Neutral Citation Number: [2019] EWHC 2109 (TCC)

Case No: HT-2017-000148

IN THE HIGH COURT OF JUSTICE
BUSINESS AND PROPERTY COURTS OF ENGLAND AND WALES
TECHNOLOGY AND CONSTRUCTION COURT (QBD)

Royal Courts of Justice
Strand, London, WC2A 2LL

Date: 31/07/2019

Before:

MRS JUSTICE O'FARRELL DBE

- -

Between:

(1) HOCHTIEF (UK) CONSTRUCTION LIMITED **(2) VOLKERFITZPATRICK LIMITED**	**Claimants**
- and -	
ATKINS LIMITED	**Defendant**

- -
- -

Suzanne Chalmers (instructed by **Clyde & Co LLP**) for the **Claimants**
Luke Wygas (instructed by **CMS Cameron McKenna Nabarro Olswang LLP**) for the **Defendant**

Reading day: 29th October 2018
Hearing dates: 30th, 31st October 2018, 1st, 5th, 15th November 2018
21st, 22nd, 23rd, 24th January 2019

- -

Approved Judgment

I direct that pursuant to CPR PD 39A para 6.1 no official shorthand note shall be taken of this Judgment and that copies of this version as handed down may be treated as authentic.

....

MRS JUSTICE O'FARRELL

Mrs Justice O'Farrell:

1. This dispute arises out of the East Kent Access Road Phase 2 project, comprising the construction of two new dual carriageway roads, the A256 and A299, to improve transport links in East Kent.

2. Kent County Council ("KCC") was the employer for the project. KCC engaged Jacobs Engineering UK Ltd ("Jacobs") to carry out the design of the project (excluding the detailed design of the structures) and to act as project manager.

3. On about 27 August 2009 the claimants, Hochtief (UK) Construction Limited and Volker Fitzpatrick Limited, acting in joint venture ("the JV"), were appointed as principal contractor for the project by KCC ("the Main Contract").

4. In December 2009 the JV engaged the defendant ("Atkins") to complete the civil and structural design elements of the Main Contract ("the Subcontract").

5. The scope of work under the Subcontract included the permanent civil and structural design for:

   i) the Cottington Road Bridge ("the Bridge"), a two-span bridge carrying the A256 dual carriageway road over the Canterbury to Ramsgate railway line and Cottington Road; and

   ii) the Cliffsend Underpass ("the Underpass"), a 120-metre-long tunnel under the railway line to accommodate the A299 dual carriageway.

6. The Bridge runs approximately north-east to south-west with a 30 degree end skew. It is 61.5 metres long, formed of a double span of steel beams, each of 30.7 metres, acting compositely with a cast in situ reinforced concrete deck above, spanning between two 1.5 metres thick reinforced concrete abutment walls. The approach embankments meet the bridge deck at a height of 9 metres above the road and railway. Cantilever wing walls at the sides of the abutment walls are set at various angles and lengths to form a transition with the approach embankments behind and to locally support the fill. The wing walls on either side of the abutment walls are not symmetrical, as they are required to accommodate varying physical constraints.

7. The design of the approaches to the Bridge incorporated a stepped layer of lightweight fill material, Filcor, into the general fill supporting the abutments. The Filcor comprised expanded polystyrene cube ("EPC") blocks. The EPC blocks were covered by sheets of high density polyethylene ("HDPE") membrane to prevent damage from any hydrocarbon spillages from vehicles using the carriageway.

8. Following completion of the Bridge in 2011, surface settlement of the carriageways on the north and south sides of the approach embankments was discovered, forming localised depressions. Between 2012 and 2014 remedial works were carried out.

9. The Underpass is 126.5 metres long, with a roof/deck 1.8 metres deep, and is 21.6 metres wide. At the time of construction, the Underpass was one of the longest jacked structures of its type in the world, a significant engineering achievement.

10. Each deck was jacked into position from the west end of the Underpass, pushed along concrete slide-paths, one on each side of the structure. A huge amount of jacking force was required to push the decks into place. To accommodate this, an anti-drag system ("ADS") was necessary to reduce friction between the top of the decks and the ground above. The ADS comprised pairs of steel sheets, each one metre wide, sandwiched along the length of the Underpass. An anchor headwall beam was built first, to hold the ADS sheets. The decks were then jacked beneath the beam. During the jacking process, the steel sheets were slid along each other to reduce the force needed to push the decks into position. Bentonite slurry was injected above the tops of the decks to lubricate them during installation. Following completion of the jacking process, in situ concrete head walls were constructed.

11. The Underpass was completed in March 2012. In April 2012 signs of leakage were observed at the west end of the Underpass, including rust staining on the headwall beam at the west end of the Underpass, icicles above the carriageway and fine cracking to the concrete face of the headwall. In 2013 remedial works were carried out.

12. On 12 June 2017, the JV issued these proceedings against Atkins for breach of contract and/or negligence in carrying out the design of the structures. Damages are claimed in the sum of £802,475.35 in respect of remedial works to the Bridge and £122,559.82 in respect of remedial works to the Underpass.

13. The JV's case in respect of the Bridge is that Atkins failed to design or specify any adequate system of drainage of sub-surface water from above or adjacent to the membranes. This permitted excessive water penetration into the chalk fill, causing softening and collapse compression of parts of the general chalk fill of the embankment approaches, resulting in differential settlement of the carriageways.

14. Atkins disputes liability. Its case is that in general the pattern of settlement was not collapse settlement but foundation settlement that was expected in such construction. Atkins provided for adequate sub-surface drainage in its design by incorporating 6N fill on top of the HDPE membrane and specifying that the membrane should be laid to a fall of 1:40 away from the abutments. The design intent was that most sub-surface water would flow into the 6N fill and be dissipated into the sides of the embankment or the fill in the embankments. Local depressions were caused by workmanship issues, namely, the JV's failure to lay the membrane to the required line and fall, the placement of chalk fill over the membrane beyond the edge of the EPC blocks and behind the wing walls, with the result that water was permitted to collect in the chalk fill in the side slopes, and poor compaction and handling of the chalk fill.

15. The JV's case in respect of the Underpass is that the water leakage was caused by Atkins' failure to design or specify an adequate waterproofing system for the joints between the elements at the west end of the Underpass. The JV acknowledges that there were deficiencies in its workmanship, namely, voids in the grout fill, but its position is that properly applied grout would not have prevented the leakage that occurred.

16. Atkins disputes liability. Its case is that leakage was caused by matters for which the JV was responsible, namely, failure to remove parts of the ADS sheets from the end of the construction, and failure properly to install grout in the 100mm void between the roof section nearest the end of the Underpass and the headwall anchor beam.

17. Subject to issues on liability and causation, quantum has been agreed.

Evidence

18. The following witnesses gave evidence at the trial:

    i) Mark Pritchard, the JV's design manager for the contractor designed elements of the project;

    ii) Santiago Daniele, the JV site agent for the construction of the Underpass;

    iii) David Ongley of Crawford & Co Adjusters (UK) Ltd, the loss adjuster for claims made in respect of the remedial works;

    iv) Christopher Fry, technical director of Atkins and lead engineer for the Bridge;

    v) Tomasz Kucki of Atkins, design team engineer in respect of the Bridge and the Underpass;

    vi) Wai Hung Wales Cheung of Atkins, project manager for the Bridge.

19. The Court had the benefit of written and oral evidence from the following experts:

    i) Robert Jessep of Robert Jessep & Partners Ltd, engineering expert for the JV;

    ii) Tony Bracegirdle of Geotechnical Consulting Group, engineering expert for Atkins.

20. This case was prepared and conducted impeccably on both sides. Counsel had an impressive command of the factual and technical details relevant to the issues. Their careful preparation was evident from their skilful cross-examination of the witnesses. Unfortunately, an accident suffered by the claimant's counsel during the trial resulted in an unforeseen adjournment and delay in resuming the hearing in two further tranches. The Court is very grateful to all concerned for their understanding, patience and co-operation to facilitate timely and efficient completion of the hearing.

The Subcontract

21. On 27 August 2009 KCC and the JV entered into the Main Contract under which the JV agreed to carry out the construction of new dual carriageway roads, namely the A256 and the A299.

22. The Main Contract was the NEC3 Engineering and Construction Contract, 2005 edition (with amendments to June 2006), incorporating Option A and other agreed options. The Main Contract provided that the detailed designs of the structures were Contractor Designed Elements for which the JV was responsible.

23. The specification for the main contract works was set out in volume 2A of the Works Information Documents. The structures to be designed by the JV, set out in volume 2B, included the Bridge and the Underpass. Drawings for the works were set out in volume 2D.

24. On 17 December 2009 the JV and Atkins entered into the Subcontract (made under seal) whereby Atkins agreed to carry out the design elements of the Main Contract, including the permanent civil and structural design for the Underpass and the Bridge.

25. The Subcontract was subject to the terms and conditions of the NEC3 Professional Services Contract, June 2005 (with amendments dated September 2006) and further amendments agreed by the parties.

26. Clause 21 set out Atkins' obligations:

> "21.1 The *Consultant* provides the Services in accordance with the Scope.
>
> 21.2 The *Consultant's* obligation is to use the skill and care normally used by professionals providing services similar to the *services*."

27. Clause 11.2 included the following definitions:

> "(9) To Provide the Services means to do the work necessary to complete the *services* in accordance with this contract and all incidental work, services and actions which this contract requires.
>
> (11) The Scope is information which either
>
> - specifies and describes the *services* or
> - states any constraints on how the *Consultant* Provides the Services
>
> and is either
>
> - in the documents which the Contract Data states it is in or
> - in an instruction given in accordance with this contract."

28. Part 1 of the subcontract data provided that the scope of Atkins' work was set out in:

i) Sections 2.1 and 2.2 of Atkins' proposal dated 24 September 2009 (excluding the programme referred to therein) ("the Atkins Proposal Document");

ii) Paragraphs 1 to 3 of section 3.5 of Atkins Proposal Document;

iii) the document entitled "East Kent Phase 2 Design Interfaces for the Cliffsend Underpass";

iv) the document entitled "Amendments and Clarifications to the Scope of Works as set out in Section 2 of Atkins' proposal dated 24 September 2009, agreed between Atkins and VFH" dated 30 October 2009 ("the Clarifications Document").

29. Section 2.1 of Atkins' Proposal Document stated that the scope of works for which Atkins was responsible included the following:

> "Civil and structural design is required for two structures, based on the outline designs which have been produced by Jacobs for the Project Client, Kent County Council ('KCC'), and expressed in the Client ITT.
>
> During the tender stage, Atkins has developed, in conjunction with Hochtief (UK), a 'non-conforming' scheme for the Cliffsend Underpass and a 'conforming' scheme for the Cottington Road bridge.
>
> …
>
> It is understood that the following services are required of Atkins:
>
> Cliffsend Underpass - Outline and detailed design of the underpass structure …
>
> Cottington Road Bridge - Preliminary and detailed design of structure …"

30. The deliverables set out in section 2.2 of Atkins' Proposal Document provided that Atkins was responsible for producing the 'Approvals in Principle' ("AIPs"), containing the proposed outline design for the Underpass and the Bridge. Further, Atkins was obliged to assist the JV in obtaining KCC approvals and Network Rail endorsements of the AIPs.

31. The Clarifications Document stated:

> "The works are to be designed in accordance with the requirements of the Main Contract, including, but not limited to:
>
> - Volume 2A Specification; and
> - Volume 2B "Structures to be designed by the Contractor"
> - Volume 2D Drawings…
>
> The Subcontractor (Atkins) shall provide all of the civil and structural design deliverables that the Contractor (VFH) is required to provide to Kent County Council under the Main Contract for the structures included within the scope of this agreement, including:-

> - intermediate and intimate earthworks which have structural impact on / interaction with the main structural elements...
>
> All designs shall be prepared in accordance with the requirements of the Main Contract.
>
> The scope includes provision of multiple design submissions (including AIP's, Form Cs, Design and Check Certificates) as required to obtain TAA approvals and Network Rail acceptance in accordance with the requirements of the programme ...
>
> The Subcontractor (Atkins) shall prepare general arrangement drawings for review by the Contractor (VFH) prior to provision of formal design submissions, attend meetings to discuss those drawings and take cognisance of the comments arising in those meetings in development of the design.
>
> The Subcontractor (Atkins) shall develop a single design solution for each structure following the initial value engineering period.
>
> The Subcontractor (Atkins) shall endorse Construction Certificates / Certificates of Construction Compliance for the designs included in the Scope."

32. Exclusions from the scope of Atkins' design responsibility were set out in the Clarifications Document and included:

> "Any highway design and associated drainage facilities including, in particular, revisions of the highway design to comply with the requirements of VHF's tender design for Cliffsend Underpass."

33. It is common ground that Atkins owed a concurrent duty of care in tort to the JV in respect of its professional design services.

34. On 12 March 2010 the JV executed a subcontract with Tony Gee and Partners ("Tony Gee") under which Tony Gee agreed to act as the Category 3 checker for the project.

The Bridge - chronology

35. In October 2008 Jacobs issued its geotechnical desk study data report for the project. In November 2008 Jacobs issued its geotechnical investigation factual report for the project, including the results of boreholes, trial pits and cone penetration tests in the vicinity of the Bridge.

36. At a design meeting held on 3 December 2009, attended by representatives of Jacobs, the JV and Atkins, it was recorded that:

> "Design of earthworks to the approach embankment of the new position of the over bridge. This is still the responsibility of

> Jacobs. It was pointed out that there is to be an increase in the height of the embankment to the south-east corner to allow for a noise bund."

37. In December 2009 Atkins issued a ground investigation report and a geotechnical design report in respect of the project.

38. On 18 December 2009 Atkins issued its AIP design for the Bridge. The construction sequence at section 3.11.4 stated that the abutments would be backfilled using Class 6N fill material. Section 6.3 stated:

> "Differential settlement to be allowed for in the design of the structure.
>
> A maximum 10mm differential settlement along the centreline of the structure will be allowed for in the design. A maximum 20mm differential settlement between the structure and approach embankment will be allowed for in the design."

39. In January 2010 Jacobs issued its earthworks design report.

40. The project design and specification prepared by Jacobs for KCC indicated that the general approach embankments to the Bridge could comprise layers of Class 1, 2 and 3 fill material, including chalk. The ends of the embankments would be about 9 metres high and would be formed sloping down to the back of the abutments, with structural fill placed against the Bridge. The structural fill was specified as relatively free draining, granular fill (Class 6N/6P material). Any sub-surface water that entered the fill would drain through drains at the base of the abutments and wing walls.

41. In a design review meeting on 23 February 2010 Atkins noted that potential excessive deflection of the wing walls might necessitate a design change. Initially Atkins proposed strengthening the piles supporting the walls but on 8 March 2010 Chris Fry of Atkins sent an email to Mark Pritchard of the JV suggesting that the 6N fill behind the abutments could be replaced with lightweight backfill to reduce the piling costs.

42. That suggestion was agreed and at a design meeting held on 23 March 2010 it was decided that lightweight EPC blocks would be used behind the abutments and wing walls in place of the 6N structural fill.

43. On 30 March 2010 Atkins submitted a revised AIP for the Bridge, showing EPC blocks behind the abutments and wing walls, covered with two layers of a protective waterproof membrane, the HDPE membrane. The method of construction for the Bridge approach embankments at section 3 of the AIP was as follows:

> - "Install abutment drainage.
> - Backfill immediately behind the end abutments with polystyrene blocks.
> - Construct reinforced earth embankment to NE wing wall.

- Seal the polystyrene with two layers of High Density Polythene.
- Place Class 6N capping material.
- Construct slab foundations for Vehicle Restraint Systems.
- Transport material excavated from Cliffsend site via Sevenscore roundabout for formation of the bridge approach.
- Compact material to form bridge approach."

44. The same amount of differential settlement was allowed for as set out in Section 6.3 of the earlier version of the AIP.

45. On 19 April 2010 Atkins identified potential clashes between the HDPE membrane and Jacobs' design for the highway drainage. Atkins informed the JV that revisions to the design would be required to relocate a few drainage catchment pits.

46. On 19 May 2010 Jacobs sent an email to the JV commenting on the AIP for the bridge. Atkins stated in the schedule of comments:

> "The structural backfill has been changed from a granular material to polystyrene blocks. This solution considerably reduces weight of the backfill material therefore embankment settlement immediately behind the abutment should be minimised."

Against that statement, the following comment was added by Jacobs:

> "Our calculations have shown that settlement at existing ground level behind the abutment could be of the order of 68mm. Please confirm what settlement is expected behind the abutment at carriageway level."

Atkins' further response was:

> "The construction work will be scheduled so that most of the settlement of the fill behind the abutment will occur during construction stage. Long term settlement will have a minimum impact of the highway surfacing and asphaltic plug joint, as both will be installed after most of settlement will [have] occurred."

47. On 24 May 2010 Tony Gee, the Category 3 checker, sent to Atkins and the JV a query sheet for the Bridge, which stated:

> "Please consider extending the polythene sheets along the drainage of the abutment wall due to possible accidental contact with the petroleum solvents at the lower level."

48. The response from Atkins was:

> "Noted. Full containment of the polystyrene is being considered, subject to agreement with the TAA and discussions with polystyrene suppliers."

49. On 25 May 2010, Atkins issued the specification for the Bridge, including acceptable earthworks materials, their classification and their compaction requirements, drainage requirements and combined drainage and kerb systems.

50. On 15 June 2010 KCC approved the AIP for the Bridge.

51. In June 2010 construction of the Bridge commenced. By the end of 2010 the JV had constructed the main bridge structure and the embankment up to approximately 50 metres from the abutments, leaving a gap between the embankments and the abutment walls. The height of the embankments was temporarily increased to surcharge the load and accelerate settlement.

52. The infill sections of the approach embankments up to the structural fill were constructed with a lower core of Thanet Sand (Class 2 cohesive) fill, overlain with Class 3 chalk, including in the verges. Settlement cells were installed at 10 metre intervals below these parts of the approach embankments to monitor settlement of the underlying ground during and after these parts of the embankments were constructed.

53. On the north side of the Bridge the soil was stabilised with lime and vertical band drains were installed through the compressible foundation materials underlying the embankment to accelerate settlement. Such measures were not adopted on the south side of the Bridge.

54. On 30 September 2010 Mr Kucki of Atkins sent an email to Mark Pritchard of the JV:

> "I have attached the sketch up file and some pictures of the polystyrene outline for the South Abutment.
>
> Also I would like to confirm that the whole polystyrene block would need to be encased in HDPE, seam welded membrane to prevent damage to polystyrene in case of an oil spillage."

55. On 13 October 2010 the JV submitted technical query TQ 53 asking Atkins to confirm the specification for the HDPE membrane wrapping around the EPC blocks. On 18 October 2010 Atkins responded that:

> "The HDPE should be 1.0mm thick, hydrocarbon resistant membrane. All joints must be welded.
>
> Please use GX Geomembrane by Visqueen Building Products or similar."

56. By email dated 26 January 2011 Atkins stated that discussions with the manufacturer confirmed that a single layer of 1.5 mm thick HDPE with welded joints would be adequate.

57. On 15 February 2011, the JV submitted TQ 87 asking Atkins to consider a revision to the specification for the HDPE membrane, namely, cutting the polystyrene blocks to create a uniform slope rather than the specified benching on the grounds that the 1.5 mm thick HDPE membrane could not be bent to suit the stepped detail. Atkins response was issued on 28 February 2011:

> "The proposal is not acceptable as the interface of the HDPE sheet on the 1:1 slope could create a slip plane between the polystyrene blocks and the soil surface. This would induce increased earth pressure on the abutment wall which is not acceptable."

58. On 16 February 2011 the JV submitted TQ 88, proposing to omit the HDPE membrane from being wrapped round the EPC blocks and extend it over the top layer of EPC blocks:

> "1. Cut earthworks batter to approx 1:1 (see TQ 87).
>
> 2. Install Filcor lightweight material and hollow blockwork / drainage pipework to rear of abutments and wingwalls. Voids between cut earthworks batter and Filcor material will be filled with self compacting material e.g. single-sized pea shingle as described in TQ 87.
>
> 3. Install 1.5 mm HDPE liner with welded joints above top layer (approx 900 mm below FRL or FGL on batters). Install 150 dia perforated drainage pipe along perimeter of proposed HDPE layout leading into 150 dia carrier and connect positively into highway drainage…
>
> The benefits will be:
>
> - Spillages will be captured and positively drained into highway drainage.
> - Significant reduction in the amount of welding required to HDPE liner.
> - Minimise the risk of damage to the HDPE liner during installation of Filcor material and whilst backfilling.
> - Shorter programme duration.
>
> Please confirm that the above proposal will be acceptable."

The accompanying marked up drawings showed the HDPE membrane laid under the 6N capping on the top layer of EPC blocks, extending approximately 5 metres beyond the edge of the EPC blocks. The drawings showed 150mm diameter perforated pipe drains around the perimeter of the membrane, with notes stating that they should be connected positively into the highway drainage.

59. In an internal email of 16 February 2011, Mr Fry of Atkins stated that the JV proposal set out in TQ 88 might work, provided the edge detail was very robust, but raised a query with Mr Kucki regarding drainage: "… where does everything drain to (presumably via separator chambers)."

60. The following day Mr Kucki replied to Mr Fry, raising doubts as to whether approval would be forthcoming for the proposal in TQ 88:

> "All the bridge drainage will be discharged to a new highway drainage system, fitted with pollution interceptors (Jacobs design). This is the case for the current design and could be left as it is for the proposed alternative.
>
> I have got serious doubts about getting an approval from KCC for the proposed detail. In the AIP stage we have shown the HDPE layer over the top of the polystyrene only, wrapping about 1.0m down the polystyrene blocks. KCC picked up on this in one of their AIP comments and requested full wrapping of the blocks. I remember that it has been an issue for TGP as well.
>
> From my point of view we should be saying "no" to the TQ. There are some technical issues associated with this proposal, e.g. we need to look at potential spillage from vehicles travelling at low level (Cottington Road and new slip road). But, more importantly, we have already got a problem with TAA approvals affecting our profit margin (I needed to bite into our risk pot) and this solution would only make things worse.
>
> I am inclined to refuse the proposed solution, unless Tony [Heron] can demonstrate to us how much it is worth to him and give us an incentive to fight the battle with Kent."

61. Later that day Mr Fry replied that he had spoken to Mr Pritchard and the JV agreed to park TQ 88 until he had spoken to Jacobs, KCC and Tony Gee to determine whether there was any objection in principle to the proposal.

62. At a design team review meeting held on 7 March 2011, attended by the JV, KCC and Jacobs, it was stated that:

> "There will be settlement of both the underlying formation strata and the embankment filled material. An overall settlement of 237mm is predicted. In terms of the underlying strata, about 100mm of settlement is predicted to occur within the top 2 m. The top 2 to 4.5 metres of the formation strata are considered to be compressive. It was stated that initial estimated settlement of up to 230mm is predicted to occur over the first four weeks after the embankment infill with the remaining residual settlement of up to 10% occurring later…
>
> Alternative measures to reduce differential settlement were discussed: …

> (a) confirm what degree of settlement is likely;
>
> (b) identify what degree of remedial expenditure is appropriate to mitigate that settlement;
>
> (c) confirm the question of the degree to which this is a problem …
>
> Mark Pritchard is to ask Atkins if they are satisfied with the likely level of settlement that will take place under the polystyrene lightweight fill …
>
> The JV proposal to use polystyrene lightweight fill entails the incorporation of an HDPE liner to isolate the polystyrene from potential hydrocarbon contamination from traffic accident fuel spills and from everyday use.
>
> Mark Pritchard advised that the current under stepped arrangement for the polystyrene blocks would be impracticable to construct. The welded liner should only be necessary to resist the downward penetration of hydrocarbons. Sketched proposals for a welded liner over the top only of the polystyrene lightweight fill, with suitable perimeter overlaps, edge seals to the abutment structure upstand walls, etc and perimeter drains were tabled for review by Jacobs. Would Jacobs accept this design development - Jacobs to comment …"

63. On 10 March 2011, the JV issued a project managers instruction to Atkins to design the kerb entry deck drainage system for the Bridge. This was additional to Atkins' original scope of work and was required to resolve the clashes between the lightweight fill (EPC blocks and HDPE membrane) and the highway surface drainage.

64. On 16 March 2011 at a design team meeting attended by the JV, KCC and Jacobs, it was recorded that:

> "Settlement
>
> Whilst settlement in general may only be in the order of 50mm, this could not be guaranteed and comes down to a question of confidence the possibility of 100mm of settlement would require preventative action.
>
> Mark Pritchard was to verify that Atkins was satisfied with the likely level of settlement that will take place under the polystyrene lightweight fill but Mark replied that this was not an issue in terms of VFH/Atkins design responsibility because VFH/Atkins had no design responsibility for the embankment design and therefore Atkins did not need to consider this issue.
>
> …
>
> Light weight fill / membrane / backfill interface

> Mark Pritchard advised that the liner options to resist the downward and sideway penetration of hydrocarbons were still being developed in terms of sealing around the sides, etc. Jacobs (Ian Payne) accepted the use of a high level HDPE liner extending over the top of the lightweight fill in principle, subject to agreeing the edge seals."

65. On 22 March 2011 Jacobs issued drawing number 331700/SK/137 showing a proposed arrangement of proprietary band drains to be installed to accelerate settlement beneath the approach embankment behind the North abutments (but not the South embankment). Those drains were installed between 31 March and 13 April 2011.

66. On 28 March 2011 the JV submitted technical query TQ 95, asking Atkins to confirm acceptance of the proposed detail for the HDPE membrane to be installed at high level only. The attached sketches showed the HDPE membrane laid on a sand-cement screed to a fall of 1:50 away from the abutments, with the edges of the membrane stepped down over the upper two layers of EPC blocks and extending 5 metres out into the general embankment fill.

67. On 28 March 2011 Atkins prepared a document entitled "Departures from standards listed in the Approval in Principle" for the Bridge, stating:

> "In accordance with BA 42/96, clause 3.8 the backfill material to integral bridge abutment should be free draining selected granular fill with properties and grading complying with classes 6N and 6P
>
> …
>
> In order to reduce the lateral pressure typically exerted on the back of integral bridge abutments by granular backfill material we propose to use polystyrene blocks as the backfill material…"
>
> In accordance with BD 30/87, clause 4.1 the following classes of material… are acceptable for backfilling retaining walls and abutments:
>
> (a) Class 6N – selected well graded granular material
>
> (b) Class 6P – selected uniformly graded granular material (note: this includes chalk)
>
> …
>
> In order to reduce the lateral pressure typically exerted on the back of integral bridge abutments by granular backfill material we propose to use polystyrene blocks as the backfill material
>
> …
>
> The polystyrene blocks will be covered in a hydrocarbon resistant high-density polyethylene membrane to prevent its

> deterioration in case of an oil spillage on the East Kent access route.
>
> Polystyrene blocks will also be protected by 150mm layer of mass concrete."

68. On 30 March 2011 Atkins issued its final AIP, including the above stated departures from standards. It was approved by KCC and Jacobs on 15 June 2011.

69. Under cover of emails dated 11 April 2011 (to Jacobs) and 13 April 2011 (to Mr Kucki and Mr Fry of Atkins), Mr Pritchard of the JV sent a more detailed drawing of the proposed HDPE membrane detail. The drawing showed the HDPE membrane laid on a sand-cement screed at a fall of 1:50 over the top of the EPC blocks. The ends of the membrane were stepped down the top two layers of the blocks and then extended into the embankment horizontally for 5 metres. The drawing also showed 150mm thick ST2 concrete laid on top, to protect the membrane, and 150mm diameter perforated pipe at the abutment.

70. On 19 April 2011, Tony Heron, deputy project manager for the JV, sent an email to Atkins requesting responses to TQs 87, 88 and 95. In response, Mr Kucki of Atkins, who was unaware of Jacobs' approval in principle given at the meetings in March 2011, stated:

> "The detail of the HDPE layer is subject to discussion with KCC and TGP; both of them have requested full wrapping of the blocks."

71. In April-May 2011 the southern approach embankment infill was constructed, with a four-week settlement monitoring period from 18 May to 15 June 2011.

72. In May-June 2011 the northern approach embankment infill was constructed, with a four-week settlement monitoring period between 20 June and 18 July 2011.

73. In June/July 2011, construction of the main carriageway commenced.

74. On 13 June 2011 Mr Heron sent an email to Jacobs enclosing a further drawing showing the proposals for the HDPE membrane as per the April proposal.

75. Between 16 June 2011 and 8 July 2011 the EPC blocks were installed behind the South abutments. Between 19 July 2011 and 10 August 2011 the EPC blocks were installed behind the North abutments.

76. On 1 July 2011 the JV issued TQ 98, requesting permission to use 1mm thick textured HDPE liner on the side slopes behind the wing walls, to assist the placement of fill on top. That proposal was accepted by Atkins on 12 July 2011.

77. By email dated 4 July 2011, Mr Pritchard notified Messrs Cheung, Fry and Kucki at Atkins that they were unable to fully wrap the EPC blocks with the membrane and suggested a meeting to discuss the JV proposal, so that it could be incorporated onto an Atkins drawing and presented to Jacobs. The sketch showed the HDPE membrane laid on top of the EPC blocks as before but the membrane was mechanically fixed to the

abutments, was not stepped down over the upper layers of EPC blocks and extended 15 metres into the embankment fill.

78. By email dated 8 July 2011, the JV proposed that behind the wing walls they wished to place the structural fill in the steps of the EPC blocks before laying the membrane on top. Atkins responded that they would show the detail as suggested on their drawings but the fill layer on top of the EPC blocks needed to be fine enough to avoid puncturing the membrane.

79. On 12 July 2011 Mr Cheung sent Mr Pritchard the liner detail drawings to check that they reflected their recent discussions. Mr Pritchard responded:

> "We're virtually there just a few minor changes:
>
> - Abutments – all liner will be 1.5mm smooth not textured on the flat section, need mortar fillet where the liner meets the structure as it cannot be bent through 90 deg.
> - Wing Walls – 1.5mm smooth attached to concrete and 1.5mm textured underneath.
> - Mortar fillet against concrete face to avoid 90 deg. bend
> - No concrete protection to the liner on the wing walls – not necessary
> - Fill / below the liner to be Structural Fill
>
> I've marked up 1 abutment and 1 wing wall drg. Alterations needed on all similar drgs."

80. On 13 July 2011 Atkins issued the revision C06 drawings of the abutments and wingwalls. The C06 drawings showed the EPC blocks, placed benched into a 45 degree slope, formed in the general fill of the approach embankments either side of the Bridge. The EPC blocks were protected by the HDPE membrane, on top of which was placed a capping layer of Class 6N fill. Under the carriageway, but not under the side slopes, a 150mm layer of ST2 concrete was placed under the capping layer on top of the membrane. The HDPE membrane was laid to a fall of 1:40 away from the abutments, extending across the top layer of EPC blocks and 10 metres into the chalk fill embankments.

81. It is common ground that the C06 drawings represented Atkins' final design for the EPC blocks and HDPE details at the abutments and wingwalls.

82. On 21 July 2011 Atkins were instructed to extend the kerb deck drainage system around 20 metres to the north of the Bridge.

83. On 8 August 2011 the JV sent an Early Warning Notice regarding the settlement at the Bridge, stating:

> "The detailed design of the Cottington Bridge embankments, the lightweight fill behind the Cottington bridge abutments and the

> likelihood of differential settlement of the embankments has been regularly reviewed over the last 12 months. There is currently an opportunity to introduce transition slabs over the lightweight fill/embankment structural fill interfaces. Confirmation is required regarding the advisability of the transition slab option. If this option is instructed, we would need your requirements to be able to take it further."

84. In August 2011 the HDPE membranes were installed over the EPC blocks, first on the south embankment and then on the north embankment. The 150mm thick concrete protection was cast over the top of the membranes. The fill and sub base for the road construction were placed over the top of the concrete protection layer.

85. By September 2011, the carriageway construction was complete and the Bridge was opened to traffic.

86. In late 2011 local depressions were observed in the carriageways on the Bridge, approximately 20 to 30 metres away from the abutments, approximately 0.5 metres wide and 30mm to 40mm deep. KCC introduced speed restrictions on the Bridge, followed by the closure of the outer lanes of the carriageway, to ensure the safety of road users, pending remedial works.

The Bridge **-** *investigations*

87. Prior to construction, settlement cells were installed beneath the approach embankments to monitor settlement of the underlying ground. Readings were taken up to 1 August 2011 and between January and April 2012.

88. From 2 December 2011, nails were installed in the surface of the carriageways to enable additional settlement monitoring of the surface of the carriageways on either side of the Bridge and the central reservation.

89. In January 2012 cone penetration tests were carried out by Lankelma on either side of the Bridge, identifying weak and soft layers of chalk fill, as set out in the experts' first joint statement:

> "The CPT data indicated the following zones of weaker, softer or looser materials generally based on a correlation between cone resistance and sleeve friction and generalised soil descriptions and cone resistance to shear strength correlations:
>
> a. South West (CPT 1): a weaker/soft layer in chalk fill at a depth of between 2.2 m to 2.5 m in a layer generally described as a medium dense sand to silty sand;
>
> b. South Central (CPT 6): a soft layer of about 0.2 m thickness at about 4 m depth in Thanet Sand fill in a layer generally described as a stiff clay;
>
> c. South East (CPT 4): locally loose/soft/weaker chalk fill between about 1.6 m and 1.8 m depth (described as locally

> loose silty sand to sandy silt) and four layers of soft loose Thanet Sand fill between about 2.5 m depth and 4 m depth (in layers generally described as firm to stiff clayey silt to silty clay);
>
> d. North West (CPT 2): a layer of weaker/very loose chalk fill between about 1.5 m and 2 m depth (generally described as a very loose sandy silt to clayey silt);
>
> e. North Central (CPT 5): locally loose/weaker chalk fill between about 0.9 m to 1.2 m depth (described as loose sandy silt to clayey silt) and a layer of soft to firm Thanet Sand fill between about 2 m and 3 m depth (generally described as a firm clay);
>
> f. North East (CPT 3): a layer of loose/weaker chalk fill was reported between 0.5 m and 1.0 m (described as loose sandy silt clay silt)."

90. The Lankelma earthworks test results confirmed that the chalk fill placed by the JV did not exceed the specified mean air voids content of 8%.

91. On 19 March 2012 Christopher Tate, chief engineer for the JV, prepared a factual report on the settlement investigation which he sent to Mick O'Hare, senior project manager and director of the JV:

> "Settlement of the newly opened road on the approach embankments to Cottington Bridge was first noted towards the end of 2011. Small differential movements could be seen across the 'plug joints' in the asphalt at the back of the bridge abutments, together with opening of the movement joints between the bridge wing walls and abutments; in addition, acoustic fencing on the southeast approach suffered loss of vertical alignment over about four panel lengths. Subsequently, depressions of the kerb lines became noticeable on both sides of the bridge, with a gap developing between the asphalt surfacing and kerb line locally on the southwest approach. Cracks in the verge topsoil have also become evident where the reinforced soil wall abuts the northeastern wing wall of the bridge…
>
> Recent reading of the settlement cells indicate that some foundation movement has occurred between the end of the earthworks settlement period and current date. Interpolation of settlement cell data suggests that since the road was opened more foundation settlement has taken place to the south of the bridge (a maximum of 78mm at SC2, as at 18.3.12) than to the north (a maximum of 29mm at SC4, as at 18.3.12). This foundation settlement has obviously contributed to the overall settlement of the road but is unlikely to be the sole cause of localised depressions, such as the loss of vertical alignment of acoustic fencing to the southeast of the bridge and separation of asphalt

> surfacing and kerbs to the southwest. It is of interest to note that the settlement cells furthest from the bridge (SC1 and SC6) show virtually no movement since the road was opened…
>
> Where weak zones have been identified in the chalk fill it is suspected that they are the result of post construction inundation by water from rainfall infiltration. Collapse settlement may have been triggered at some point thereafter, which could have led to the more localised settlement expressions that have been observed… Site testing records show that the chalk fill was placed at moisture contents within the range permitted by the project specification and that average air voids were below the prescribed target mean of 8%...
>
> It is evident from the survey data that (except adjacent to the start of the reinforced soil wall) settlement of the road is more pronounced on the south side of the bridge…
>
> On the south side of the bridge in particular, settlement of the east and west road channels, is greater than the central reserve. This is consistent with water penetration of the embankment fill, since the 'soft' verges adjacent to the channels would be more prone to infiltration by rainfall/snow melt water than the 'hardened' central reserve. However, a factor to consider is that road settlement is also taking place (to a lesser degree) above the lightweight polystyrene blocks backing the bridge abutments and over immediately adjoining earthworks fill areas where the inclusion of a concrete protection/transition slab and an impervious membrane below the pavement layers would be expected to prevent water ingress.
>
> A correlation between fill softening and road settlement is suspected…"

92. By letter dated 22 March 2012, Mr O'Hare informed Jacobs that in the opinion of the JV, Mr Tate's factual report demonstrated that the embankment was performing in accordance with the anticipated settlement predicted by Jacobs. That opinion was rejected by KCC by letter dated 18 April 2012, by reference to the fact that, although the underlying strata had not moved by any significant amount (+ / - 20mm), surface levels had settled locally by up to 70mm.

93. In about April 2012 the JV excavated trial pits, revealing that the chalk fill around the edge of the membrane had become very soft and saturated with water. The JV produced drawings showing the monitoring points and details as to the location and extent of the EPC blocks and the HDPE membrane.

94. In September 2012 the JV excavated trenches around the perimeter of the membranes, indicating that water was ponding on top of the membrane, particularly at the edge furthest from the abutment walls, where the water which travelled down the membrane entered the chalk fill.

95. In their first joint statement the experts recorded:

> "These excavations revealed the fill over the verges and at the ends of the membranes was saturated, and where this was chalk fill, this was very soft, including under the end of the membrane in the verge 20m away from the abutment on the south east of the bridge. Photographs of these excavations show the presence of water above the membrane."

96. In Autumn 2012 remedial works were carried out by the JV. The remedial works included a membrane lined drainage trench across the width of the carriageways and central reservations, excavated to 350mm below the level of the protection slab, with a 150mm diameter perforated pipe surrounded in single sized course aggregate and backfilled in no-fines concrete to the underside of the road pavement construction. This drainage system collected water at the ends of the membrane and drained it through the existing highways drainage. In the verges, membrane lined trenches filled with no-fines granular fill were installed. Additional gullies and associated pipes were installed at the rear of the south abutments to collect surface water.

97. Post-remedial monitoring was carried out between January 2013 and September 2013.

98. In April/May 2014, final resurfacing works were carried out.

The Bridge - issues

99. The parties agreed a list of issues but many of the questions have fallen away during preparation and hearing of the evidence. The key issues in respect of the Bridge claim can be summarised as follows:

   i) whether Atkins was responsible for the final design of the abutments and wingwalls, including the EPC blocks and HDPE membrane details, and any required sub-soil drainage;

   ii) the nature and extent of any undue differential settlement on the Bridge approaches;

   iii) the cause(s) of the differential settlement on the Bridge approaches:

      a) whether Atkins' design for the approach embankments made adequate provision for sub-surface drainage;

      b) whether the JV's works were in accordance with Atkins' design and to a reasonable standard;

      c) whether the differential settlement was caused and/or contributed to by design and/or workmanship issues;

   iv) whether Atkins were in breach of the Subcontract and/or negligent;

   v) whether the remedial works carried out by the JV were reasonable and necessary as a result of any inadequacies in Atkins' design.

Design responsibility

100. The Subcontract imposed on Atkins responsibility for the detailed design of the Bridge. Such design responsibility was made clear from sections 2.1 and 2.2 of Atkins' Proposal Document and the Clarifications Document.

101. The design for which Atkins was responsible included the design of the structural fill behind the abutments and wing walls relevant drawings. The extent of that design responsibility was apparent from Volume 2B of the Main Contract, which identified the relevant drawings, including Jacobs' drawing 331700/1700/9427/101 defining the designated outline for the Bridge.

102. Atkins did not have responsibility for the design of the highway and associated drainage, as stated expressly in the exclusions part of the Clarifications Document. However, Atkins was responsible for drainage of the structural fill behind the abutments and wing walls as this formed part of the civil and structural design of the Bridge. Atkins was also responsible for considering the impact of its design, including any changes to its design, on other elements of the design prepared by Jacobs. This was accepted by Mr Kucki in cross-examination:

> "Q. As I understand it in relation to the highway the division of responsibility was between you and Jacobs over the bridge?
>
> A. Yes, there was an interface.
>
> …
>
> Q. Would you also agree that you could not design your elements of the work without having regard to the other elements of the work which were being designed by the employer's designer, Jacobs?
>
> A. Yes, we need the input for alignment of the highway and for the drainage.
>
> Q. Specifically you were responsible for providing the design of the bridge structure itself and a section of structural fill on either side of the bridge?
>
> A. Yes.
>
> …
>
> Q. There was an interface, was there not, between the approach embankments that were your responsibilities and the approach embankments which were Jacobs' responsibility?
>
> A. Yes.
>
> …

Q. Your responsibility extended to the approach embankments on either side because the structural fill behind the abutments was your responsibility wasn't it?

A. Yes.

…

Q. Do you agree that when you are carrying out your design, in general terms, as a competent designer, you would consider the impact of your design on other elements of the works?

A. Yes, to the extent of the knowledge of what they have designed.

Q. Yes, you can't design your element entirely in isolation, can you, you have to think about what the effect of any changes to your design, for example will have, and how your design will fit with the other design?

A. Yes.

Q. If you see a problem you either change your design or you, at the very least, raise that with the other designer?

A. Yes."

103. Mark Pritchard was the JV's design manager for the contractor designed elements of the project. He described his role as overseeing the implementation of the structural designs prepared by Atkins and acting as a liaison between the contractors and KCC/Jacobs to ensure that the designs were approved. During the course of the project, the JV issued technical queries and made proposals for changes to the design where they affected buildability issues. However, such proposals were made to Atkins for consideration and, if accepted, incorporation into Atkins' design. The JV did not thereby assume responsibility for any part of the design. Atkins remained responsible for preparing the AIP and the final design drawings for the structures.

104. It is common ground that the C06 drawings contained Atkins' final design for the abutments and wing walls.

105. Atkins accepts that the adequacy of its design, compliance with its obligations under the Subcontract, and the claim for damages should be determined against the design as set out on the C06 drawings.

The Bridge - nature and extent of the settlement

106. The JV's case is that there was undue differential settlement in the approaches to the Bridge, causing material depressions across the carriageway. The settlement data and site investigations indicate that, in general, the differential settlement occurred at the ends of the membrane, where there was saturated, very soft chalk fill. The probable nature of such settlement was collapse compression of the chalk fill.

107. Atkins' case is that, in general, the overall settlement of the embankments and carriageways was predicted settlement of the underlying ground. The settlement data indicates that the greatest settlement occurred at the edges of the carriageways, associated with softening of the chalk fill in the verges. Settlement recorded in the north east was caused by the presence of a full height soil (chalk) structure. Settlement in the south occurred under the membrane and not at the edges.

108. Mr Pritchard's evidence is that in late 2011 localised depressions were noticed in the approach embankments to the Bridge, about 20-30 metres from the abutments, affecting the carriageways and vehicle barriers. Some of the depressions were approximately 0.5 metres wide and 30mm to 40mm deep. Over the following twelve months, the depressions became more pronounced across the width of the carriageway. KCC introduced speed restrictions to ensure the safety of motorists.

109. In cross-examination, he accepted that there were various problems with the carriageway including, but not limited to, the depressions the subject of the claim:

> "Q. There were a number of issues with the bridge that were not centred around the edge of the membrane?
>
> A. Yes.
>
> Q. And it was all those issues taken together which were causing the speed restrictions?
>
> A. Yes, although I think it would have been the main areas that would have been the main concern to the KCC supervision team, that would have drawn our attention to it."

110. There is limited photographic evidence of the depressions. The available photographs show ponding of water at the sides of the carriageway and misalignment of the fences and safety barriers as a result of differential settlement of the carriageway. In cross-examination Mr Pritchard accepted that the photograph of the gap between the asphalt and the kerb in the south west was approximately 60 metres away from the abutment and therefore unconnected with any membrane issue. The photograph of the acoustic fencing was approximately 10 metres away from the abutment. Unfortunately, therefore, the photographs do not show the extent of the depressions and whether they extended across the width of the carriageway on the approaches to the Bridge.

111. The best evidence of the as-built details is that contained in the drawings produced by the JV in 2012, showing the monitoring points. The drawings are not to scale but they were prepared for the purposes of the investigations into the cause of the settlement and there is no other evidence to cast doubt on their accuracy. I accept that they are the most reliable as-built records available.

112. The 2012 drawings show that, as constructed, on the north side of the Bridge, the HDPE membrane extended between 20 metres and 32 metres from the rear of the abutments under the carriageway and in the side slopes the membrane extended about 10 metres beyond the EPC blocks. On the south side of the Bridge, the membrane below the eastern carriageway extended about 20 metres from the rear of the abutments, the

membrane below the western carriageway extended between 12 metres and 20 metres from the rear of the abutments. Below the side slopes to the south, the membrane extended only 2 metres beyond the edge of the EPC blocks.

113. As-built levels for the carriageway on the approaches to the Bridge are not available. Hence, it is not possible to establish the total settlement figures. The available settlement data shows that in the period between December 2011 and January 2012 settlement of the cells occurred at different rates: (a) in the south east, over 40mm; (b) in the south west, about 30mm; (c) at the centre line south, up to 18mm; (d) in the north east, up to 18mm, (e) in the north west, about 10mm and (f) at the centre line north, up to 15mm. The divergence in the rates of settlement of some of the cells indicates significant differential settlement.

114. Mr Jessep considers that the localised, differential settlement that occurred was undue in terms of location, shape, magnitude and timing. He reaches the following conclusions from the settlement data, which he has plotted on graphs and diagrams appended to his report:

i) It provides evidence of increased total settlement and consequent differential settlement broadly coinciding with the ends of the membrane to the south-east, north-east, north central reservation and south-west of the bridge.

ii) A similar pattern applies to some extent on the south central reservation, although there is increased apparent settlement extending over the length of the infill section of this part of the embankment.

iii) To the north-west of the bridge the apparent differential settlement occurred between the abutment and the end of the membrane.

iv) There is also evidence of increased settlement and differential settlement about 50 metres from the abutment on the south-west line which is unrelated to the issues in this case.

115. Mr Bracegirdle's view is that the differential settlement in the approaches to the Bridge was within the expected range of settlement and any localised problems occurred as a result of the placement of chalk in the verges behind the wingwalls and poor compaction of the fill by the JV. He takes issue with the conclusions drawn by Mr Jessep from the settlement data:

i) The settlement for each point on the bridge is relatively consistent over the period of monitoring, indicating that the embankment fill settled together, although some parts settled more than others.

ii) The settlement in the north-east is explained by the presence of a chalk fill, reinforced soil structure extending from the edge of the embankment towards the centre line of the embankment. Over this section the chalk fill extends to the full depth of the embankment and therefore the settlement is greater.

iii) The data shows that the settlement is largest at approximately 15 metres from the abutment wall on the south side of the bridge. Although there is some doubt as to the final extent of the membrane it was probably about 25 metres from the abutment. Therefore, the largest settlement was indicated underneath the membrane and not at the ends of the membrane.

116. Mr Wygas, counsel for Atkins, submits that the JV has failed to produce evidence to substantiate the pleaded damage. No evidence was produced from KCC as to the nature or extent of the damage to the carriageway. In cross-examination, Mr Pritchard confirmed that he continued to use the Bridge weekly for a period of at least 18 months but no photographs or measurements were taken of the troughs about which the JV complains. He confirmed that the localised depressions were seen mainly towards the verges. The JV failed to produce settlement data in relation to the construction period so as to give a comprehensive picture of the behaviour of the structure.

117. Despite those limitations in parts of the evidence, I am satisfied that the JV has established that undue differential settlement occurred on the approaches to the Bridge in the region of the ends of the membrane. Mr Pritchard's evidence that there were localised depressions across the carriageways at the approximate edges of the membrane is supported by the trial pits and trenches. The experts agree that those excavations uncovered saturated, soft chalk at the edges of the membrane. The settlement was more prominent at the sides and in the outer lanes of the carriageway because the cross falls led to water ponding in those locations.

118. I accept Mr Jessep's interpretation of the settlement data. The data shows overall settlement, as would be expected through consolidation of the underlying ground. However, it also shows that settlement was not uniform. There was a rapid increase in the rate and extent of the settlement between December 2011 and January 2012, during a period of heavy rainfall. Some of this settlement occurred underneath the membrane; this is particularly apparent in the north west. However, at the north central and north east monitoring points, there is increased settlement towards the ends of the membrane. In the south west, south central and south east monitoring points, there is a correlation between rapid settlement and the ends of the membrane. Overall, there is a reasonably clear pattern of settlement at or around the edges of the membrane.

119. Mr Wygas relies on the JV's stated position in 2012, as set out in the factual report produced by Mr Tate in March 2012 and Mr O'Hare's attempt to persuade KCC that there was no undue settlement. The letter did indicate settlement at the sides of the carriageway but also identified differential settlement at the ends of the membranes, stated that the settlement was not confined to the verges and stated that the likely cause was fill softening caused by post-construction inundation. In any event, KCC did not accept the JV's argument that this was within expected settlement parameters and subsequently the JV agreed to carry out the remedial works the subject of the current claim.

120. Drawing that evidence together, it is probable that the nature and extent of the settlement was differential settlement giving rise to depressions extending across the carriageway. The weight of the evidence is that such settlement was associated with collapse compression of the chalk fill at the edges of, and under, the membrane following inundation of the fill.

The Bridge - cause of the differential settlement

121. The JV's case is that undue differential settlement was caused by softening and collapse compression of sections of the chalk fill adjacent to the membrane due to excessive water penetration into the chalk fill. The excessive water penetration was due to deficiencies in Atkins' design, namely, the absence of any or any adequate drainage for sub-surface water accumulating over the membranes and percolating into the chalk fill.

122. Atkins' case is that localised depressions of concern were caused by the improper use of chalk fill at shallow depth and poor compaction adjacent to the ends of the membrane. The JV failed to construct the Bridge approach details in accordance with the design. The JV laid the membrane parallel to the carriageway and not perpendicular to the abutments. The membrane was cut short in the side slopes and behind the wing walls in the south. The JV placed chalk fill, instead of the specified 6N fill, on top of the membrane in the verges and side slopes behind the wing walls. Water flows readily through the Class 6N fill and could flow down the sides of the embankment. However, chalk is relatively impermeable as compared to Class 6N fill. The effect of placing chalk fill over the membrane was that water accumulated in the chalk "dams" at the edges of the membrane.

123. Mr Jessep's opinion is that Atkins' design failed to include any system to collect and remove sub-surface water over the structural fill and the membranes following the introduction of the membranes into their design. The falls of the membranes away from the abutments allowed sub-surface water over the membranes to drain into the approach embankments general fill. Atkins should have recognised that additional sub-surface drainage would be required to the road pavement layers, including the sub base capping. Atkins should have designed sub-surface drainage over the membrane preventing water penetrating through the carriageways from reaching the back of the abutment and wing wall.

124. Mr Bracegirdle's opinion is that Atkins' design contained adequate drainage provision by means of the layer of permeable class 6N fill material over the membranes, which would allow free drainage of water to the edges of the membrane and dissipation into the sides of the embankment or the fill in the embankments. The JVs failure to follow Atkins' design prevented such free drainage of water to the sides of the embankment. Contrary to Atkins' design, although the JV placed Class 6N fill on top of the membrane under the carriageway, it placed chalk fill on top of the membrane under the verges and chalk fill on top of the EPC blocks as structural fill. The relative impermeability of the chalk fill, as compared with the Class 6N fill, resulted in the formation of "chalk dams", allowing water to accumulate and inundate the chalk fill.

125. Mr Bracegirdle considers that even if drains had been installed, the amount of rainfall in the UK and the various paths by which water could percolate into the fill made water penetration of the chalk fill inevitable. Sources of water included water leaking from the fin drains installed at the edge of the carriageway embankments, water from the road base which would percolate into the capping and then into the chalk fill, water percolating through the verges and central reservation and water percolating through the sides of the embankments.

126. Given the inevitability of water penetration, the chalk fill required careful and proper preparation before and during its installation to remove air voids. This was the

responsibility of the JV. The JV failed to properly place and compact the chalk fill. Therefore, Mr Bracegirdle's opinion is that the collapse settlement of the chalk fill was caused by the JVs poor workmanship.

127. Mr Jessep agrees that properly placed and compacted class 6N fill would not have been susceptible to significant collapse compression and the use of chalk fill is likely to have contributed in places to some local settlement of the verges generally within 8 metres of the abutments where the class 6N capping was specified by Atkins. However, this was not the primary cause of the undue settlement in the approach embankments of concern.

The Bridge **-** *discussion and findings on cause of settlement*

128. The experts have identified relevant industry and academic guidance on the use of chalk fill and drainage.

129. The Design Manual for Roads and Bridges ("DMRB") includes Advice Note HD 33/06 (2006), which contains guidance for the design of surface and sub-surface drainage of trunk roads and earthworks associated with highway schemes. The recommendations include provision for sub-surface drainage to remove any water which may permeate through the pavement layers of roads away from the formation:

> "Sub-surface drainage is normally necessary in order to remove any water which may permeate through the pavement layers of the roads in both cut and fill situations. This can be achieved on embankments by the provision of fin or narrow filter drains …
>
> Sub-surface drainage is effected by installation of longitudinal sub-surface drains at low edges of road pavements. These serve to drain the pavement layers and pavement foundations they also prevent ingress of water from verge areas adjacent to the pavement.
>
> It is also essential that water is not retained within the sub base and for that matter the capping layer. Water reaching the formation and sub-formation must be drained to longitudinal sub-surface drains by adequate shaping of the formation and sub-formation such that no undrainable low spots occur."

130. When chalk is compacted to form a fill, a relatively high proportion of fines are created which can reduce permeability of the material. Chalk fill can be prone to significant collapse compression upon inundation with water as explained in CIRIA Report C574 (2002). The bridges between intact chalk lumps in the fill are destroyed by wetting and the solids collapse into the air voids. This risk can be reduced by limiting the air void content to about 8-10% and specifying a minimum water content at the time of compaction. Nonetheless, the risk of collapse compression remains if the chalk fill is not protected from subsequent rainwater inundation:

> "Chalk fills are generally protected against inundation. Collapses have occurred where fills have been constructed over ground subjected to flooding. Prolonged saturation can cause

> degradation of intact blocks by softening and fines production. Drainage along margins or through chalk fills needs to be well constructed and regularly checked."

131. In the BRE paper by Charles and Watts (IP 5/97), they examined compression collapse in fill materials caused by inundation:

> "Poorly compacted, or excessively dry, fill is always likely to be vulnerable to collapse compression …
>
> A wide variety of types of unsaturated fill formed in different circumstances can be vulnerable to collapse compression, for example … chalk fill …
>
> Inundation can be due to either submergence by a rising groundwater level water infiltrating downwards from the ground surface…
>
> The objective is to prevent the occurrence of collapse settlement in the fill and several possible approaches could be considered:
>
> - place and compact and engineered fill so that it has no collapse potential,
> - eliminate collapse potential of an existing non-engineered fill by increasing the fill density by some form of ground treatment before building takes place,
> - eliminate collapse potential of an existing non-engineered fill by inundating the fill before building takes place, and
> - prevent inundation of the fill occurring during the life of the structure. …
>
> Where construction is to take place on a fill with collapse potential, a solution might be to prevent inundation occurring during the life of the structure. However, while in theory it may be possible to prevent water penetrating the surface crust of the fill by care in design and construction, in practice it will be difficult to ensure that some water does not penetrate into the backfill during the life of a structure …
>
> In most situations and approach relying primarily on prevention of inundation does not provide a satisfactory solution to the hazard posed by a fill with collapse potential."

132. Thus, the potential for chalk fill to suffer collapse compression on inundation with water was widely recognised at the time of the project. The risk could be minimised by care in placing and compacting the fill, including limiting the air void content to about

8-10% and specifying a minimum water content at the time of compaction. However, the risk would remain unless the chalk fill could be protected from water inundation.

133. Mr Bracegirdle accepted that HD 33/06 recommended that Atkins should make provision for sub-surface drainage in its design of the lightweight fill to the abutments and wing walls. Atkins were free to depart from the guideline provided that its alternative design did not give rise to any stability issues:

> "Q. So do you agree then that if that guidance had been followed, Atkins design should not have provided for water to be draining off over the edge of the embankments?
>
> A. No, I do not accept that at all because the Atkins design was something completely outside this document … As long as you have got a system which provides for a dry foundation for the highway and by foundation, I mean typically the top metre or half a metre, as long as that's not saturated, it's fine and you can discharge water off the sides, providing it's done in a way that doesn't prevent stability issues with the sides of the embankment …
>
> Q. Your evidence is that the design didn't comply with these requirements specifically but provided that the effect of the design was such that it didn't cause any problems then you can't complain about it.
>
> A. That's absolutely right yes…
>
> Q. Because we are not talking about following the guidance. We are talking about moving away from the guidance, allowing the water to flow off the end of the membrane into the chalk fill beyond and allowing it to fall off the sides of the embankment in a way that wouldn't normally be permitted.
>
> A. Wouldn't normally be done yes…"

134. Atkins' original design provided that the structural backfill behind the abutments should be of well graded granular class 6N or 6P fill. This would have permitted relatively free drainage of sub-surface water into the highways drainage system designed by Jacobs.

135. Atkins changed its design by incorporating the use of the EPC blocks and the HDPE membrane in place of the class 6N or 6P fill. The revised design, as set out on the C06 drawings, introduced an impermeable layer, the membrane, on top of the EPC blocks. The membrane was designed to be laid to a fall of 1:40 away from the abutment and to terminate in the chalk fill. The design did not incorporate drainage around the edges of the membrane to transport any water on the membrane away from the chalk fill.

136. Mr Fry's oral evidence was that Atkins' design intent was for sub-surface water to be drained from above the membrane away from the abutments into the side slopes. The 6N fill above the membrane was intended to act as a drainage fill and the 1:40 fall of the membrane was intended to be laid perpendicular to the abutment:

> "I think the sections shown on our drawings, which followed on from the discussions that took place on TQ 88, were quite clear that the only buildable practical way in which we saw this being undertaken was to have a 1:40 fall which was perpendicular to the back face of the abutments, and there would have to be some modifications when you reached the wing walls, depending upon whether they had a sloped top or not.
>
> …
>
> … We recognised that there was an issue about any water that actually permeated through the road surface. We were confident that the majority of the water would be taken by the kerb drainage system which ran on the North approach. But anything that permeated would have to sit on the membrane and find its way out, and the best way of finding its way out would be for it to be taken down the membrane which was draped over the side slopes.
>
> …
>
> … We had chosen to employ a 6N capping to the HDPE membrane onto the carriageway, with the recognition that this was a drainage medium
>
> …
>
> the 6N material was provided as a drainage medium, not just on capping underneath the carriageway but also, as demonstrated on our drawings, on the side slopes above the membranes…"

137. That intention was not specified on any of the Atkins drawings. The development of the design by Atkins, as set out in the chronology above, does not support Mr Fry's suggestion that this issue was considered by Atkins or communicated to the JV. The earlier C04 drawings did not provide for any fall in any direction and therefore made no provision for drainage of the water from the surface of the membrane away from the chalk fill.

138. Mr Pritchard accepted in cross-examination that the C06 drawings showed a fall in the membrane away from the abutment at 1:40:

> "Q. So we have a fall away from the abutments at 1:40?
>
> A. Yes…

Q. …what this section is telling you is above the membrane we put 6N capping all the way down over the top of the membrane?

A. Yes.

Q. And that continues down over the membrane, doesn't it?

A. That is the requirement, on top of the membrane, yes…

Q. That is the same with the wing walls as well, isn't it, the membranes fall away from the wing walls, so you don't end up with water going –

A. Yes, it is the same principle but of course it is not the carriageway then, it is the side fill…"

139. There are no notes on the C06 drawings that indicate that the 6N capping layer was intended as a drainage medium or that the membrane was intended to drape over the sides of the embankment to dissipate any sub-surface water. There is no contemporaneous document supporting Mr Fry's suggestion that Atkins decided to use 6N capping to drain water above the membrane.

140. In any event, regardless of Atkins' intention, the effect of the C06 design was that a significant proportion of water falling onto the membrane would have drained down to the edge of the membrane lying across the carriageway. Mr Fry accepted that the C06 drawings did not make any special provision at the interface between the edge of the membrane and Jacobs' design, or address the mechanism by which the water arriving at the edge of the membrane under the carriageway could drain to the embankments:

"A. … all of these drawings, for all of the wing walls as well as the abutment systems, show 6N above the HDPE membrane.

Q. I agree with you but the difficulty is that they don't provide the detail of what happens at the end of the blocks, do they?

A. Not these drawings, no.

…

Q. … Your design does allow for the membrane, which you designed to extend into that general embankment fill, doesn't it?

A. Over the top of it, yes…

Q. And at the end of the membrane it would meet that general embankment fill, wouldn't it?

A. Yes."

141. During the course of his oral evidence, Mr Bracegirdle proffered a theory that the chalk, when wet, would form a 'skin' that would contain the water on the membrane and allow it to discharge to the side slopes. I reject that theory as inconsistent with the evidence of the very soft, saturated chalk found in the trial pits and trenches excavated at the edges of the membrane.

142. TQ 88 correctly identified the need for drainage around the perimeter of the membrane but Atkins failed to respond to it. It appears that Atkins initially wanted to wait until Jacobs and KCC indicated their approval of the JV proposal. Unfortunately, during the critical period in 2011, when the lightweight fill design was finalised, Mr Kucki was in the process of leaving the project to take up a post in India. Mr Cheung took over preparation of the C06 drawings but he did not have Mr Kucki's knowledge of the design development and did not recall his involvement in this area of the design.

143. Atkins' design did not expressly provide for, and no reasonable contractor would have understood the C06 drawings as requiring, Class 6N fill to be placed over the membranes where they extended into the side slopes and verges beyond the EPC blocks. Beyond the EPC blocks, the membrane would be placed onto the chalk fill. The C06 drawings did not identify class 6N fill to be used as a drainage medium over the membranes and no cross-fall was introduced to allow drainage into the side slopes.

144. Atkins should have, but failed to, include in its design sub-surface drainage to ensure that water collecting on the membrane would be carried away from the chalk fill and into the highways drainage system. Mr Fry accepted in cross-examination that drains placed around the edge of the membrane would have captured water percolating horizontally through the 6N fill above.

145. The JV failed to follow Atkins' design in three respects. Firstly, Mr Pritchard's evidence was that the membrane was laid parallel to the carriageway, rather than perpendicular to the abutments. Mr Jessep's analysis of the as built levels showed that in fact the membrane as laid was generally perpendicular to the abutments, although the fall was shallower than specified. I accept Mr Jessep's evidence that this might alter the direction and rate of flow of water across the membrane but would not result in any material change to the outcome. Water would still flow off the ends of the membrane into the chalk fill under the carriageway.

146. Secondly, the JV cut back the membrane behind the wingwalls in the south to less than 10 metres beyond the edge line of the EPC blocks. The JV proposals in the technical queries showed the membrane extending 5 or 15 metres beyond the EPC blocks. The C06 drawings showed the membrane extending 10 metres beyond the EPC blocks at the abutments but did not indicate the detail to be followed at the wing walls. Therefore, although it was acknowledged by the JV that the membrane would have to extend beyond the EPC blocks to protect them from hydrocarbons, the precise requirements of the Atkins' design were not clear. In any event, Mr Bracegirdle agreed in the experts' second joint statement that the length of the membrane had little impact on the efficacy of any drainage away from the fill.

147. Thirdly, the JV accepts that it placed chalk fill over the side slopes and beyond the wing walls to the south east and north west and over the side slope to the north east. I accept

Mr Jessep's evidence that this would cause local softening of the verges but does not explain the wider incidence of settlement depressions which occurred on the carriageway.

148. In summary, Mr Jessep's opinion as to the cause of the undue differential settlement is supported by the following evidence and accepted as the probable cause of the settlement. Firstly, the undue settlement and differential settlement occurred predominantly at the ends of the HDPE membranes. Secondly, the trial pit and trench investigations found saturated very soft chalk in places below the ends of the membranes. Thirdly, the settlement cell monitoring data, showed rapid rates of settlement of the carriageways and central reservations between December 2011 and January 2012 at the ends of the membranes, coinciding with a period of significant rainfall. The LIDAR data relied on by Mr Bracegirdle is less reliable than the site-specific data but is not inconsistent with Mr Jessep's analysis. Fourthly, a corresponding reduction in the rates of settlement of the carriageways and central reservation occurred in early 2012, coinciding with a reduction in the rate of rainfall observed. Fifthly, the progression of settlement depressions occurred in both directions away from the ends of the membranes. Finally, following installation of the drainage trenches in autumn 2012, although subsequent settlement occurred, the monitoring data shows that this was limited to overall settlement of the embankment; there is no evidence that any further differential settlement took place.

149. For the above reasons, I find that the collapse compression of the chalk fill was caused by excessive water penetration due to Atkins' failure to design adequate sub-surface drainage for water accumulating on the membranes and percolating into the chalk fill.

The Bridge – breach/negligence

150. Atkins was responsible for the design of the Bridge, including the design of the lightweight fill behind the abutments and wing walls, and any necessary sub-surface drainage.

151. HD 33/06 constituted guidance as to the necessity for adequate sub-surface drainage, of which Atkins was, or should have been aware. Atkins failed to follow that guidance in its design.

152. The risk of collapse settlement of chalk fill on inundation was widely recognised and a risk of which Atkins was, or should have been aware. Atkins failed to design adequate sub-surface drainage to accommodate the revised design incorporating the EPC blocks and HDPE membrane. The absence of sub-surface drainage permitted water to collect on the membrane and percolate into the chalk fill. As a result, the chalk fill was subject to collapse compression which caused the local depressions that occurred across the carriageway.

153. For those reasons, I conclude that Atkins' design was inadequate, negligent and in breach of the Subcontract.

Remedial works

154. Mr Jessep's opinion is that the remedial works carried out in September 2012 were reasonable and appropriate. In the absence of such work, further discharge of sub-

surface water into the chalk fill probably would have led to future undue settlement of the carriageway.

155. Mr Bracegirdle's opinion is that the remedial works were unnecessary given that saturation of the chalk fill beneath the membrane had already taken place. The drainage works would not have been sufficient to stop continued wetting of the chalk fill beneath the membrane.

156. Mr Bracegirdle's view is that further settlement in early 2013, after heavy rainfall in December 2012 and January 2013, showed that the installation of the drains as part of the remedial works carried out by the JV were ineffective. I reject that analysis of the data. The monitoring data shows that after November 2012 the whole embankment settled and such settlement was limited. Thus, it was uniform and not significant.

157. Mr Bracegirdle accepted in cross-examination that it was necessary to install drains to remove water collecting on top of the membrane:

> "Let me say it was necessary to put drains in because I feel real concern, and I would have felt real concern at the time, of the possibility of uncontrolled rising water level above the membrane due to water being trapped in there."

158. The nature and severity of the depressions were such that KCC had imposed speed restrictions and closed the outside lane in both directions. It was necessary and reasonable for the remedial works to be carried out. The main purpose of the remedial scheme was to address the undue settlement across the carriageway. It was reasonable and proportionate for the JV to install a comprehensive drainage scheme to ensure that no further damage occurred. Following the remedial works, the differential settlement stopped.

159. For those reasons, I am satisfied that the remedial works carried out by the JV were reasonable in scope and necessary to address the defects caused by Atkins' design.

160. Mr Wygas seeks to raise an argument that specific parts of the remedial works carried out are not recoverable by the JV from Atkins as a result of Atkins' defective design and therefore, its global claim is not recoverable.

161. The JV disputes that its claim is a global claim. The pleaded case by the JV was that the costs recoverable from Atkins as a result of its defective design were the costs incurred in the reinstatement of the approach embankments and road, as set out in the quantum schedule attached to the Amended Particulars of Claim.

162. The pleaded defence denied that any remedial works would have been necessary if the drainage had been properly designed and installed and the general fill supplied and laid in accordance with the specification; the remedial works carried out related to the drainage on the highway and did not relate to any settlement issues.

163. For the reasons set out above, that defence has been rejected. Atkins was responsible for the design of the sub-surface drainage. Atkins's design was defective and in breach of the Subcontract. The remedial works were required as a result of differential settlement caused by Atkins' inadequate design.

164. In response to the quantum schedule, Atkins admitted some of the figures and put the JV to proof in respect of other figures, requiring the JV to substantiate the works and show that they related to the defects alleged against Atkins.

165. The JV relied on the witness statement of Mr Watson, the JV's quantity surveyor for the remedial works, to substantiate the remedial costs claimed, including a response to the challenges raised by Atkins in respect of the quantum schedule.

166. At trial, quantum was admitted. Mr Watson was not cross-examined and his evidence was not challenged.

167. Atkins contend that parts of the resurfacing and traffic management costs are not recoverable as damages. Reliance is placed on Mr Jessep's concession that part of the resurfacing work was not related to any works that Atkins had designed. This is not a pleaded defence to the quantum claim. In any event, Mr Watson's unchallenged evidence was that the resurfacing and traffic management costs were necessary as a result of the drainage remedial works, which the Court has found were a direct result of Atkins' defective design.

168. Atkins contend that the JV is not entitled to recover the costs of installing the drains in the verges. Reliance is based on Mr Jessep's concession that the JV's placement of chalk fill in the verges, contrary to Atkins' design, caused the softening in those areas. Again, this is not a pleaded defence to the quantum claim. Mr Watson's unchallenged evidence was that the drainage works would not have been necessary (or would have been recoverable by the JV from KCC) if Atkins' design had been adequate.

169. For those reasons, I reject Atkins' argument that the JV is not entitled to recover the remedial costs claimed.

The Underpass - design

170. On 1 April 2010 Atkins produced its AIP design revision 5 for the Underpass.

171. Section 3.9 of the AIP stated:

> "Unusual features of design
>
> The underpass structure will be constructed beneath, and adjacent (in plan) to, the operational railway using a mixture of tunnelling and jacking techniques. The form of construction will require, during construction, gaps between deck downstands and the supporting piled abutments concrete sections, to cater for the deck jack process as well as construction tolerances.
>
> It will be impossible to seal these voids from the outside of the structure after completion of the jacking operation, and it therefore proposed to fill them with high-strength, non-shrink, cementitious grout, using grout tubes previously cast in the deck. The grout will form a non-permeable barrier to prevent seepage water ingress. Additionally, hydrophilic sealant points and water

> bar details will be provided to provide additional defence against water ingress.
>
> The deck will be installed in 6 sections to allow for installation of inter-jacking stations between precast deck units. There will be no physical connection between deck units neither in temporary nor in permanent situation.
>
> The gaps between units will be filled with high-strength, non-shrink, cementitious grout after completion of the jacking operation. The grout will form a nonpermeable barrier to prevent seepage water ingress. Additionally, hydrophilic sealant points and tok strips will be provided to provide additional defence against water ingress.
>
> To allow the jacking process over cut will be created around the jacked deck and filled with lubricant. After completion of the jacking operation the lubricant will be substituted with cementitious grout."

172. On 30 July 2010 Atkins issued drawing number 5089893–RLS–200–CBR–00010 revision B01, its general arrangement plan and long section for the underpass.

173. On 26 August 2010 Atkins issued drawing number 5089893–RLS–200–CBR–00011 revision B02, showing an elevation of the west end of the Underpass and cross-section through the same. A note on the drawing stated that the gap between the outside edge of the deck and the rear of the abutment beams should be filled with high-strength non-shrink grout following the deck jacking operation. Weep holes were to be provided at 2 metre centres in the lining walls to the sides of the Underpass to allow water to drain into the carriageway below.

174. On 14 October 2010 the reinforced concrete headwall beam was cast.

175. On 4 January 2011 Atkins issued drawing number 5089893–RLS–220–CBR–10001 revision C01 showing a plan, elevation and details for the headwall beam. The beam was 1.5 m deep, generally 4.5 m wide and was to be pre-cambered by 40mm at the centre of its span.

176. On 26 April 2011 Atkins prepared a technical note for the underpass. At section 4.3 it stated:

> "The main (temporary works stage) purpose of the west headwall is to provide anchorage for the ADS system … In the permanent solution the gap between the underside of the headwall beam and the top of the last deck unit will be grouted, a small upstand added on the west side and the exposed face clad with masonry."

177. In August 2011 the jacking operation was completed.

178. McBurney Civil Engineering, a sub-contractor, carried out the grouting operations and provided a method statement dated 26 August 2011, which stated:

> "Timber shutters will be made to suit the gap between the box and the rails. These shutters will be reused where possible. The shutters will be sealed with silicone to prevent grout loss. At either end of the box 2 no. letterboxes will be created to ensure the grout that is poured in from the one end flows through and fills all the voids.
>
> The grout will be mixed in a grout pan to the manufacturers recommended mix ratio.
>
> The grout will then be discharged into vessels to be transported to the letterbox. This process will be repeated until the grout appears in the end letterbox.
>
> For box 1 and box 6 the outer exposed edges will be shotcreted to seal the vertical gap.
>
> Once the gap between the box and the rails has been successfully grouted the vertical gap between the box and the face and the soffit can then be grouted."

179. On 25 October 2011 Atkins issued drawing number 5089893–RLS–200–CBR–10004 revision B01 showing the details for the west approach headwall.

180. On 14 December 2011 the reinforced concrete headwall was cast in situ.

181. By March 2012 the structure was complete.

The Underpass – water leakage

182. In April 2012 KCC reported that water was leaking through the joint between the Western headwall and the underlying deck section.

183. On 30 November 2012 Mr Pritchard sent an email to Atkins, attaching photographs of the staining and a sketch, showing the likely path of the water ingress on the west approach to the Underpass.

184. 3 December 2012 Mr Kucki responded to Mr Pritchard, stating:

> "I think that the best solution will be to dig out the West headwall and waterproof the potential paths of water ingress…
>
> I think that most likely the water gets in there between the deck and headwall, through the gap for the ADS. Has this gap been grouted? If yes, what is the likelihood that this has been done robustly?"

185. The following day Mr Fry added his suggestion that a perforated interceptor drain could be installed at deck level just behind the concrete block, taking penetration water to the deck end.

186. On 15 July 2013 a method statement was produced for the remedial works.

187. Between 24 July 2013 and 30 September 2013 the remedial works were carried out. A chamfer was incorporated between the top of the deck and the rear of the anchor beam. The rear of the anchor beam and the top of the deck were sprayed with a waterproofing system. The gap between the roof deck and the anchor beam was chased out with a grinder and sealed.

The Underpass issue

188. The JV's case is that the water ingress was caused by Atkins' inadequate waterproofing detail for the 100mm gap. Atkins' defence is that the water ingress was caused by workmanship issues.

189. It is common ground that the ADS steel sheets were left in place over the full length of the tunnel after the jacking operation and, during Mr Jessep's investigations, no grout was found between the sheets.

190. Photographs taken by the JV during remedial works indicate that grout injected between the underside of the headwall beam and deck generally penetrated into or displaced the fill locally but in some places there were voids between the grout and the headwall beam.

191. The JV concedes that there were workmanship issues with the grouting, which created significant voids, some with water emanating from them. It is also conceded that these shortcomings would probably have exacerbated the leaks through the Western headwall and hence contributed to the level of staining and deposits on the face of the deck section that occurred. However, the JV case is the grouting alone would not have been sufficient to prevent seepage through the joints, even if the grouting had been completed perfectly, with or without removal of the ends of the ADS sheets. In any event the JV contends that Atkins should have instructed removal of the ADS sheets if they were critical to success of the waterproofing.

192. The experts have agreed in their joint statement that undue seepage of water occurred through the western end of the Underpass. The primary path of water ingress was through the grouted 100 mm gap between the headwall beam and the underlying deck section. A potential secondary path for water flow was between the rear of the headwall facing and the headwall beam through fine cracks in the headwall.

193. The experts have also agreed that waterproofing of the western headwall of the Underpass was required to prevent such water seepage.

194. The issue is whether the water seepage was caused by:

i) a deficiency in Atkins' design, namely, Atkins' failure to specify additional waterproofing measures, such as a membrane or waterstop, or other water collection system; or

ii) the JV's poor workmanship, namely, failure to remove the ADS sheets from the 100mm gap and/or failure to install the grout properly so as to fill the gap.

The Underpass – expert evidence

195. Mr Jessep's opinion is that it was foreseeable the groundwater could run along the top of the deck of the underpass and that the buried Western headwall would be exposed to the water. The design of the Underpass should have included adequate measures to address the potential for water to seep between the deck section and the headwall beam and between the headwall beam and the headwall.

196. Mr Jessep's opinion is that Atkins specified non-shrink grout which would not provide adequate waterproofing as a result of ongoing differential deflection of the elements of the underpass, namely the headwall beam and the deck section.

197. Atkins was responsible for the design of the underpass. If it was necessary for grouting to be carried out in a specific manner so as to ensure a waterproof joint, Atkins was responsible for specifying the grouting and method to be adopted. Atkins did not specify the removal of the ADS sheets prior to grouting and therefore, it was not unreasonable to leave them in place. In the absence of an instruction to the contrary, it was reasonable for the JV to apply the grout through the inlet pipes.

198. The areas of water leakage do not correlate with the areas of poor grouting. The voids observed in the grout probably increased the volume of water seepage through the West End of the underpass but grouting of the void between the headwall beam and the deck section below could not reasonably have been expected to form a waterproof joint, even if perfectly installed with the ADS sheets removed.

199. A reasonably competent designer responsible for the design of the underpass would have designed adequate waterproofing measures to prevent water from leaking through the West End of the underpass. Atkins design included no such adequate waterproofing despite the foreseeability of groundwater running along the top of the deck sections. In this respect, Atkins performance fell below the standard of a reasonably competent engineer.

200. Mr Bracegirdle's view is that it was always evident that water could potentially accumulate behind the headwall beam, albeit at low pressure, and that measures would be required to prevent water flow between the headwall beam and the tunnel roof.

201. His opinion is that grouting is a standard method of waterproofing in tunnels and is sufficient to impede water ingress. A cementitious non-shrink grout is adequate to seal against water ingress where loading remains constant over time, as is the case with the Underpass.

202. A competent contractor should have understood the importance of grout filling as a waterproofing measure and taken steps to ensure grouting was administered carefully and in a controlled manner at to ensure full coverage as a defence against water ingress.

203. Mr Bracegirdle's opinion is that the leakage at the west headwall was a direct consequence of poor workmanship. The use of the bentonite manifold ports to inject the grout did not allow for careful and controlled injection of the grout. It was

impossible to know where the grout was placed and therefore whether the 100mm gap had been filled, or waterproof seal achieved. A careful approach, executed by a competent contractor, would have been to first inject the grout in the side between the decks and the piled structure. This would have sealed the longitudinal sides of the 100mm gap. The front and back of the 100mm gap could be sealed by caulking, at the front, prior to the casting of the headwall beam and, at the back, prior to any backfill being placed over the anchor beam. Grout could then be injected through grouting holes in the caulking in a controlled manner, ensuring the continuous progression of grout from one injection point to the next.

204. Had the underpass constructed in accordance with good working practices, the waterproofing detail designed by Atkins would have been appropriate and effective.

The Underpass - Discussion and findings

205. I reject Mr Jessep's theory that relative deflection caused cracking, resulting in leaks requiring remedial works. Mr Kucki's evidence, supported by Atkins' drawings, was that the design provided for a pre-camber to be built into the deck, which would result in a pre-camber even when weighted. Mr Jessep provided no finite element analysis to support his theory that, contrary to the design intent, the deck would sag under load. He stated that he would expect such differential deflection to occur over a period of months but the grouting was carried out some six months after the anchor beam and last deck were in place. In any event, as Mr Wygas submitted, there is simply no evidence, from the photographs or investigations, that there was any relative deflection cracking.

206. The design did not expressly specify removal of the ADS sheets from the 100mm gap but the JV should have recognised the need for, and carried out, the removal of the ADS sheets before grouting. Mr Daniele accepted in cross-examination that the JV knew that the purpose of the grouting was to reduce the possibility of water ingress. The presence of the ADS sheets in the 100mm gap would impede full penetration of the grout. Without full penetration of the grout, it would not be possible to create a watertight seal.

207. Mr Pritchard agreed that it would have been possible to cut the ADS sheets at the front and back of the anchor beam and remove them to carry out the grouting:

> "Q. But cutting the sheets at the back of the anchor beam was possible, and then you would end up with an ADS sheet of let's call it 4.7 metres, because you would have a bit at either end?
>
> A. Yes, yes.
>
> Q. You could pull those out by hand, couldn't you?
>
> A. If it was completely clear, yes, just about. Yes…
>
> Q. So what we can surmise from that is they were cuttable; the process of building the underpass meant that they were available to be cut?

A. Yes.

Q. And they were removeable?

A. Under the headwall they could have been but bearing in mind that the back of that headwall was underground …

Q. The back of that headwall was not underground at the end of the jacking process was it?

A. Not at the end of the jacking process, no."

208. Mr Daniele estimated that the exercise would have taken about one hour or so:

"Q. When you cut the ADS sheets at the front of the anchor beam you could have also cut the ADS sheets at the back of the anchor beam?

A. That's correct.

Q. The cutting of ADS sheets would have taken minutes?

A. In my experience it's more than minutes …

Q. Would it have taken an hour? …

A. Based on my experience I would say probably half an hour per pair of sheets, yes, and then obviously on top of that .. that is the cutting but then they have to be safely removed, so you know that would be a manual handling operation as well, but yes we are talking about hours."

209. The JV should have recognised that it was necessary to remove the ADS sheets before grouting to make the 100mm gap watertight.

210. Atkins' design did not specify the methodology for the grouting operation. That was not surprising because grouting is a specialist operation. It was open to the JV to decide to grout the 100mm gap using the inlet pipes in the decking but it did so at its own risk.

211. The JV did not raise with Atkins any issue as to the practicability of grouting the gap to produce a watertight seal. Mr Pritchard accepted in cross-examination that the grout injection works could have been carried out to achieve a seal:

"Q. What you could do is you could seal up the front of the 100mm joint …

A. Yes.

Q. with injection ports and have injection ports in that caulking and seal up the back?

A. You would and could and that would obviously all create extra work in this instance, but you could, yes…

Q. Then if you injected the grout through the front, let's say, you would know when it reached the back because it would start to exit the ports at the back?

A. Yes."

212. The grouting of the 100mm gap was a workmanship issue. The grouting was a specialist activity. If the JV had any concerns about the practicality of achieving a seal, those concerns should have been raised with Atkins. No such concerns were raised.

213. It is accepted that the voids in the grout caused at least some of the water seepage. For the above reasons, I find that the JV has not established any deficiency in Atkins' design or that the cause of the leakage was anything other than poor workmanship.

214. The reasonableness of the remedial works and quantum were agreed.

Conclusions

215. For the reasons set out above, the JV's claim in respect of the Bridge succeeds. The JV is entitled to damages against Atkins in the sum of £802,475.35.

216. The JV has failed to prove its claim in respect of the Underpass. Therefore, I dismiss the claim against Atkins in respect of the Underpass.