



Army and Navy Flyover ECC Bridge No. 1000

Future of the Army and Navy Flyover

Supplementary report to Interim Measures Version 01, 20/08/2019.

6th September, 2019



Document Control Sheet

Document prepared by:

Structures Floor 2, Seax House,

Victoria Road South,

T E <u>@essexhighways.org</u> W <u>www.essex.gov.uk/highways</u> <u>www.essex.gov.uk/enquiries</u>

Chelmsford,

Essex

CM1 1QH

Issue	Status	Author	Date	Check	Date	Review	Date
01	Final		4/9/19		5/9/19		5/9/19

Table of revisions

Original Version Produced	5/9/19	Issue 1
Reviewed		Issue 2
Published		Issue 3

Distribution

Organisation	Contact	Number of Copies
Essex Highways	Simon Butt	Electronic
Essex Highways	Andrew Cook	Electronic
Essex County Council	Cllr Bentley	Electronic



Army and Navy Flyover, ECC No. 1000

Future of the Army and Navy Flyover

Contents

1.	Executive Summary	3	
2.	Introduction	4	
3.	What has happened?	5	
3.1	September to October 2018 - Thermal	5	
3.2	July 2019 - Thermal	5	
4.	Discussion	7	
5.	Recommendation	9	
Appendix A – Record Drawing			



1. Executive Summary

Following the emergency closure of the Army and Navy Flyover on 25 July 2019, Essex Highways has continued to monitor the elements damaged by the temperature related movement of the structure and have in addition widened the monitoring to include similar elements throughout the flyover. The additional monitoring has revealed new defects within the flyover's supporting concrete foundations.

Following a meeting with stakeholders on 28 August 2019 and additional hot weather temperatures from 23 to 27 August 2019, this further report has been prepared to assess in more detail the short term options for the future of the structure. This report should be read in conjunction with the report, Army and Navy Flyover – Interim Measures Version 01, dated 28 August 2019. This report discussed the defects identified at that time and provided various options with their indicative cost and programme length.

It is the recommendation of this report that the Army and Navy Flyover is not repaired and reopened. Without significant investment requiring long programme and additional disruption reducing capacity further, the flyover will continue to demonstrate thermal movements greater than the sub-structure can accommodate. A short term fix will not enable safe use of the structure as temperatures rise. With the indicative timetable for the long term improvement of the junction (work currently being undertaken by the Army and Navy Task Group) providing a site start in 2023, the value of a long term fix is questionable.

The structure cannot be left in its current condition even with the removal of traffic as it is still experiencing movement. Therefore, unless substantial works to repair it are undertaken, which are not deemed cost effective, it is recommended to remove the structure at the earliest opportunity to reduce the maintenance liability for ECC. Alternatively the structure will require propping to ensure that its movement does not pose a risk to the public.

By removing the structure a benefit may be derived allowing the use of the inner island areas of Parkway and Essex Yeomanry Way approaching the flyover to assist short term capacity improvements in light of the closure of the flyover.



2. Introduction

The Army and Navy Flyover is a 15 span steel and concrete structure on steel supporting trestles located on the approach and above the Army and Navy Roundabout in Chelmsford. The structure, which was a new construction in 1978 has in recent years exhibited large movements related to thermal effects which required intervention in 2018 and most recently in July 2019.

The structure remains closed following the issues identified in July 2019 which are outlined in the following paragraphs.

The paragraphs below in italics provide a more detailed description of the structure.

The Army and Navy Flyover carries a single 3.10 metre wide carriageway over the Army and Navy roundabout at the junction of the A414 and A138. It operates on a tidal basis under traffic signal control with traffic running from east to west in the mornings and from west to east in the afternoons. The speed limit on the bridge is 20 miles per hour. Traffic over the bridge is restricted to light traffic and maintenance vehicles. The structure is curved in both horizontal and vertical planes.

The flyover comprises fifteen spans which are simply supported and vary from 11.03 metres to 20.46 metres in length. Each span consists of a reinforced concrete deck slab supported by regularly spaced steel cross beams and two longitudinal steel beams. The reinforced concrete deck slab acts compositely with the steel beams which are supported by cast iron bearings with a downstand plate at the beam ends sitting in a groove in the bearing.

The deck is supported by steel portal frame trestles consisting of a cross beam and two columns. Lateral stability of the structure is provided at each trestle by the cross beam with stiffened haunches that ensure portal frame action. Longitudinal stability of the structure is provided by additional framing that links four columns beneath spans D5 and D11 (see Appendix A).

The flyover was originally designed in 1977 for a loading of 20% HA load or a 9.9 tonne gritting lorry with a 1.5 tonne trailer. The structure was built in 1978 and was originally intended as a temporary solution to improve the traffic situation at this busy junction.

For the purposes of this report, the bridge spans are numbered D1 to D15 from west to east as shown in Appendix A. Trestles are numbered T1 to T14, T1 being the first trestle in from the western abutment.



3. What has happened?

The structure is in a poor condition with a history of maintenance work to steel and concrete elements. However there have been two confirmed temperature related issues with the structure in recent years.

3.1 September to October 2018 - Thermal

In September 2018 movement of the northern column at trestle seven was brought to our attention on social media. This was confirmed to be the case by engineers and movement was also identified at the northern column to trestle six. The flyover was closed to traffic at this point and measures were put in place to support the structure whilst an investigation took place to understand the root cause. Various on site investigations complemented by desk based analysis determined that the cause of the movement was from thermal effects during high summer temperatures which peaked at 34.1°C.

The issues were exacerbated by deterioration of the structures bearings which had become fixed longitudinally due to corrosion and hidden defects. The holding down bolts to the trestles six and seven had deteriorated due to water ingress and corrosion within the grout plinths beneath the base plates to the point that at failure (northern column to trestle seven) there was little section remaining to resist shear from lateral movement of the sub structure.

The defects were addressed during an emergency intervention, during which the trestles to six and seven were propped and base upstands broken out and reconstructed complete with new holding down bolts. Existing reinforcement was maintained. Elsewhere corrosion severed holding down bolts to the southern column of trestle two and to the northern columns of trestle nine and 12 were also replaced. No work was undertaken to address the problems at the bearings.

3.2 July 2019 - Thermal

Following the issues outlined above temperature and location remote monitoring equipment was introduced onto the structure in March 2019. Over the course of the months, the monitoring equipment indicated gradually increasing movement of the structure as ambient temperatures increased. The movement, which is in a southerly direction caused by the gradual lengthening of the deck of the structure as the material temperature increase. During a particularly hot spell in July temperatures peaked at 37.9°C on the 25 July 2019. Following review of the forecast and the monitoring readings a decision was taken to complement the remote monitoring by visits to the structure to inspect the areas susceptible to defects from the lengthening of the deck. During the second of these visits on 25 July 2019, upward movement of the baseplate and supporting grout was identified at the northern columns of trestles six and seven. The structure was closed immediately to traffic at this point through Essex Highways changing the signing to closed on both approaches, however as the inspection progressed a loud metallic noise was heard and movement of the northern columns to trestle six and seven was found to be up to 3mm. Since 25 July it has become apparent that the position vertically fluctuates depending on the temperature. In addition, cracks measuring 0.15mm were found to have opened within the concrete upstands constructed in 2018.

Page | 5





In the weeks since the closure of the flyover there have been regular inspections of the columns and their reinforced concrete upstands throughout the flyover. These inspections, which were undertaken daily during the high temperatures and weekly thereafter, have revealed that the structure supports are swaying with cyclic variations in ambient temperature. The swaying of the structure is causing uplift forces within the holding down bolts which can now be seen to be having a detrimental effect on the reinforced concrete upstands. Cracking noted to the concrete upstands to the northern columns of trestles six and seven have widened over the period of the enhanced monitoring. During the period of enhanced monitoring, cracking has been noted to the upstands at other column locations, monitoring of these is ongoing.



4. Discussion

It is well known that the structure was introduced as a temporary structure in 1978 and the temporary nature of the structure is perhaps best evidenced by the design details of the bearing arrangements and the detailing of the **lightly reinforced** concrete upstands, which support the columns.

The deterioration of the bearing arrangements are the cause of the current problems that the structure is exhibiting. It is impossible to maintain and repair deterioration of the beams which are supported by the bearings without lifting and replacing each span in place. Given the 25 year design life of the structure, it has been designed not to require maintenance during that period.

Moreover the cyclic warming/cooling of ambient temperatures during the day appear to be causing several of the concrete upstands to exhibit slowly widening cracks caused by the swaying of the sub-structure. The upstands which support each column are very lightly reinforced and not designed for the thermal induced uplift forces and shears that they are currently being subjected to. This continued swaying means that the structure needs to be propped to reduce the risk to the public if further significant temperatures fluctuations are experienced. It is unknown how it deals with extreme cold temperatures. At present, the cracking is within acceptable tolerances but it will deteriorate further.

Other elements - parapets, thrust pads and joints - are also in a poor condition and require investment to maintain the safe use of the flyover. Although receiving periodic maintenance in the 41 years that the flyover has been in place, key elements are in need of major investment.

Without significant investment the Army and Navy Flyover cannot safely be reopened to the public. The current condition of the flyover means that its behaviour, particularly in hot weather, is unpredictable. Should the repair of the current thermal related defects take place, the behaviour of the flyover would remain unpredictable due to the root cause not being addressed.

The previous report, Army and Navy Flyover - Interim Measures Version 01, considered different options to deal with the immediate and long term issues at the flyover. The following two options were considered as viable to address the thermal movement issues and condition generally;

- Option 3 Replacement of bearings and deck ends to address root cause of issue
- Option 4 Deck replacement

These options were considered to have a programme length of up to 92 weeks from commission and an estimated cost of up to £1.8 million. Other options short of this were considered to offer no confidence that the current problems would not reappear in the year ahead. Given this programme length and cost, there is no benefit in pursuing a solution that fixes the thermal problems given the future plans for the Army and Navy junction, which the indicative timetable is indicating a site start of 2023.





The safest course would seem to be continue the current closure of the flyover. However, monitoring of the flyover should continue if the structure remains in place as it is expected that the concrete upstands will continue to deteriorate, particularly if the UK experiences a severe winter and the urgent requirement for propping cannot be ruled out should the defects within the upstands begin to significantly develop. There is a risk if this situation arises that there will be a full closure of the roundabout until the propping can be installed.



5. Recommendation

Taking due regard for the condition of the flyover, the programme time and investment required to permanently fix the thermal movement issues, it is the recommendation of this report that the flyover remain permanently closed. The complete removal of the flyover would address concerns in the safety of it in the event of future deterioration of the reinforced concrete upstands.

Alongside other measures to combat the congestion in the area that will result from the continued closure of the flyover, it is further recommended that consideration be given to making better use of the inner island areas within Parkway and Essex Yeomanry Way approaching the junction which can assist with improving flows through the junction. Removal of the flyover also offers some improvement to the long programme and disruption that is likely to be caused during that work.

If the flyover is not removed before a period of extreme weather which causes further significant cracking through movements of the columns, then it is recommended that serious consideration is given to the temporary propping of the structure. This will cost in the region of £62,000

The timescale for removing the flyover and the cost is provided below, extracted from the report, Army and Navy Flyover - Interim Measures Version 01;

Description	Program	Estimated Cost	
	Construction	Total (Inc. Design)	
Flyover remains closed. Flyover removed.	13	27	£380,000



Appendix A – Record Drawing



