times, especially if large crowds could be expected on the footbridges.

8. Financial implications

8.1 A breakdown of the costs associated with this report is provided in the tables below.

Waterloo Bridge

	Description	Cost
1.	Install 12 month monitoring equipment and regime for the bridge	£190,000
2.	Undertake concrete testing of the bridge across it's whole length	£150,000
3.	Design, Feasibility Studies, review of previous condition studies, Action Plans, Data gathering and analysis etc.	£75,000
4.	Verifying Load Assessment Model with new collected data	£25,000
5.	Client Costs & Compliance & Audit	£35,000
6.	Risk & Contingency	£50,000
	TOTAL	£525,000

Golden Jubilee Footbridges

	Description	Cost
1.	Parapets for the Golden Jubilee Footbridges	£475,000
2.	Client Costs & Compliance & Audit	£40,000
3.	Risk & Contingency	£60,000
	TOTAL	£575,000

8.2 The total cost of the work associated with Waterloo Bridge work and the Golden Jubilee Footbridges is £1,100,000. A contribution of £100,000 of grant funding from Transport for London has been secured in 2016/17 for the Waterloo Bridge works.

8.3 These costs will be fully met from the budget for 'Waterloo Bridge Improvements' that exists as part of the approved capital programme.

8.4 A claim is being pursued against the original designers and constructors of the Golden Jubilee Footbridges for the costs to repair the defective parapets. If the claim is unsuccessful, under a legal agreement with the London Borough of Lambeth, 50% of the costs should be recoverable from Lambeth.

9. Legal implications

9.1 By virtue of the Highways Act 1980 the Council, in its capacity as local highway authority, is responsible for the upkeep and maintenance of bridges within its ownership

9.2 As will be noted elsewhere in this report, a potential claim against the original designers and constructors of the Golden Jubilee Footbridges for a design defect is being considered by the Council. Initial advice will be sought from Counsel on the strength of the claim and whether or not a claim is worth pursuing.

10. Ward member consultation

Ward Members have been provided with a briefing note appraising them of the impending issues and recommendations.

If you have any queries about this report or wish to inspect any of the background papers, please contact: Andy Foster, Asset Manager (Bridges & Structures) – email afoster1@westminster.gov.uk

Background Papers

1. Planned Preventative Maintenance (PPM) for 2015/16 in respect of Highways, Lighting and Bridges & Structures

For completion by Cabinet Member for City Management and Customer Services

Declaration of Interest

- I have no interest to declare in respect of this report

  Signed……. Date ……
  Councillor Melvyn Caplan, Cabinet Member for City Management and Customer Services

- I have to declare an interest

  State nature of interest: ……

  ……..

  Signed……. Date ……
  Councillor Melvyn Caplan, Cabinet Member for City Management and Customer Services

  (N.B.: If you have an interest you should seek advice as to whether it is appropriate to make a decision in relation to this matter.)

For the reasons set out above, I agree the recommendation(s) in the report entitled:

"**Waterloo Bridge Articulation & Concrete Strength"**

Signed……Date……
Councillor Melvyn Caplan, Cabinet Member for City Management and Customer Services

If you have any additional comment which you would want actioned in connection with your decision you should discuss this with the report author and then set out your comment below before the report and this pro-forma is returned to the Secretariat for processing.

Additional comment: ……
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NOTE: If you do not wish to approve the recommendations, or wish to make an alternative decision, it is important that you consult the report author, the Director of Law, the City Treasurer and, if there are staffing implications, the Director of People Services (or their representatives) so that (1) you can be made aware of any further relevant considerations that you should take into account before making the decision and (2) your reasons for the decision can be properly identified and recorded, as required by law.

NOTE TO CABINET MEMBER: Your decision will now be published and copied to the Members of the relevant Policy & Scrutiny Committee. If the decision falls within the criteria for call-in, it will not be implemented until five working days have elapsed from publication to allow the Policy and Scrutiny Committee to decide whether it wishes to call the matter in.