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Pàrlamaid na h-Alba

Official Report

INFRASTRUCTURE AND CAPITAL INVESTMENT COMMITTEE

Wednesday 20 January 2016

Session 4

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INFRASTRUCTURE AND CAPITAL INVESTMENT COMMITTEE
3rd Meeting 2016, Session 4

CONVENER

*Jim Eadie (Edinburgh Southern) (SNP)

DEPUTY CONVENER

*Adam Ingram (Carrick, Cumnock and Doon Valley) (SNP)

COMMITTEE MEMBERS

*Clare Adamson (Central Scotland) (SNP)
Alex Johnstone (North East Scotland) (Con)
*Mike MacKenzie (Highlands and Islands) (SNP)
*Siobhan McMahon (Central Scotland) (Lab)
*David Stewart (Highlands and Islands) (Lab)

*attended

THE FOLLOWING ALSO PARTICIPATED:

Mark Arndt (Amey)
Colin Clark (Fairhurst)
Wayne Hindshaw (Transport Scotland)
Richard Hornby (Arup)
Scott Lees (Transport Scotland)
John Russell (Amey)
John Scott (Ayr) (Con) (Committee Substitute)

CLERK TO THE COMMITTEE

Steve Farrell

LOCATION

The Adam Smith Room (CR5)

Scottish Parliament

Infrastructure and Capital Investment Committee

Wednesday 20 January 2016

[The Convener opened the meeting at 10:00]

Decision on Taking Business in Private

The Convener (Jim Eadie): Good morning. I welcome everyone to the third meeting in 2016 of the Infrastructure and Capital Investment Committee. I remind everyone present to switch off mobile phones, as they affect the broadcasting system. As meeting papers are provided in digital format, you might see members using tablets during the meeting.

Apologies have been received from Alex Johnstone. I have great pleasure in welcoming John Scott, who is attending the meeting as a substitute.

Agenda item 1 is a decision on taking business in private. Do members agree to take item 5 and any future consideration of evidence in the committee's inquiry into the circumstances surrounding the closure of the Forth road bridge in private?

Members *indicated agreement.*

Forth Road Bridge Closure

10:00

The Convener: Under agenda item 2, the committee will take oral evidence in its inquiry into the circumstances surrounding the closure of the Forth road bridge. In that inquiry, which is one of the most significant pieces of work that the committee has undertaken this session, the committee aims to be thorough and robust in its investigations in order to get beneath the surface of the reasons behind the closure. The committee is aware that people in Fife, the Lothians and, indeed, across Scotland who have been subject to disruption since the closure will be keen to ensure that the appropriate action was taken in the lead-up to and discovery of the issue and that all necessary precautions have been and will be taken to prevent the situation from recurring in the future.

I welcome Richard Hornby, who is director of Arup; John Russell, who is operations manager at the Forth bridges unit, Amey; Mark Arndt, who is operating company representative at the Forth bridges unit, Amey; Scott Lees, who is head of network maintenance at Transport Scotland; Wayne Hindshaw, who is chief bridge engineer at Transport Scotland; and Colin Clark, who is a partner at Fairhurst. Good morning, gentlemen.

I place my thanks on the record to Transport Scotland and Amey for hosting the committee's visit to the bridge yesterday. We found the trip to be extremely informative and useful in putting our scrutiny into its proper context.

I invite Scott Lees to make an opening statement on behalf of Transport Scotland and Amey.

Scott Lees (Transport Scotland): Thank you for the opportunity to set out our role in the Forth road bridge closure. Transport Scotland welcomes the inquiry, and it will endeavour to fully explain our understanding of the incident and detail the considerable work that has been undertaken to reopen the Forth road bridge and effect a permanent repair. Our assembled panel has been fully involved in the response to the incident and in providing subsequent advice to the Scottish ministers on the closure and the proposed repairs.

The decision to close the bridge was necessary to maintain public safety and the structural integrity of the bridge. That decision was not taken lightly; it was firmly based on the expert opinion of our engineers and backed up by our independent experts, who are here today.

Our full focus remains on repairing the bridge as quickly as possible. However, we welcome the

opportunity to clarify some of the points that have been raised in relation to the defect.

Following the decision to dissolve the Forth Estuary Transport Authority and appoint an operating company for both crossings, Amey took over the responsibility for the bridge in June 2015. Amey continues to use the same well-tested FETA procedures to inspect, manage and maintain the bridge with the same well-experienced staff complemented by Amey's own considerable resources. The procedures that are followed represent good industry practice and are undertaken by experienced staff who have a thorough knowledge of the bridge.

We ensured that there were no compulsory redundancies as a result of the transfer in order to retain the unique knowledge and experience that had been built up among long-serving staff. That approach was successful. The vast majority of FETA employees transferred into Amey. Two staff opted to leave, but not before comprehensive shadowing and handover processes were completed. The bridge manager left several months before the dissolution to join our operating company in the north-west of Scotland, where he still works. The bridge master left two months afterwards to take up a significant post abroad.

There have been questions about the level of funding that was provided to maintain the structure since tolls were removed in 2008. The last six years of tolls generated an average annual income of around £10.5 million and since 2008 the Scottish Government has provided funding of nearly £108 million, so year on year the average budgets were similar to those prior to toll removal. If funding for emergency safety-critical work was required, FETA had the opportunity to draw on its own financial reserves or discuss the need with Transport Scotland. That occurred, for example, in relation to the repair of the cable band bolts, and additional funds were provided from our own maintenance budgets.

FETA's indicative forward capital programme was considered and funding provided to meet its contractual requirements and deliver capital maintenance on a prioritised needs basis. Transport Scotland made grant offers in line with the outcome of discussions with FETA officials and those were accepted by the FETA board.

Moving on to the truss end link assembly project, FETA had considered works to that arrangement since 2006. Over the years, a number of reports have been considered on possible ways to strengthen that area of the bridge. During all of that, no issue with the truss end link member or the pin joint was identified, rather the principal concern related to the tower bracket weld strengths, which, although part of the truss end link assembly, are unrelated to the unexpected defect that closed the bridge.

By 2009, a preliminary preferred option was identified, which would see the entire truss end link assembly replaced at eight locations with an estimated cost of up to £15 million. However, that concept was at an embryonic stage and FETA decided to seek to appoint a consultant to design the final solution. That tender opportunity was advertised in May 2010 but was withdrawn in March 2011 due to affordability issues.

It should be noted that the truss end link assembly scheme was not dropped from FETA's capital programmes. From 2011, FETA worked to re-evaluate the problem and develop a more proportionate, cost-effective solution to improve the bracket weld strengths. That construction project commenced in May 2015, with an estimated cost of £430,000.

We believe that the defect was unforeseen. As always in managing and maintaining our assets, we will take the opportunity to learn lessons from the incident in an effort to continuously improve. The incident has highlighted how important the crossing is to Scotland's economy and its people.

The decision to close the bridge set unprecedented challenges for strategic traffic in the east of Scotland and for people living in the local communities. We remain grateful for their patience and the support that was demonstrated, as well as for the on-going patience of the freight industry.

In closing, I would like to reassure the committee that we have exerted every effort to reopen the bridge as quickly as possible and to mitigate the impacts of restriction. Every effort is being made to fully reopen the bridge to heavy goods vehicles. Strengthening work to the affected north-east section is on programme and, subject to favourable weather and no further defects being found, we will be in a position to reopen the bridge to HGVs by mid-February.

The Convener: Thank you, Mr Lees. If I heard you correctly, you said that funds were provided for maintenance and capital work from your own maintenance budgets. What year was that and how much money are we talking about?

Scott Lees: The sum was £2 million. Perhaps Wayne Hindshaw can advise us of the year.

Wayne Hindshaw (Transport Scotland): It was spread over two financial years: 2012-13 and 2013-14.

The Convener: Okay. Is it correct to say that the £15 million was for essential maintenance work that you had identified would be necessary across the whole of the bridge?

Scott Lees: No. The £15 million related to the proposed scheme to replace the truss end link assembly, which as I said was at a very early stage; the figure of up to £15 million was the estimated cost for that, which was prepared by FETA.

The Convener: How much of that work has been carried out to date and how much has been spent on that work?

Scott Lees: FETA decided not to proceed with that scheme and came up with an alternative solution. It took a number of years for FETA to prepare that and the work commenced only last year, in May 2015. There was a trial of the strengthening work at one of the towers, which proved successful and the work has moved on to the other towers. At present, that project has a budget of £430,000. Mark Arndt can perhaps advise where we are with that spend.

Mark Arndt (Amey): As Scott Lees says, the project was associated with strengthening repair of the bracket at the north-west tower, which was undertaken as a trial that commenced in May 2015. The project was commenced by FETA and was transferred to Amey at the beginning of June. Amey saw that trial through to completion in June or July this year and, since that time, we have applied the lessons from that project to activity on the other three areas of the tower. That activity kicked off in August at those other locations. We continued the work that was commenced by FETA as a trial and we have implemented that on site at two other locations. Work on the third location is being taken forward as we speak, as planned works.

The Convener: I am sure that my colleagues will want to go into the detail of that later. At the point at which the authority transferred from FETA to Transport Scotland, how much of the planned work had been committed to?

Mark Arndt: The planned work for that element was to do with the bracket that supports the truss end links. One out of the four areas was progressed as a trial—it was commenced by FETA and concluded by Amey in June. The learning from that project was then taken forward, and all the work to strengthen or replace those brackets has been or is being progressed as we speak.

Scott Lees: That is part of a programme of work that was handed over at mobilisation. FETA's work programme was in train and was handed over to Amey, which has continued that work. Amey has adopted the longer-term programmes that FETA developed into its forward projections.

The Convener: The decision not to proceed with the £15 million investment was taken by FETA—is that correct?

Scott Lees: Yes.

The Convener: Okay. I will leave it there.

It might be useful to the committee if you could outline, to inform our understanding, the frequency of each type of inspection on the Forth road bridge. What different types of inspection are undertaken?

Mark Arndt: Bridges in the United Kingdom generally follow a programme of general inspection, which is a visual inspection every two years, a principal inspection that is undertaken at close proximity to each element every six years and special inspections that are undertaken if there are particular issues associated with elements. However, the Forth road bridge is a large, major structure, as we all know, so it has its own special criteria that define its inspection regime.

The inspection regime for the Forth road bridge is set out clearly in the Forth road bridge engineering manual, which explains the rationale for the inspection frequency and type for every component of the bridge on the basis of criticality and vulnerability. That is a risk-based approach that looks at the consequences of failure, the likelihood of failure, the load path transfer and a suite of options in determining the inspection frequency for every component of the bridge. The truss itself, of which the truss end links form a part, is made up of a diversity of components from posts and bottom chords to truss end links, and the frequency of the inspections of the truss components varies between six months and five years depending on the identified criticality and vulnerability.

The post member, which sits between the two truss end links, is inspected annually. When you are out there, you are in such close proximity to the truss end links that they are generally inspected at the same time. The truss end links are captured within the inspection of all the other truss components, if you like, so that element is inspected annually. Scott Lees outlined the historical FETA practice that we have continued with, whereby, since 2001, the truss end links have been inspected on a six to 12-monthly basis. The most recent inspection of that area was undertaken on 19 May last year.

I would like to clarify that the Forth road bridge is unique. It is not that we send teams out to look at it, rather we have a huge site presence there 24/7—there are about 70 to 90 staff at any one time carrying out diverse maintenance and routine cyclic activities. Although the truss end links are inspected on a six to 12-monthly basis, we generally have people out on most areas of the bridge throughout the year.

10:15

The Convener: Can you clarify for the benefit of the committee when the crack in the truss end link was first reported? What type of inspection gave rise to that?

Mark Arndt: I would also like to clarify that it was not a crack that was identified, but a failed member. The failed member was identified on 1 December 2015. That defect was not identified during a planned inspection, which took place in May, but was identified during a site visit to the bridge, which involved members of our inspection and engineering team, including my colleague John Russell.

The Convener: When were previous safety inspections carried out on the defective area and what was recorded?

Mark Arndt: As I said, the records that are available to us through the Forth bridge database show that it was inspected regularly between every six to 12 months, back to 2001, which is the earliest record that I have. In each inspection recorded on the database no defects were identified.

Mike MacKenzie (Highlands and Islands) (SNP): I would like to understand a wee bit more what happens during an inspection. Is it a visual inspection that looks for cracks, bends and things that are worn, or are measurements taken and so on?

Mark Arndt: I will ask John Russell to talk through the basis of the inspection. That area is very difficult to access. It is a visual inspection. If potential defects were identified or something did not look right, there might be a recommendation for further testing or paint removal or whatever.

John Russell (Amey): On that particular area, we have had two inspectors on the bridge for a number of years. The main inspector is George Elliot, who has more than 20 years' experience. In his last inspection on 19 May, George would have climbed out on to the open truss and, attached by a Sala line to the bottom chord, he would have walked to the end where the pin comes down and attaches to the end of the truss end link. He would have done a visual and hand inspection to see whether he could see or feel any cracks or movement that should not be there. In general that can be done with mirrors attached to the end of wooden poles. That is how we have inspected the main cables, which is how we found the problem with the cable band bolts.

The truss end links are probably the most inaccessible part of the bridge. In the paperwork you will see information on the scaffolding that we have had to put in place there. The convener and Mr Stewart visited the bridge yesterday and although there was a lot of scaffolding, I am sure that they could get an idea of how inaccessible it is. Generally speaking, rope access would be needed to get to that area.

George Elliot would go out to the bottom chord and inspect with mirrors and by feeling any defects. He would take photographs and bring them back for inspection. We have had 23 inspections at that locus since 2001 and there have been no defects noted on any of those inspections.

The Convener: In your professional opinion, and with the benefit of experience and hindsight, was there any other reasonable or appropriate assessment, analysis or monitoring that could have been used to predict the defect?

John Russell: In the current circumstances, using the technology that we have at the Forth road bridge, that defect could not have been foreseen. If you are asking for an opinion about the future, the structural health monitoring that is being carried out on the new crossing covers an awful lot of the components and feeds into a new system. Previously as FETA, and now as Amey, we have suggested that we should have structural health monitoring on the current bridge too. We are doing some of that at the moment and getting data back to help us judge how some of the other components are doing.

It is all technology. It is a 51-year-old bridge with a 60-year design. In my opinion, structural health monitoring on the current crossing is the way forward.

The Convener: I am a bit confused. You say that it would be possible to predict such a defect in future but it was not possible to do it until now. Why is that?

John Russell: We did not have any structural health monitoring in place so we had no sensors on those areas on the bridge. We are putting them on now to try to get the data about how things are working. If such structural health monitoring had been in place, it might perhaps—I emphasise "perhaps"—have been picked up.

The Convener: Dave Stewart, Alex Johnstone and I attended a technical briefing at the Forth road bridge in December. At that point, we were assured—in response, I think, to a question from Alex Johnstone—that the bridge would be reopened to all traffic. That has not happened, because there is a restriction on access by heavy goods vehicles. Will you explain why what we were advised in December did not happen?

Mark Arndt: We have always made it clear that the repair to the broken member is reliant on two major factors: one is the weather, which we have managed to work through—that is a credit to the

teams who are on the bridge—and the other is there being no identification of further defects.

We fully designed a solution that is commonly known as the splint repair—information on that is available through various media outlets—for the broken member in order to allow traffic to return to the bridge. That design was fully checked and certified on the basis of allowing all traffic to return to the bridge. However, in any design, we need to make assumptions: conservative assumptions were made.

The truss end links that you probably saw out on the bridge have pin connections at the bottom. Those allow the bridge to cater for wind movement, temperature and traffic. The bridge is a huge structure with almost unstoppable forces. The pin caters for that at the end of the bridge deck by swinging back and forward in the fluctuations. If the pin becomes seized, that completely changes the articulation of the bridge. Remember that because of its size the bridge is an almost unstoppable force; if the pin becomes locked and seized, that changes the bridge's characteristics. There is no way that we could design any member to cater for a fully locked pin, so the design catered for a conservative assumption about the degree of friction in the pin and its ability to rotate.

When we completed the strengthening repair phase 1, jacked the bridge back up and installed the structural monitoring devices, we did some controlled load testing to validate the assumptions in the design. The results from that controlled load testing indicated that the pin had become completely locked—a scenario for which the phase 1 repair design could not cater.

We introduced a quick phase 1 repair to get the bridge open to traffic, including HGVs—caveated by the knowledge that there is an assumption that there would be some rotational accommodation in the pin. However, until we effected the repair, did the load test and observed the results, that accommodation was not predictable. That is where we are today.

David Stewart (Highlands and Islands) (Lab): At the technical briefing, you told the members that about 86 per cent of the bridge's dead-weight is to keep the bridge up. Obviously, you leave the remainder for traffic, and HGVs have a disproportionate effect on the bridge. The other side of the coin is that many haulage companies—as many members do, I meet them—are concerned about the current closure. Is it possible that when the bridge reopens for HGVs you might restrict its use by some of the heavier HGVs or abnormal loads? If I remember the briefing from yesterday correctly, such loads can be up to 150 tonnes—for example, turbines being moved.

Mark Arndt: We had a really successful meeting and briefing last week with representatives of the haulage industry, who are really sympathetic and understand the challenges that we are working through and the challenge that is in front of us.

The design that we plan to take forward comprises two parts: interim temporary works that will allow HGVs to return to the bridge as soon as they are in place; and replacing the linkages. The design solution for the linkages will return the bridge to its pre-December articulation and load-carrying capacity, which will cater for HGVs and abnormal loads.

Colin Clark, who is leading on the design side, may want to comment on that.

Colin Clark (Fairhurst): In the stage 2 design, we will catch the top chord and hold the structure. That will relieve the dead loading, initially from the existing link. The load will then be shared between the existing link and the new temporary works, which will allow us to run traffic across the bridge. Once we are at the stage of replacing the link, the works at stage 2 become the temporary works and will take the full load, as they are designed to.

The Convener: What is the anticipated timescale for opening the bridge to HGVs? I am conscious that you may be considering a number of scenarios. What are the best and worst cases?

Mark Arndt: Based on the data that we have, the target for opening the bridge to HGVs remains mid-February. We have looked at all eight areas where a similar component exists. You will recall from the site visit that those are the side spans and on the main span. We have identified the side-span links as being non-critical to allowing the return of HGVs. That leaves four areas of potential concern on the main span. We are aware of one broken link and we are undertaking design and construction works right now to address that. That programme has a completion date of mid-February.

The Convener: The estimated completion date may be mid-February, but what if you encounter further difficulties? What is the worst-case scenario?

Mark Arndt: The worst-case scenario is that all four of the remaining pins are seized. We have confirmed that one is not seized and is articulating properly, which leaves three areas of potential concern. If all three need to be done it would take, working 24/7 as we did throughout December and mobilising all the resources that we can mobilise, until about mid-March—or towards late March, in order to take account of weather problems or the like. At present, all we know is that there is a broken link at a single location.

John Scott (Ayr) (Con): Mr Lees maintains that the incident was entirely unforeseen, but it was identified in 2009 that the truss end links needed to be repaired. Was the fracture in the member not a foreseeable outcome of replacement not being carried out when it was first identified as being needed in 2009?

Scott Lees: I will start, and Colin Clark, who has twenty years' experience of the issue, can provide a bit more context afterwards.

I have spoken to a lot of people and read numerous reports. I spoke to the former bridge master on the issue. He did not think that the incident could have been foreseen. The problem that had previously been identified was related to the bracket weld strength, not to other parts of the bridge. When the handover from FETA to Amey took place, none of those points was raised as an issue, a concern or a risk during the mobilisation period.

We took at face value from what we had seen of the scheme in train from 2009 to 2015 that the member that failed had not been identified as being a risk. The scheme had taken some time to start; that might lead you to conclusions about whether there was a great deal of risk or concern about the issues it addressed.

Colin Clark: When FETA asked us to carry out the study originally, we identified various elements of the truss end links. The full assembly involves the load from the truss going into the end post, coming down and into the pin, and then going up the link members before going into the brackets, which are connected to the main tower.

10:30

The areas that we identified as being at risk at that time, under specific assessment loadings, were the welds and areas of the bracket. We also had concerns about the ability of the end post to carry the load. We had a workshop with FETA to review a number of aspects. Following that, we developed a conceptual design, which was reported in 2009. It involved putting in a different system to create an alternative load path by connecting to the top chord, and removing the end post and the link members from the load path.

Subsequent to that, there were various discussions. We were asked to consider works that would address the critical overstress in the welds and one section of the bracket within the tower. That is the scheme that has been developed. We have to make alterations within the tower to allow us access in order to enhance the welds. That is what is going on at the moment.

John Scott: Various reports between 2009 and 2015, when the member failed, used the words "threaten the structural integrity of the bridge". My degree was in civil engineering—albeit that I got it a long time ago—so when I hear the words, "threaten the structural integrity", I know that you should run for the high ground.

In 2009, what would have been envisaged as the mode of failure if the work were not carried out? We have had a worst-case scenario, but it seems that no one anticipated it, except for the engineers who created that report in 2009 and identified the issue as threatening the structural integrity of bridge. The seizing of the pin in place turned the bridge from a mechanism into a structure, and the bridge was not designed to cope with that. That must have been envisaged, given previous failures such as that of the Tacoma Narrows bridge.

Scott Lees: I say again that I am looking at the same reports that you are looking at and have spoken to a lot of the people to whom you will speak later. Many of those questions require answers from the former bridge master. He was responsible for the bridge at that time.

The advice that I have been provided with is that the people in FETA had an embryonic idea that was revised because, at £15 million, it was deemed to be unaffordable. With regard to subsequent decisions, there is nothing wrong with what they did. They did what a lot of people who manage assets do: they had a fresh look at the perceived problem, challenged themselves to find another way of addressing it and came up with a solution.

I assume, from what I have seen and from the actions thereafter that the risk was seen as acceptable. If it was not, FETA should have flagged it as safety-critical work. As I said earlier, if there was anything that was safety-critical, FETA could have used its reserves or come to Transport Scotland and asked for help. I have found no evidence of that, so I consider that the risk was deemed to be manageable.

The Convener: So, your assessment of the evidence is that no safety-critical work was postponed or not undertaken because of cost constraints.

Scott Lees: FETA had a programme of work. There was a lot going on at the time, including the viaduct bearing replacement anchorages and the main cable investigations. The team considered those to be the main priorities in terms of risk, and those were funded. FETA did not lose sight of the other work, which continued, but the main safety-critical works were done. John Russell, as a former—

The Convener: You say that

"the main safety-critical works were done."

Does that mean that there were safety-critical works that were not done?

Scott Lees: No—I did not mean that.

The Convener: Okay. I just wanted to be clear about that. We need maximum clarity in order to understand what has happened.

Clare Adamson has been waiting patiently, but John Scott can have a quick supplementary.

John Scott: On that point, why did various reports say that the issue "threatened the structural integrity", which is as strong language as can be used in any report? Why were those words used if, in your view, there was not a threat? Was that the view of others?

Scott Lees: Yes, but the person whom the report was written for would have considered that and made their own recommendation to the FETA board on what to do.

John Scott: Should we seek to get evidence from him, then?

Scott Lees: Yes, I think so.

The Convener: We will have plenty of opportunity to do that in the course of the inquiry.

Clare Adamson has been waiting patiently to ask a question.

Clare Adamson (Central Scotland) (SNP): I have a couple of supplementary questions on the evidence that we have heard so far, and then I have my own questions, if that is okay, convener.

Just so that I understand, was the issue with the articulation of the pin that was identified after the repair was done a result of that repair, or was it just that the problem was identified at that point? When was the articulation of the pin last working properly?

Mark Arndt: The repair in no way influenced the articulation of the pin; indeed, it would only have benefited that. If you can imagine, the pin is supported by two trussing link members. One had completely failed, so I guess that the pin would have been sitting not quite parallel, which would have induced additional stresses into the member. The remaining sections at the north tower only have all been looked at. That is what John Russell alluded to earlier when he mentioned structural monitoring equipment. At the moment, we are investing a lot of time and money into putting in place a structural health monitoring system for the components, so that we can have confidence when we open the bridge. That is why the restriction to 7.5 tonne vehicles is in place.

On the programme of works, the north tower is now completely functioning and we are getting reliable data through on it. At the north tower, as I said, the side spans are non-critical. We know about the broken link member, and the link member on the other carriageway is articulating as well as it should do under the design parameters.

For the south tower, the cabling works and the work that is associated with that are now all in place. In fact, as we speak, the strain gauge monitoring system is going live. Around about now, we will probably be doing a simulated load test on that to gather information.

Somebody alluded to the fact that 80 per cent or so of the load on the bridge is its dead load. The other major influencing factors on it are wind, temperature and traffic, which are about a third each. Unfortunately, today, it is not windy and very stagnant—the wind is probably the biggest influential load on the bridge—the temperature is fairly consistent and the traffic has load restrictions on it. That is why we are probably doing a simulated load test as we speak to try to force movement into the bridge under controlled circumstances so that we can ascertain whether the other pins are articulating as we hope they are.

Clare Adamson: So the problem with the articulation of the pin could have been there before the truss end link was identified.

Mark Arndt: Yes—it could have been.

Clare Adamson: Can you give us an estimate of how long the bridge would have been closed if FETA had gone ahead with the £15 million project that it identified?

Scott Lees: We have had a chat about that. Obviously, we are hypothesising, because FETA had not finalised the design, but John Russell and I had a wee debate about that and we reckoned that it could have been done with a number of overnight closures.

John Russell: They would have been overnight closures at weekends.

Scott Lees: There would probably have been three months of overnight weekend closures.

Clare Adamson: My own questions are about the decision-making process on closing the bridge. Can you talk us through the timeline? Obviously, traffic was restricted to a single lane on 1 December 2015. An engineering assessment was then carried out, which went to Transport Scotland and to ministers. Bearing in mind that you have said that safety and maintaining the bridge's integrity were the two driving factors in the decision to close the bridge, will you talk through the process?

Mark Arndt: I will talk you through the timeline and the circumstances surrounding the recommendation to close the bridge. As I said, on 1 December 2015, we hosted a site visit with a

number of my colleagues. At about 3.30 we received a phone call back in the office, and the bridge manager and I were requested to inspect an element of the bridge, because it had been identified as having failed. We did that. As we are based at the bridge, it was undertaken within half an hour or so. We realised the magnitude of the potential disruption that we would be talking about. We notified Transport Scotland between half past 3 and 4 o'clock. We then quickly engaged Fairhurst, which has a long, historical experience not only of the bridge but of the truss end link assembly componentry. That happened at 4 o'clock. We had various telephone conference calls with Scott Lees and his colleagues at Transport Scotland and Fairhurst to take advice on what it meant for the bridge.

By 9.30 that night, a contraflow was in place on the southbound carriageway. We put that in place then because at the time of the defect identification and the preliminary assessment we were heading into the peak rush hour. A contraflow takes about two and a half hours to safely install on the bridge. Therefore, 9.30 was the earliest time that we could get that on proportionately to take the load traffic off that affected member.

On the same night, the guys worked around the clock. We engaged Arup, which is an independent checker. The basis for the prognosis was that Fairhurst was the designer of the bracket work that we are strengthening, Arup was the checking party and Amey managed the process. That was the logical team to progress the matter.

At 11 o'clock that night, Arup was engaged to work with us and our colleagues to do the check. We undertook overnight monitoring at the other members that we could access. Again, it was windy and dark, and that was the safest prognosis in terms of the people undertaking the inspection. That led us to the contraflow situation, which led into 2 December. I can keep talking you through the timeline of how we got to full closure if you want.

Clare Adamson: Yes, please.

Mark Arndt: You can imagine that we have quite complex computer models that replicate and simulate the loading effects on the bridge. On 2 December, the teams updated the models to replicate a broken truss end link. That took a little bit of time. There were also various loading patterns and articulation movements to cater for. That analysis continued throughout the day and, indeed, overnight.

At the same time, our on-site team was mobilised. It inspected all the other eight areas to ensure that there were no similar defects or broken members elsewhere which, visually, there were not. However, we also felt it prudent to undertake non-destructive testing. By that I mean that we physically removed the paint from the affected member and the welds, and we did localised testing, which would give indications if cracks were present.

All that work proceeded throughout the day on 2 December. On 3 December, which was the day on which it was recommended that the bridge be closed, the teams on the design and the assessment side had been working throughout the previous night and into that morning. We had removed the paint and mobilised a non-destructive testing team to come out to the site. It visited the site and tested the single remaining link that was in place at the north-east tower. The results from that became available just after lunch time, in the early afternoon. That identified the potential propagation of a crack in the one remaining link. That changed what the guys had to model in their analysis. It meant not just that one of the twin links had potentially failed but that both links had to be modelled as failed. The only conclusion from that was that the bridge required closure.

There were various dialogues and meetings. As I said, our offices are on site and Transport Scotland was with us. By 4 o'clock, Amey submitted a written recommendation on the background basis and justification why the decision to close the bridge was proportionate and responsible and had the full support of independent experts.

By 6 o'clock that evening, the independent parties had supported that decision and made a written recommendation to Transport Scotland and the Scottish ministers. At 8 o'clock that evening, we held an initial senior meeting with Transport Scotland representatives, prior to a briefing with the First Minister, to chat through again the prognosis basis and the risk-based approach that was needed.

10:45

The decision was not taken lightly by the engineers, Transport Scotland or the Scottish ministers. John Russell has been at the bridge for 35 years and has experience of the cable band bolts and the concerns about the main cables over the years. Before we reached our conclusion, all of us around the room individually said how we felt and whether we were happy with the recommendation. It was the most uncomfortable that any of us had ever felt in that scenario, and it was the most uncomfortable experience that John Russell had had on the bridge.

At 8.30 on 3 December, we held a briefing with the First Minister, the Deputy First Minister, the cabinet secretary and the transport minister to

keep them abreast of the situation. As you can imagine, they were shocked at first but, to be fair to the Cabinet members, they were supportive, they understood what we were saying and they asked appropriate questions. By about 9 o'clock that night, a consensus was reached that the bridge should be closed on the ground of maintaining the safety of all traffic and the bridge's structural integrity. The closure came into effect at midnight that night and was in place throughout December.

Clare Adamson: Thank you for that comprehensive account.

The Convener: We need to move on. Adam Ingram has some questions.

Adam Ingram (Carrick, Cumnock and Doon Valley) (SNP): Some of them have been answered already. My remaining questions are for the Amey representatives.

It is unfortunate, to say the least, that we have this problem within six months of your taking over the contract. Would you like to comment on that? Amey is experienced in the maintenance of bridges, but I am sure that it does not have any experience in maintaining and strengthening major suspension bridges.

Mark Arndt: I would counter that. Amey has experience of major structures, primarily in the UK. We led on the Hammersmith closure in London before the 2012 Olympics and on the Tinsley viaduct strengthening and repair. You are correct in saying that we do not have a lot of experience in suspension bridges. However, when Amey tendered for the contract, we recognised not only that we had lots of positives but that there were areas in which we needed to enhance our experience. That was the primary reason why Arup, the engineering representative on the Queensferry crossing, was brought in as our partner for the commission. Representatives from Arup attended the competitive dialogue meetings, supported us throughout mobilisation and supported us in taking design schemes forward such as the truss end link bracket strengthening works, which I have mentioned. Arup is an integral part of our team, as is Fairhurst, which has a long history on the bridge. That is the comprehensive team that we have assembled.

It is not the dream start to the contract that we would have wanted, to be honest, but the best experiences often come out of the worst situations and I give credit to the teams that were in the office or out working on the site in December. We had over 300 people who were safety inducted on the site, and no stone was left unturned in terms of scaffolding and welding resource. It was a privilege and an honour to work with those people in the circumstances, and all credit is due to them.

It was an integrated, teamwork approach, working with Transport Scotland and with regular briefings to ministers. It was not a situation that any of us wanted, but a lot of positives have come out of it. Indeed, we have had the support of the communities who were affected by it. I think that we have the best part of 2 million likes, or whatever it is, on Facebook. We have also had people approaching us about how to change careers and get involved in engineering. Many positives have come out of the situation, but there has been a big negative impact and we are still working through the challenges of that with the HGV industry. John Russell might want to add something to what I have said.

John Russell: I just want to add one little note about having this situation land on my doorstep in my first six months in the job. I have worked on the bridge for 30 years and I think that I have seen out three general managers or bridgemasters in that time. You can ask Barry Culford next week what his first few months were like when he took over from Alastair Andrew in 2008: we had a series of incidents in his first week of taking over involving closures, problems with hangers, problems with cables coming loose and a dropped object canopy that lost half its equipment on the southbound carriageway. It was not a great start for Barry Culford and us at that time either.

To be honest, although the current problem is massive and we closed the bridge down because of it, it was just another day at the Forth road bridge, unfortunately. It is a 50-year-old bridge and a great structure, but we have to maintain it to keep it going. What happened was a bigger problem, but it was also just another day at the Forth road bridge.

Mark Arndt: Just to close that out, we need to remain mindful that 95 per cent of the staff who were delivering the services at the bridge before Amey took over in June are still there. It is the same people doing the same tasks and the same jobs, enhanced by the larger team that Amey is able to offer but with the same supporting consultants.

Adam Ingram: So you did not have any difficulty in putting together the team to design and implement the repair solution, for example, because they were all to hand.

Mark Arndt: As I said about the timeline, the crack or failed member was identified in the early afternoon, by 4 o'clock that day we had our design team ready and by 11 o'clock that evening we had the design check team ready. We enhanced that through the appointment of an Amey technical director who has more than 30 years' experience as a chartered structural engineer. I would challenge anybody to do anything more than what we did.

Adam Ingram: Earlier, Mr Russell talked about installing structural health monitoring. Why was that not done when you took over the operation of the bridge? Why do we have to wait for the incident to happen before that is put in place?

John Russell: To be honest, I worked with FETA and, previously, the Forth Road Bridge Joint Board for many years, but we did not install that monitoring either, so it is really not an Amey problem. It is difficult in the environment that we have to get back to the information that we had at the Forth road bridge before Amey took over. However, we had conversations many a time in the senior management team about trying to link in with the structural health monitoring that was going to be put in place on the new crossing. We hoped to get some of that technology put on the Forth road bridge.

As Scott Lees and Wayne Hindshaw said earlier, though, we have to prioritise what we do. We had a capital plan that we called a wish list. Every engineer will tell you that what they want to do is to go over every single thing that is out there and fix everything until it seems brand new. However, we cannot do that because there is limited scope for access and limited funding. Even when we had money coming in from tolls, we had a substantial wish list.

We hope that we will be able to continue with the structural health monitoring that we have at the moment and enhance it and move it on to other locations on the bridge where we think that it might be useful.

Adam Ingram: Is it common practice—perhaps Mr Lees can answer this—for that kind of monitoring to be put in place on bridge structures, including older ones like the Forth road bridge?

Scott Lees: I am fairly new to that issue. However, we have had discussions on it, and Richard Hornby might add to what I will say. Certain older bridges have had systems retrofitted as technology has advanced. Sometimes that has been because they think that something is wrong with the bridge and they want to know about it, and sometimes it is because of age.

Richard Hornby (Arup): Structural health monitoring is an embryonic science, and it is not common or widespread in its use. Normally it is installed as a retrofit when problems are identified, such as when there are broken members or signs of distress are noted in elements. Rather than repair, you install the monitoring.

In this instance, the area that failed had not been identified as being overstressed. This component is a chain with five links and the element that failed was the strongest link. The repair on which £400,000 has been spent was to that point of structural instability, and it is just about to be completed.

With regard to instrumentation, these moving components—I have just replaced the same component on the Humber bridge—have a finite life, and there is a time to replace them. Structural health monitoring of such things has not been done widely. There will be a monitoring system on the Queensferry crossing, which is a 21st century bridge. With 21st century technology, we have the capability to put that stuff in place so that we are ready for such events in 50 years' time, but that was not contemplated in 1964.

Adam Ingram: But it is available now.

Richard Hornby: It is available now, and it would be a prudent thing to do on elements that are vulnerable. However, it would almost colour one's criticality and vulnerability assessment to say that, rather than us having to look at these elements at six-month intervals by visual inspection, something would be returning data to a computer so that we would all avoid having to go out to that location.

Adam Ingram: Yes. I think that it was Mr Russell who indicated how difficult it was to inspect this particular element of the bridge.

Was it never discussed at board level, during FETA's time or subsequently, that a monitoring system should be put into place?

Richard Hornby: When the strength of this particular element of the member was assessed by Fairhurst and checked by another independent consultant, it was shown to have adequate capacity. Unless it is actually displaying signs of distress, you would not go back to look at a particular area.

Adam Ingram: Okay, but we are not talking about just this part of the bridge. In general terms, was introducing that kind of monitoring never discussed at board level?

John Russell: What I can say is that we have a retrofitted dehumidification system, which is blowing dry air along the cable. The reason why the new bridge is getting built is the problems that we thought we had with the main cable. That system has been retrofitted. We have acoustic monitoring on the cable to listen for breaks and so on. Again, that was retrofitted. A number of schemes have been taken forward. It is just a case of prioritising.

Richard Hornby is right: if something is not seen as overstressed, why would you need to do something about it, if you are inspecting it on a regular regime? That was what was happening.

Adam Ingram: What would be the cost of installing the system?

Richard Hornby: The order of magnitude cost for the Queensferry crossing is between £5 million and £10 million.

Adam Ingram: What is the cost for what you are doing now?

Richard Hornby: Again, I cannot comment on the cost of the items in what is being done now. However, in some respects you are looking to a single element to give complete coverage of the bridge, including all the elements that have been identified in a 60-year-old structure that was designed for half the loading. You are looking at a needle in a haystack in terms of all the elements that you want to cover.

Fairhurst has produced a very telling plot that identifies the areas that are overstressed or that would not satisfy current codes of loading, and it colours in almost all of the bridge. That is what informs the inspection of our mobility assessments. However, to cover the whole bridge in structural health monitoring would be an enormous task.

11:00

We are sitting down with Amey at the moment to make recommendations on the crucial elements—to say, in light of what has happened, we need to ensure that we get coverage of moving parts and elements for which a failure would have a significant consequence.

Adam Ingram: Have you got a figure that you can give us?

Scott Lees: For the current structural health monitoring system? I would be lying if I said that I had it to hand. I could give it to you after the meeting if that is acceptable.

Adam Ingram: That is fine. You could write to us.

The Convener: That is helpful, thank you.

Mike MacKenzie: I ran a building company for many years and I occasionally did civil work, although it was not my main work. I compliment all of you on undertaking the work under stress, under duress and under time pressure, in difficult and arduous weather conditions and in difficult working conditions generally. You have all done an exemplary job. I am sure that I speak for the whole committee in saying that and I hope that you will take that back to your teams who are working on the bridge. I was, frankly, astonished that you managed to get the bridge open again so quickly. You are due great credit for that.

I am trying to understand the technicalities of the fault. The pin seized—did the seizure cause the breakage in the link or did the breakage cause the seizure? Is the seizure a result of excessive load on that point preventing it from turning through frictional forces or is there a distortion there? What kind of event led to it? Was it just metal fatigue that led to it or was there a particular event, such as high wind or whatever, that you can identify as the probable cause? It would be useful for the committee to understand more precisely what led to this happening.

Mark Arndt: I will give you an overview and then hand over to Richard Hornby to give you more technical details. I really appreciate your positive comments, which we will feed back. That is testament not to me or others here but to the people out on site. As has been said, December was exceptionally windy. It was not a pleasant working environment for anybody out there.

The bridge relies on a degree of rotation in the pins. There is never a perfect pin with no friction in it, so design assumptions are made about the level of friction. The level of friction or restraint for the pin involved has increased over time.

In the first couple of days, we engaged a specialist metallurgist to come out and inspect the failed member. His conclusive recommendation was that there was indeed a fatigue failure because the propagator initiated at the weld interface, which is potentially the weak interface. That could have happened because of a little bit of grit when the bridge was installed. Nobody really knows what could have initiated it. That then propagated along the weld and progressed into the member itself, which led to a quick failure. That is the kind of crack or failure pattern that can be seen.

There is a photograph in the papers that are before the committee where that pattern can be seen. It begins at the weld and propagates into the member, and we very quickly see a jagged pattern progress up through the member, which is highly reflective of a fatigue crack. I will let Richard Hornby explain the friction aspect in more detail.

Richard Hornby: To put things in context as regards the failed member, for permanent loads the link only really carries the weight of the deck between that end of the deck and the first hanger. The comment about between 70 and 90 per cent of the capacity being dead load applies to the cable. The traffic loads that arrive at the link are spread out over almost half the main span, which is a much longer load length. The variable loads are significantly larger than the permanent ones for this element.

Under normal operation, in an overload failure—a particular event failure that results from the wrong type of vehicle going over or that sort of thing—the load would have to be half the length of the structure, so it is highly unlikely that an overload caused the problem. However, when a

pin seizes, the bridge tries to move backwards and forwards by a very small amount under almost every vehicle that passes over it.

The pins are in position to allow that free movement, and that movement is unstoppable—it has to be seen in the context of holding up a truck that is in the middle of the bridge, between the towers, which are 1km apart. Those are the dynamics of what we are trying to restrain, and that just will not happen with a member bending. That load moving backwards and forwards when the pin is seized will gradually cycle the stress—it is like bending a paper clip backwards and forwards—and eventually the link will go. Therefore, as soon as the pin had seized, the link would have had a finite life and the crack would have gradually grown.

Although the crack would have gradually grown, in the first instance it would have been a very small crack that would not have been detectable in the six-monthly and yearly inspections. It would probably take such a crack a number of months to grow from a crack that was visually detectable to something that had totally failed. From the onset of a crack, things move quickly. However, in this instance, the crack probably would not have been growing because the displacements were quite small, which would have helped. The strain associated with developing these loads is actually quite small.

Mike MacKenzie: That is useful and has given me a much better understanding. Will you talk a wee bit about how the temporary solution was installed and tested?

Mark Arndt: It was not a temporary solution; it was a solution to get the bridge open. People probably do not appreciate the effort that was involved in the installation. Access is the biggest challenge out on the bridge and, as John Russell said, the area involved is probably one of the most inaccessible, because the member is the only thing between you and the River Forth.

We had to provide people in the workforce with a safe-access working platform before they could begin the work, and we came up with two solutions: hanging scaffolding and tower scaffolding. The committee's information pack has a couple of pictures of what those look like. Hanging scaffolding hangs off the bridge and is faster to install than tower scaffolding, which is built from the ground up in a tower format.

We did not adopt a hanging scaffolding access system at the broken member because the one link that remained in place could have failed, and a quick drop of the bridge deck at that point, with people working on scaffolding supported off the bridge, was an unacceptable risk. Therefore, at that location, we adopted tower scaffolding. That meant that we had to use a barge to transport all the scaffolding materials from the land side out to the north pier defences. Similarly, a team was barged out there every day and night, with lights and everything, to scaffold up the full height of the tower—the committee members who were there yesterday will have gained an appreciation of how high that is. We also barged out a mobile elevated working platform, which is, in essence, a lorry with a long-reach basket on the back of it. It was a huge lorry with an extendable reach of 50m, and it was barged out with a full lifting plan in place to lift it out on to the pier defences. All of that went on during the high winds, the rain and everything else that prevailed throughout December.

The work commenced at that area to provide access to the broken member. At the other seven locations, we used the hanging scaffolding solution. It is a bit faster to install because there is not so much material, and it hangs off the structure with a stable platform for the teams to work on.

Concurrent with all that access work going on, the design of the splint or the phase 1 repair was completed, and fabrication took place concurrently with the scaffolding work. It worked really well with the design check certification, steel manufacture and fabrication. That arrived on site in tandem with the scaffolding being finished, which is why we were able to open the bridge so quickly.

Getting steel out on to the bridge is not as simple as just lifting it. We need a specialist lifting plan with Hiabs to drop it through. We were working in a confined area and manoeuvring big bits of steel down through a bridge. That is very different from building a new bridge, when there might be factory conditions for certain components.

The team worked hard to lower the splints into place. They were then tack-welded in place. We had probably more than 40 welders on site who were working concurrently in all eight areas, as were the scaffolders. Lighting was used so that the work could progress day and night. The teams had to stand down regularly because the winds got so high that it was unsafe to work, but they just got off the scaffolding and waited until the control room indicated that the wind speed had dropped sufficiently to allow them to return. Because the work progressed day and night, the bridge could be opened earlier than had been foreseen. It was unfortunate that the rotation of the pin was not as we had hoped as, otherwise, HGVs would be on the bridge today.

Mike MacKenzie: That is useful. Will you talk about the longer-term, more permanent—forgive me for using the words—final solution? Have you identified such a solution? Will you explain a bit

about how it was designed and what it will look like on the bridge?

Mark Arndt: I will give you a quick overview then hand over to Colin Clark, who is the design lead for that part.

Slide 7 shows a visualisation of what phase 2 will involve. In simple terms, it will involve installing a new bracket system above the carriageway at each of the tower locations. The second part will involve installing a spreader beam below the top chord, which is shown on slide 8, and that will support the truss at that location. Slide 9 shows that cables will attach the top hanger to the bottom spreader beam. The team will then jack the bridge up at that location to cater for its dead load, and once that is in place, HGVs can return to the bridge because the new arrangement will support them. Having that new arrangement in place will allow us to install a brand new truss end link assembly that will be designed for maintenance and accessibility.

There is an important point about legislation. When the bridge was built in 1964, people designed for what was best practice at that time. However, in the early 1990s, legislation on designing for maintenance and accessibility was introduced in the UK. That has been through several iterations, with the last one being the Construction (Design and Management) Regulations 2015. They mean that designers need to take account of access, maintenance and replacement in the future. That will be in place for the replacement truss end links.

I do not know whether you want Colin Clark to give you more detail.

Mike MacKenzie: That is probably sufficient for our purposes.

Will you give us some idea of the cost of the splinting work that has been carried out so far and the cost of the final work?

Scott Lees: To get from where we are now to the phase 2 solution in the one tower, along with the splints in all eight places and everything else that has been done, will cost around £5 million. We are still designing the next phase, so we cannot give you an accurate estimate of cost. That will come in due course and I will be happy to share that estimate with the committee as soon as that work is defined.

11:15

The Convener: Mr Hornby, I think that you said that the Humber bridge truss end links have just been replaced. Is that correct?

Richard Hornby: Yes—they have just been replaced. Those links are slightly more complicated than the Forth bridge ones.

The Convener: Can you explain whether a similar problem was experienced there?

Richard Hornby: There is similarity. The pins there had worn a big hole. The holes were circular to start with, but the rotations—as we have been discussing—had elongated those holes so that a cross member was starting to bear on concrete and there was a fear that the pins would seize up. That is why the links were replaced.

The Convener: Are there any lessons for us from that experience?

Richard Hornby: It will certainly feed through. We designed the repair for the Humber bridge for replaceability and maintainability of the bearings and measures to ensure that the pins are moving. The lessons learned in that construction process will go forward so that they are implemented in the final solution that we reach here.

John Scott: I will continue in that vein. When was the need to repair the truss end links on the Humber bridge identified?

Richard Hornby: It was identified four or five years ago.

John Scott: So the ones on the Forth road bridge were identified some years before.

Richard Hornby: They were identified before but, as I mentioned earlier, the links of the chain that were showing distress on the Forth bridge were the fixed connections into the tower and the main structural connection within the truss, rather than the moving components.

John Scott: I am fascinated by the point that it is apparently not the weakest link in the chain that has failed but the strongest.

Richard Hornby: Under normal operation, yes, it is.

John Scott: That poses a question. Given the link that failed, was the evaluation of what were the weaker and stronger links inaccurate?

Richard Hornby: One has to base one's assumptions or analysis on the inspections that one has. There was no evidence to suggest that the pins were not moving.

John Scott: That was in normal circumstances. However, given the wear in the pin that you had seen at the Humber bridge and the need that was identified in 2009, I ask you and Mr Clark as independent experts whether that type of failure of a truss end link could have been anticipated. Given the assessed need for repair in 2009, given that the bridge is—in your words—horribly

overstressed with the current loading and given the bridge's age, could those failures have been anticipated? I can well understand the wear of pins in rotational circumstances.

Richard Hornby: There were no displayed signs of distress in the element. Assessments were done in which areas were identified as being overstressed in potential loading scenarios, such as accidents on the bridge causing queues. Those scenarios had been identified and were the basis of the strengthening works that were undertaken. There was no evidence from the inspections that had been carried out that the pins were not moving.

John Scott: Does Mr Clark agree?

Colin Clark: Yes.

John Scott: It is absolutely fascinating. Can I turn to other types of stressing and loading? Purely by coincidence, just over a year ago, I was on the deck of the Forth road bridge and I was struck by the vibration of the expansion joints below the bridge perhaps due to the pounding of the traffic on a Saturday afternoon, which was surely very light. You described the wear and damage to the steel as being like what happens when we bend a paper clip. Would that constant pounding over time—I was inspired to become an engineer when I visited the Forth road bridge in 1964, as a child—have led to deterioration in the steel?

Richard Hornby: The construction of the Queensferry crossing is timely—or maybe not quite timely enough, in the context of the failure that we are talking about. The consequences on the detailing in suspension bridges were not as well understood in the 1960s as they are now. The number of joints and the vibrations create issues with the structure, although on the basis of the assessments that we have made to date, the bridge is capable of carrying the bridge-specific live loading that it currently carries.

There will be a time limit on the bridge's ability to take that loading. Things have been done to address that and to mitigate the impact, such as the installation of dehumidification.

John Scott asked about pounding of the joints on the roadway; there are thousands of elements that see that cyclic loading, which require regular inspection and will see significant benefit from the moment when the Queensferry crossing opens.

John Scott: There will be reduced loading when the Queensferry crossing opens.

Richard Hornby: Yes. The old bridge will not carry heavy goods vehicles at all.

Mark Arndt: Everyone who has driven a rig over the bridge will be familiar with that "de duh, de duh" sound, which relates to the joints that John Scott is talking about. The important point is the maintenance that FETA began and which Amey is continuing. There is an ongoing programme of works throughout the year to address the worst-affected members, which is informed by the inspections. That is why there are overnight contraflows on the bridge. Drivers do not often see people working, though, because the workers are underneath the bridge. We jack up the bridge at localised points and put packing plates in, to smooth out the bridge. That is an ongoing programme of work that FETA began and Amey is taking forward.

John Scott: Given all that, you must be learning from the unexpected failure of the member. You must have a view as to why it failed under that constant loading—that "de duh, de duh". Perhaps the steel there was not as good as the other pieces of steel. Why was there an unexpected failure? That is what we need to know.

Richard Hornby: On the detailing of the pin and where it is housed, there is the truss itself, and the pins that come up on the outside of the truss. For us to be able to inspect the pin and see whether it is moving, the moving pin should be moving within the links, but that is not the case; the links are fixed to the pin and rotate it, and it moves relative to the truss box itself. That means that we can never see the actual moving part—that is the way in which it is detailed. In the replacement, the reverse will happen; it will be put on the outside, so that we can look at it and, if there is a problem, take it out and put a new one in.

John Scott: If I understood you correctly, you said that the timescale for the crack developing into a break would not have been as much as six months. I suppose what I really want to hear you say is that the inspection regime has worked. Are you saying that the failure of the member was unexpected for reasons that are yet to be identified?

Richard Hornby: The member failed because the pin had seized, and it had probably been seized for a number of years.

John Scott: I see.

Richard Hornby: It is only because the steel was so good that it lasted as long as it did. That is my view.

John Scott: You have inspected all the other pins in the relevant truss end links and you have discovered that they are still functioning.

Richard Hornby: The stress monitoring is going on—it is live as of yesterday evening. For the north end of the main span, we know that the pin that broke was rigid and the one on the north-west side is free to move. There is not an imperative to

get the phase 2 repair on that immediately to allow HGVs back on the bridge. On the south side, we have no data to suggest that the pin is not moving, but we will have confirmation of that from the strain monitoring in the next couple of days.

John Scott: I am catching up with what you were saying. I am intrigued by your saying that the pin has not been functioning

"for a number of years"

in its rotating mode, which allows it to work as a mechanism.

Richard Hornby: It will bend once in summer and once in winter to deal with that—it will be a yielding type of bend that occurs, if the pin is seized. In the context of something that has very small strength, in comparison, you have to do a fair number of cycles of bending before you break a paper clip. The pin will have seen a fair number of cycles.

John Scott: My knowledge fails me. Would the expansion joints have protected the structure?

Richard Hornby: The fact that the expansion joints are nice and rusty, and are maybe offering slightly more restraint to the structure than was originally intended, would help. I have worked on 20 suspension bridges. This is an immovable displacement. To hold it back, you would be fighting the main cable, and you cannot move that with a crowbar at the end of 5m of deck.

Clare Adamson: You were discussing the pin and when articulation of the pin was last working. You say that it could have

"been seized for a number of years."

What inspection process that was regularly carried out on the bridge could have identified that the pin was seized? How can the inspection regime establish whether the pins are working?

Richard Hornby: It has taken us quite a while to establish a system that reliably tells us that the pin is seized or is being subjected to high friction. That has really come down to our being able to demonstrate that a pin never slips. To do that, we have to have days' worth of data to discover the event that would have caused the thing to rotate. The pin has to overcome the friction in the first place. If there is a high level of friction, the pin will not slip until that friction is overcome. We need to be there and recording at the exact moment that the slip occurs. We have to rely on structural health monitoring to determine that the thing is moving; otherwise, inspection is six-monthly to check that there is not a crack.

Clare Adamson: So, prior to this, there was nothing in the inspection regime that could have identified whether the pins were moving.

Mark Arndt: No. As I said, a visual inspection regime was and is in place. As Richard Hornby explained, unless you were there at the precise moment that the pin rotated, it would not be observed.

John Scott: Would not it have been reasonable to have a system in place to solve that problem?

Richard Hornby: There was one installed on the top end of the link, but the inaccessibility of the location meant that it was virtually impossible to get a grease nipple on to lubricate the bearing.

John Scott: Although I have nothing but respect for the people who designed the Forth road bridge with only slide rules and log tables, was it perhaps a design weakness that there was not something to ensure constant rotation of the pins?

Richard Hornby: There is also the physical demand of displacement to consider. Two things have happened since the days when the bridge was designed. Understanding of the vibrations of buffeting by wind that generate cyclic movements of the deck would not have been in the calculations at all in those days. There is also the change in traffic loading and the weight of vehicles. I do not know the figures for the Forth bridge, but a 40-tonne vehicle on the Humber bridge makes the whole deck move an inch one way as it gets to the quarter point. As the vehicle gets to the three-quarters point, the deck moves an inch back the other way. The fretting to the pin is directly proportional to the weight of individual vehicles. That would never have been foreseen when the Forth road bridge was built.

11:30

John Scott: I take issue with you on that. I cannot believe that wind loading would not have been taken into account, given the failure of the Tacoma Narrows bridge.

Richard Hornby: You need to bear in mind the instability response of the Tacoma Narrows and the wind tunnel testing that was done in those days. The way that wind turbulence tunes to the structure—rather than the structure creating the turbulence, as was thought with the Tacoma Narrows—was not understood then.

Siobhan McMahon (Central Scotland) (Lab): I would like to you clarify something, Mr Hornby. We are talking about one pin. You said that because of the way that it had been designed, it was not possible to see it, but that because of the way it has been repaired, it will now be possible to see it. Is that just the case for that pin? Will you not be able to see the rest of them?

Richard Hornby: My recommendation would be that all the linkages be replaced, because one has

shown itself to be time-served. All the others are ticking time bombs, to a greater or lesser extent; they should all be repaired. The best solution having been worked out for that one location, it should be implemented on all eight corners.

Siobhan McMahon: To your knowledge, is that planned?

Richard Hornby: Yes.

Scott Lees: We want the bridge to remain open for the foreseeable future and to have a long life, so we will act on that advice. It seems to be the sensible and prudent thing to do, given what we know now.

Richard Hornby: The linkages can be installed with no closures. The work involved in getting material to the underside of the deck can be done at night or at weekends.

Siobhan McMahon: You talked about the phase 1 cost of £5 million, but you were unsure of the cost of the next phase. Will the work be covered by that cost?

Scott Lees: There will be additional costs. We will work up the design, get costings and put it up for ministers' consideration. I am sure that they will see its merit. We will find a way to do this through our existing budgets, I am sure.

I hope to proceed with the work in spring or summer. We should not wait around for another incident.

Siobhan McMahon: When you have the costs, will you provide them to the convener?

Scott Lees: Sure.

David Stewart: I take the witnesses back to 2010 and FETA's initial decision to go ahead with the proposal to replace the truss end linkages. I appreciate that the witnesses are not from FETA—we will get former members of FETA to speak for themselves. However, the board clearly thought that it was important to go ahead with that work and went as far as advertising for consultants. Perhaps Mr Lees is best placed to advise us. Were the consultants ever appointed?

Scott Lees: No. I have done a lot of digging through the archives and I have a story on that—I mean a timeline, not a story.

David Stewart: I am reassured that it is not a story. Facts are what we want.

Scott Lees: They are always the facts.

FETA put out a contract notice, to make the industry aware. I have a copy of it here. It basically describes the bridge and the work that would likely be involved, and it went out in May 2010. After that, FETA worked up lots of interest in the job; lots of contractors said that they were interested and there are lots of records of acknowledgements of interest.

In September there seemed to have been a change of heart. I found an email exchange between Mr Culford and Colin Clark, who is here today. They discussed whether they were sure that the proposal was the only way to do it. It is clear that the conclusion was that the scheme as it stood was unaffordable—I think that a range of £10 million to £15 million was put in—so a dialogue then developed about another way of doing it, which led to the scheme that is being delivered now. Once that decision had been made, FETA put out a contract notice to cancel its intention to do the design consultancy works and all prospective tenderers were notified.

That is where the trail ends and the new scheme takes over. The FETA records indicate that it was an issue for a number of years. It appears that there was a lot of dialogue and exchange between the designers, Fairhurst, and the checkers, which took a good time to resolve. Once that dialogue was completed, it led to the scheme that was trialled in May last year and the works that are happening now.

David Stewart: I know that you cannot speak for FETA—its former members will speak for themselves when they come before us—but is that not a strange way of doing things? Is it not strange for a board and professionals to have a long discussion and to decide that there is a need to examine the truss end links and to appoint consultants, for consultants to be advertised for, and for the proposed contract then to be cancelled suddenly and mysteriously?

Were you in the same role in 2010?

Scott Lees: No.

David Stewart: That means that it is difficult for you to answer for Transport Scotland, but what is your view on its and the Scottish Government's view on the matter? Are you able to tell me categorically whether Transport Scotland and the Scottish Government advised, recommended or told FETA to cancel the contract to advertise for the consultants?

Scott Lees: An important fact to remember is that FETA was in charge of the bridge. Transport Scotland did not get involved in decisions about programmes or what schemes were progressed. Our role was light-touch governance. We had a real role in funding following the removal of tolls in 2008. Notwithstanding that, we were there to support FETA. There is much evidence of that. The former chief bridge engineer of Transport Scotland was regularly in contact with FETA and regularly at the bridge to help the guys do peer reviews, for example. We had an excellent relationship with FETA and its staff—we also have

such a relationship with Amey—and considered the organisation to be first rate.

FETA was in a difficult situation—there was a lot going on in 2010. The cables were a problem and there were the anchorages, which were substantial projects. As John Russell mentioned, there was a bit of an attitude of, "This is our capital programme—we have approved it." It was a bit of a wish list, but I have obtained evidence to show how the FETA capital programme around that time was prioritised. What FETA did is quite impressive. There is a board paper of 16 December 2011 called "Review of Capital Projects". It highlights that the comprehensive spending review had come back with less than FETA's proposed amount.

David Stewart: I will stop you there—we will come on to that question later. I want to know specifically about decision making. I appreciate that you were not in post in 2010. Who was your equivalent when the decision was made?

Scott Lees: We would not have been involved in the decision. My equivalent was a chap called Graham Edmund, who was the previous head of the unit, but he would not have been involved in any of the decision making. The contract was proposed to be let by FETA. Transport Scotland did not get involved in that kind of governance.

David Stewart: I understand that. We understand the role that FETA had over the bridge, but the Scottish Government was 100 per cent responsible for it. No one suggests that the Scottish Government did not have responsibility for the Forth crossing in 2010, although you were not personally there.

Scott Lees: Transport Scotland had a responsibility for funding, but governance, maintenance, operation and design work were all the responsibility of FETA.

David Stewart: Okay. You might not have the information that I seek, as I appreciate that you were not in post at the time. Did the Scottish Government say in any format—at a meeting or in a phone call or an email—that the project should not go ahead?

Scott Lees: I have not seen any evidence to that effect.

David Stewart: Right. We will ask FETA the same question.

The work obviously did not go ahead, because consultants were not appointed. On one level, it is quite difficult to assess what would have happened if you had appointed consultants and the work had been carried out. However, I presume that the terms of reference were quite clear—you mentioned that they were advertised. Has Transport Scotland carefully analysed the terms of reference for the proposed 2010 work on the truss end links?

Scott Lees: We have obviously seen them, but there has been no further consideration of them. FETA decided to drop the scheme and came up with an alternative. That was passed over to Amey during the mobilisation period and delivered. To repeat what I said earlier, at no time during the mobilisation period were the truss end links identified as a big issue.

David Stewart: I understand that. I am not looking for guilty people; I am merely trying to get the timeline quite clear. Clearly, it is difficult for you to answer some of the questions that I am raising.

Transport Scotland has not done a full analysis of the 2010 terms of reference for the report that FETA wished to carry out.

Scott Lees: No. That was a closed matter for FETA and its Fairhurst consultants.

David Stewart: Right. Is it possible to do a compare and contrast between the work that they suggested and the work that is currently being carried out?

Scott Lees: Possibly, yes, if that would have any merit.

David Stewart: Is it possible for you to make at least a basic attempt to do that for the committee? I think that that information is quite crucial for the inquiry.

Scott Lees: We had a look at the proposed scheme at a distance. As you can understand, during the past month and a half we have had to assimilate a lot of information. The proposed scheme would have introduced many benefits, but it would also have introduced many disbenefits, the key one being that the new connection would have been susceptible to vehicle strike. I do not know how much that was considered—perhaps Colin Clark can advise on that. Given that susceptibility, we would have had to put up an awful lot of barrier to protect the new linkages arrangement. The scheme was at an early, embryonic stage. Perhaps Colin Clark can confirm whether there was anything further to the 2009 workshop that laid out drawings and approvals in principle.

Colin Clark: No, there was not. At the 2009 workshop, we discussed the various options for taking the linking replacement forward. There was nothing that went beyond that, because the job was then going to tender.

David Stewart: I will ask the obvious but important question that I am sure that motorists from Fife and beyond, and haulage companies, would want to ask. If the work was carried out in

2010, might we not have had the bridge closure in 2015?

Scott Lees: We can hypothesise about that, with the caveat that I do not know what they were actually going to do. The contract notice is fairly vague. There is a workshop report that gives a preliminary preferred solution, but it does not say how the arrangement would work. If I assume that the new arrangement, which was not designed, was subsequently designed and happened to be constructed and it made that member redundant, I can of course say, because it is logical, that the defect would not have happened because it would not have been there—the member would have been redundant. However, that is not where we are. Those decisions were not made.

11:45

David Stewart: I understand that, as you say, you have not done a full analysis of the situation; nevertheless, I am sure that the committee would appreciate some further comments on that.

I know that time is moving on, but I would like to ask a couple of further quick questions.

You mentioned that the tolls came to an end in 2008. From talking to those who were involved with FETA at the time, my understanding is that the toll income was crucially important; that, by and large, the toll money went towards the maintenance of the bridge; and that FETA was also able to borrow on the basis of proposed volumes of traffic, which is presumably fairly straightforward to predict.

I am not making the case for or against tolls—I think that our votes are clear on the matter—but did the change dislocate or badly affect the maintenance regime on the bridge? Previously, the steady source of income, plus the money that was borrowed, went straight into maintenance, but there was a change when the tolls came to an end. What is your perspective on that, Mr Lees?

Scott Lees: From what I have seen, there was a steady income of around £10.5 million from tolls. The Scottish Government obviously made a commitment to fund the bridge following toll removal. If you look at that funding, you will see that it is not constant. It goes up and down with need and depending on how much money was available following UK spending reviews.

David Stewart: This is not supposed to be a trick question, but if you take what you are spending on maintenance and what FETA spent, do you know what the proportions are?

Scott Lees: As I said in my opening statement, the spending is roughly the same, year on year. If you average what we have provided, it comes to about £12.5 million a year, against a previous average of £10.5 million a year.

Given its age, the bridge might have required more urgent work. There might have been pressing needs, or safety-critical work might have been required. However, we were always there to help if that was the case.

David Stewart: I am happy to be corrected but the figures that I have seen suggest that your capital grant was £13.8 million over a three-year period, which is only 58 per cent of what FETA was spending. Is there a different analysis of maintenance need now, compared to the FETA days?

Scott Lees: The 58 per cent figure related to a capital programme for the three-year period that the FETA board approved. That was done in isolation from the spending review and any outcomes from the UK settlement. Obviously, it was difficult for FETA to deal with a situation in which, instead of having its own cash, it had to bid for funds.

I have found FETA's submissions for the comprehensive spending reviews. Our approach is different from FETA's. It said, "Here is everything that we want", whereas we build up from the bottom. We highlight the minimum funding requirement for maintenance to ensure the safe operation of the asset and for the works that are required to maintain the structural integrity of the bridge; we then consider the risks of not doing that work. That is something that Barry Colford and his team were good at. We could not fund their full budget aspirations—John Russell has described them as being a bit of a wish list—but we covered the main priorities, and the team was able to manage the risk. The "Review of Capital Projects" document shows that the team covered the main priorities and used risk analysis techniques to determine the priority of the other works in order to decide which ones should be proceeded with.

David Stewart: The question that I am asking is whether spending on maintenance was higher during the FETA regime than it is now. My understanding is that it was.

Scott Lees: From the figures that I have produced, the spending looks similar, accounting for year-on-year variations.

David Stewart: You do not recognise the 58 per cent figure that I mentioned earlier.

Scott Lees: No. I recognise that as a figure that is quoted in many of the FETA board papers, which say that Transport Scotland awarded a budget settlement for capital works for a three-year period that was a 58 per cent cut in the capital programme that the board had approved for those three years.

David Stewart: I will finish there. I certainly welcome Mr Lees's suggestion that he will provide some analysis of the terms of reference for the 2010 FETA report. It would be useful to do some sort of comparing and contrasting between the work that the report suggested was required and the work that has been carried out.

The Convener: Mr Lees, if you could furnish the committee with the other information that you have referred to in your evidence, that would be very helpful.

Scott Lees: I have provided to the clerks a full pack of information, including my timeline, which will be helpful to you in considering many of the issues. Obviously, I will provide anything that is required.

The Convener: That is much appreciated.

Am I correct in thinking that, in 2010, FETA advertised for consultants to undertake a piece of work that would have replaced the truss end linkages?

Scott Lees: Yes.

The Convener: Then, in 2011, a decision was taken not to proceed with that work. Is that correct?

Scott Lees: That is correct.

The Convener: You said earlier that no safety-critical works were not undertaken because of budgetary constraints. Am I right in that understanding?

Scott Lees: Yes.

The Convener: Finally, in your opinion—I am happy to allow the other panel members to answer this, too—was it reasonable for FETA to take the decision not to proceed with that work?

Scott Lees: I believe so. I do not find anything wrong with the approach that FETA took to managing its forward programme of work. It followed a risk-based approach, which is commonly used for asset management purposes.

The Convener: I put the same question to each of the witnesses. Mr Clark, do you have a view?

Colin Clark: It is a difficult question for me to answer. We were one of several consultants working on the bridge, so I was not party to all the information that FETA had at the time.

The Convener: You do not feel able to answer the question.

Colin Clark: I do not feel that I can answer it.

The Convener: Right. Mr Hindshaw?

Wayne Hindshaw: I have reviewed the evidence and the information in the evidence pack. The scheme appeared fourth or fifth in the list of FETA's priorities. My view is that, based on the evidence that was presented in the Fairhurst report and at the workshop, it was tolerable and appropriate for FETA to look for a more cost-effective and less disruptive solution. The solution that was presented at the workshop was clearly not fully developed and any consultant who was appointed would have looked to review it. Had it gone forward from the contract notice, a consultant might well not have taken forward the workshop recommendation—they could have come up with something different. That is what I find to be most likely.

The decision to take forward the work on a slower programme, as FETA did, was appropriate. It is interesting to note that FETA never brought the matter to us as a safety-critical piece of work that urgently needed funding beyond the capital grant that we gave it at the time. I feel that that is germane to a lot of the arguments because, some years later, when additional funds were needed urgently to take forward work on the cable band bolts, my predecessor was more than willing to listen and to act on that.

We have debated what would have happened if the works had been taken forward, which is an interesting concept. We also need to consider what would have happened if FETA had asked Transport Scotland for additional money to do those works and had presented evidence that persuaded us that they were urgent and needed doing.

The Convener: I will bring in John Scott once I have heard a response from each of the panellists.

Mark Arndt: Obviously, I can comment factually only on the period after June 2015, when Amey became involved. However, based on what I have seen, the assessment report identified that the area was not overstressed. That was independently validated by another consultant. All the inspection records to date indicated there to be no perceived problems at that area. On that basis, the decision that FETA made seems proportionate.

John Russell: As an ex-FETA employee in senior management, I will probably say that FETA made the right decision, based on the information that was provided by the report, which was that that element was not overstressed. We took forward the work on an overstressed element—the bracket. That was agreed and put forward. I think that the decision was correct.

Richard Hornby: We are slightly prejudging what the study would have come up with. At the end of the study, the consultant might well have recommended exactly the local strengthening of the overstressed element that has been

undertaken, rather than the wholesale replacement of the link.

The Convener: My question was whether, given the information that was available, the decision that was taken by FETA was a reasonable one.

Richard Hornby: I would agree with John Russell here. There was no evidence of distress in the elements of the link below. The localised strengthening that has been undertaken was proportionate.

John Scott: I note the consensus; nonetheless, I wish to ask Fairhurst and Colin Clark in particular about the threats to the future

"structural integrity of the bridge",

as outlined and identified in 2009 and 2010. Why use those words if you do not mean them?

My question was going to be, and probably remains, whether you believe that Transport Scotland engineers, or indeed the Scottish Government, understood the threat. When engineers tell you that there is a threat to the bridge's future structural integrity, I would have thought—call me old fashioned—that that bumps things up the priority list.

I do not mean to be horrid about this, but you are all saying that the risk analysis techniques that were used were absolutely fine. The bridge and the member failed, so will there be a future re-evaluation of those risk analysis techniques, given that they did not work?

The Convener: Who wants to tackle that?

Scott Lees: I was talking about FETA's procedures. It was FETA's bridge until last June. It was not Scottish Government engineers who looked at the proposal; it was FETA engineers. They decided on what proceeded or not.

John Scott: Perhaps Mr Hornby could expand on that answer.

Richard Hornby: The evidence that was presented in 2010 was that there was overstressing of particular elements, and a wholesale replacement was the answer. Some scratching of heads was done. People said, "Okay, we have many other issues with this bridge." The immediate structural integrity question that was posed by Fairhurst and the independent checker was that the particular elements at the very top of the linkage were the ones that were suspect and which needed to be addressed. Those have now been addressed. It has taken five years for them to be addressed, but they are on stream now, with completion anticipated in the next month or so.

On that evidence, and without any signs of distress elsewhere, if we were looking for things to do on the bridge, we would not have started by saying that we needed to take out the thing in its entirety on the basis of the immediate risks that threatened. The element that was identified as being at structural risk and as representing a structural problem that had safety implications has been repaired and strengthened.

John Scott: Given your knowledge, would you accept that Fairhurst's assessment of the elements that need replaced was the correct one?

Richard Hornby: On the basis of no distress being observed elsewhere, that was the correct assessment at that time.

The Convener: We were due to finish this evidence session at 12 o'clock. Given the importance of the issue, and as Siobhan McMahon has some questions, I will allow it to overrun. I am keen that you do not feel constrained by the time, Siobhan—please ask your questions as you normally would.

Siobhan McMahon: Mr Lees, you mentioned the £10.5 million toll income. The figures from the FETA board on the grant funding after the tolls show that, in 2007-08, capital and revenue totalled £8 million. Could you explain that?

12:00

Scott Lees: If you could just bear with me, I have misplaced the document that contains the funding levels. Here we are. Did you ask about 2008-09?

Siobhan McMahon: No, 2007-08. The tolls had just come to an end, and what I am trying to get to is whether revenue from the tolls was still coming in or whether, for that year, FETA simply received £8 million in grant funding.

Scott Lees: I have a document that summarises the FETA accounts. In 2008-09, there was no income from the tolls—

Siobhan McMahon: Sorry, it was 2007-08.

Scott Lees: In 2007-08, toll income was £10.2 million.

Siobhan McMahon: So the £8 million would have been on top of the toll revenue, is that correct?

Scott Lees: The £8 million for—

Siobhan McMahon: The £8 million that was given in grant funding to FETA—£4.5 million capital and £3.5 million revenue.

Scott Lees: That was probably for a particular scheme. Would that have been for the A8000?

John Russell: There was probably, and still is, some residue for the old A8000, which is now the B800, upgrade and the M90 spur. FETA was involved in the funding, because, when the Forth Estuary Transport Authority Order 2002 was introduced, there was scope for the money from tolls to go not just to the operation and maintenance of the bridge, but to other projects to alleviate congestion over the Forth, such as park-and-ride schemes and road linkages on either side. The A8000 scheme was one of those and involved a fair bit of cost.

With the tolls coming off in February, there was the residue for the rest of that financial year. Some of that would have been included in the figures, which is where you are going. There was an amount of money on the revenue side to keep staff paid from early February to the end of the financial year. Similarly on capital, there was a residue of works to be taken forward without the toll money.

Siobhan McMahon: That explains that point.

In 2014-15, the capital money went down to £1.7 million. Since, as we have discussed, the bridge is older, the traffic flow continues to increase and the tonnage and HGV numbers have increased, it seems odd that the capital grant to FETA is £1.7 million compared to its high of £8.7 million. What are the reasons for that? I understand that the contract was taken over in 2015, but what were the reasons for such a drop in the capital funding in 2014-15?

Scott Lees: I believe, and Wayne Hindshaw can correct me if I am wrong, that FETA had capital reserves and was asked to use them instead of—

Wayne Hindshaw: As the committee will be aware, Ms Nicholson—is it Ms Nicholson?

Siobhan McMahon: You can call me whatever. It is McMahon, but I answer to anything.

Wayne Hindshaw: I am sorry—my apologies.

Siobhan McMahon: Do not worry.

Wayne Hindshaw: FETA had considerable capital reserves. The intention of the bill was that, on the dissolution of FETA, the liabilities and assets would pass to the Scottish ministers. It was agreed that FETA would use some of its capital reserve to fund some projects and draw down its reserves in lieu of receiving capital grant from the Scottish Government.

I have not got the exact figures on what we gave them that year. The total grant—revenue and capital—in that year was £6.82 million, but the capital side was reduced so that FETA drew on its reserves.

Siobhan McMahon: I presume that that would have been normal practice?

Wayne Hindshaw: It was. A condition in the grant letters, back to the days when Transport Scotland provided the grant, was that, should FETA not have spent all the money it had been given, it could carry it over, add it to its reserves and use it for the maintenance of the bridge.

For a number of years, FETA carried considerable amounts of capital reserves. At one time, the reserves ran into the tens of millions of pounds but, slowly, over the past seven or eight years, they have been drawn down. At the end of the period when all the actuarial work has been done, the hand back to the Scottish ministers will be about £3.2 million to £3.4 million. It still had reserves to take forward works.

If you need specific details on the amounts of reserves, the breakdown is in the pack that Scott Lees has given to the committee or they can be provided.

Siobhan McMahon: That was helpful. Thank you very much. To return to the programme for the maintenance and the upgrading work on the bridge, what is the year-on-year budget for that work? Can it be fully funded by Transport Scotland?

Scott Lees: We took over the FETA programme, and it has been handed over to Amey. Perhaps Mark Arndt could advise on the scale of that and the schemes that we are doing.

We have announced the budgets for the following year. They are reasonably healthy. We are confident that we can fund the bridge's needs, and we are committed to doing that.

I ask Mark Arndt to explain this year's budget and the on-going works.

Mark Arndt: The budget from 1 April 2016 for this financial year is about £14.5 million. We have set out a prioritised list of schemes. There is a balance between routine and cyclic maintenance and what FETA formerly called capital projects. During mobilisation, we obviously had the FETA 10-year investment plan, and we have taken cognisance of that. We inform that with our own engineering decisions on matters that come up, such as the truss end links, and they will feature in the programme.

Other capital works that we have on-going or are programmed for this year include the motorisation of the gantry system—the cradle below the bridge that allows us to traverse along it—and the installation of a new gantry system. That will very much speed up access. As we have said, access to the component in question is very difficult, and the new gantry will aid that access significantly. Other capital works programmes are

associated with the suspended span underdeck access platforms. The members who were out yesterday will have walked along the mesh panel system. Those are coming towards their life expiry date, so there is a scheme to replace them with a more modern system.

The Convener: Now you tell us.[*Laughter*.]

Mark Arndt: Your experience was very enjoyable, I am sure. You can see the Sala wire—the safety line—in the photos. It is used when you walk along the bottom to get to the truss end links. It is 23 or 24 years old. That is getting replaced right now onsite. It was not unsafe, but all such components reach their expiry and safety critical components are essential.

There is a scheme to replace the south anchorage storage facility that was demolished as part of the cable inspection works. There is also the on-going routine cyclic maintenance, as I have said, to jack up the joints that, over time, drop down slightly and give the repetitive de-duh, de-duh effect. That work happens throughout the year.

I cannot narrow down the work to four or five schemes because there are the best part of 100 activities in the programme. They are all assigned their own budgetary requirements and taken through the approvals process with Transport Scotland.

Siobhan McMahon: We have spoken at length about how FETA came to prioritise works, so you do not have to go back over that, but do you use a similar process or is it an entirely different process?

Mark Arndt: I am not sure what process FETA went through, in all honesty. Our process is to take account of the capital programme produced by FETA, look at the basis of the defects on the bridge, the need for access, improvements in technology and suchlike, and on that basis, we make an informed decision and put that to Transport Scotland in the format of an annual programme that demonstrates how the money is allocated to each scheme and the delivery programme. Some schemes obviously do not get delivered in a single year and take a couple of years to progress.

For example, maintenance painting was a FETA scheme and we are looking at it, but we need to trial it and do it in a phased manner because access and systems in marine environments need to be trialled. The response is proportionate, but we go through a regimented and formal procedure so that it is submitted for approval by the dates that are dictated by our contract with Transport Scotland and then subsequently taken forward.

Siobhan McMahon: Have the projects that FETA established in its capital plan been adopted or did you start from scratch?

Mark Arndt: We have honoured all on-going contracts, which leads me back to the gantry motorisation and bracket strengthening work, which was fully honoured and taken forward. As I said, like John Russell and the team, 95 per cent of the people are still there so the capital plan has not been discarded by any manner of means. It is a co-ordinated effort and we have set out succinctly and in a structured manner for approval how the budget is to be spent that year.

Siobhan McMahon: I presume—you can correct me if I am wrong—that you would not adopt everything, because no one would. You would look at your own priorities to see how they are going. In your own plans for the year, regardless of the unfortunate position that you were left in at the end of last year, you would have looked at the truss to see what you could have done. Was there a plan to do anything with those? We have been through what was happening with FETA, what it had decided and how it went against that, but was doing that in any of your plans?

Mark Arndt: As I have said before, we were taking forward the strengthening of the member that was identified as overstressed. The member that failed was not overstressed. Such things take time. We are still in the midst of the bracket-strengthening work. There might have been a review and things might have been looked at but it would not be appropriate for me to say just now whether they would. That is the honest answer.

Siobhan McMahon: But they were not. When you bid for the contract that you took over, you would have talked about works to be done when you got the contract. You would have identified your priorities and that was not one of them.

Mark Arndt: No. You have to remember that this is a major suspension bridge. It would not have been prudent to discard all the prioritisation of work that had already been done by an experienced team. You have to take the best of both worlds, learn from that, and bring in any other engineering knowledge that you can to inform your work. That is the approach that we took.

The Convener: Are there any final questions?

Clare Adamson: I want to go back to David Stewart's question. Mr Lees, you talked about the decision in December 2011 to review the capital projects. I understand that FETA undertook a risk analysis that was based on a number of areas with the safety and structural integrity of the bridge at the heart of what they were deciding. Was that risk analysis robust and was there any independent accreditation of the process that FETA went through at that stage?

Scott Lees: I believe that it was robust. I do not know the answer to the second part of your question about whether it was verified, but the rigour in the governance would have come from FETA's board. The bridgemaster would have prepared a report and asked for a number of actions at the end of the report. I assume that the board would have applied rigorous governance at a board meeting, then consented to the approach.

I go back to something that I said before. I have high regard for the FETA team. They knew what they were doing. They were good. Thankfully, the majority of those staff are still with us and are continuing to do a good job on this significantly difficult incident that we are dealing with.

Clare Adamson: Mr Russell, were you involved in that process?

John Russell: Fortunately not. I remember the guys taking it away and doing several nights' work on it; they did not enjoy the process. You can check with Barry Colford and Chris Tracey next week but, if memory serves, there were independent people involved. My guess would be Atkins but I cannot remember the exact detail. Just going through the figures kept them awake for several nights over the weekend, but they came up with the right results in the end and we managed to get a priority list and go forward with that.

John Scott: I want to get my head around this properly. Mr Hornby, in your view, what caused the failure of the member was essentially the seizing in place of the pin and the fact that it was not able to move freely over a period of years, which led to the failure of the member and the break in it.

Richard Hornby: Correct.

John Scott: And, to be fair, that could not reasonably have been foreseen.

Richard Hornby: There was no mechanism to check that the pin was moving.

The Convener: Thank you for that succinct answer, Mr Hornby.

As the witnesses have indicated that they have no further points to make, it only remains for me to thank you for your attendance this morning. I think that I speak for all members when I say that we have been impressed with the quality of your evidence; you have set a high standard for the rest of the inquiry. Thank you.

12:15

Meeting suspended.

12:19

On resuming—

Subordinate Legislation

Public Service Vehicles (Registration of Local Services) (Scotland) Amendment Regulations 2015 (SSI 2015/420)

The Convener: Agenda item 3 is consideration of a negative instrument. Paper 5 summarises the purpose and prior consideration of the instrument. The committee will now consider any issues that it wishes to raise in reporting to the Parliament on the instrument. Members should note that no motions to annul have been received in relation to the instrument.

As there are no comments from members, does the committee agree that it does not wish to make any recommendation in relation to the instrument?

Members *indicated agreement.*

Housing (Scotland) Act 2014 (Commencement No 5 and Consequential Provision) Order 2015 (SSI 2015/430)

The Convener: Agenda item 4 is consideration of another negative instrument. Paper 6 summarises the purpose and prior consideration of the instrument. The committee will now consider any issues that it wishes to raise in reporting to the Parliament on the instrument. Members should note that no motions to annul have been received in relation to the instrument.

As there are no comments from members, does the committee agree that it does not wish to make any recommendation in relation to the instrument?

Members *indicated agreement.*

12:21

Meeting continued in private until 12:37.

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