

Our ref: 25.1.201/CHBB/1887

11<sup>th</sup> March 2009

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**For the attention of Steven Bell – Tram Project Director**

Dear Sirs,

**Edinburgh Tram Network Infracore  
Development Workshop Report: Trackform**

We enclose 2 copies of document no BSC/25.1.201/DWR/TR001, Issue 2 dated 12<sup>th</sup> March 2009, entitled Development Workshop Report: Trackform. This document is the output of the Development Workshop process in respect of Trackform and includes the agreed instructions from tie regarding amending existing drawings, design of a ground improvement layer and analysis and design of vibration migration. The report also includes the instructions to SDS to implement the necessary design activities.

This report has been amended as required by your letter no INF CORR 720 dated 12<sup>th</sup> February 2009.



To complete the Development Workshop process, the report needs to be agreed by the parties (ref Clause 4.8 of Schedule 23m included in the report in Appendix 6.1). To this end, the Record of Agreement table on page 2A, the report should be completed by tie and one copy of the report returned to BSC. We would be grateful to receive that copy as soon as convenient.


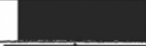

Yours faithfully,



*P.f.* **M Foerder**  
Project Director  
Billfinger Berger Siemens CAF Consortium


# Development Workshop Report Trackform

BSC Consortium		
Position	Date	Approval
BSC Project Director	12.3.09	PP 
BSC Deputy Project Director	11.3.07	

Inter Discipline Checking Process				
	Name	Position	Date	Signatures
Checked by (Siemens)	Klaus Dieker	TRW Manager	12/03/09	
Checked by (BB)	CHB BRADY	TECH DIR	12.3.09	
Author	Ralf Honeck	Design Manager	12/3/09	
Document History				
Rev.	IssueDate	Description of Change	Author	
1	28/1/09	First Issue (Draft)	R Honeck	
2	12/03/09	Change Instructions added	R Honeck	

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Revision	Summary of Changes	
	Reference	Description
1		First issue
2		Change Instructions added

Revision	Record of Agreement (ref Schedule 23, clause 4.8)		
	Name	Party	Signature
1		Tie	
		Tie	
		BSC	
		BSC	
2		Tie	
		Tie	
	CHB BRADY	BSC	
	Roland Bruchmann	BSC	
3		Tie	
		Tie	
		BSC	
		BSC	

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## **DEVELOPMENT WORKSHOP REPORT : TRACKFORM**

### **CONTENTS**

- 1 Introduction**
- 2 Misalignments**
- 3 Conclusions**
- 4 Notes of Development Workshop**
- 5 Tie Change orders**
- 6 Appendices**
  - 6.1 Process**
  - 6.2 Trackform Comparison: Presentation**

## 1 INTRODUCTION

The ETN Infraco Contract became effective on 14/5/08, at which time it was known that misalignments existed between the Base Date Design Information produced by SDS, on which the civil works price was generally based, and the Infraco Proposals for certain systems, such as trackform, on which the Systems price was based. The process for resolving such misalignments is described in Contract Schedule 23 (Novation Agreement) which requires that Development Workshops are held to determine the development of the Infraco Proposals and any consequential amendment to the design deliverables. The relevant section of Schedule 23 (clauses 4.6, 4.7 and 4.8) are contained in Appendix 5.1, Process.

The product of the Development Workshop shall be a report signed by each of the Parties (i.e tie, Infraco and SDS), to detail the conclusions in respect of each matter and payments to be made to the SDS provider in respect of the work to be carried out by the SDS provider as a result of the conclusions set out in the report.

This document, no BSC/25.1.201/DWR/TR001, is the report of the Development Workshop for Trackform.

In respect of any given system, such as trackform, the matters to be determined at the Development Workshop are set out in Schedule 23, Appendix 7, Part C (the Misalignment Report), together with any items to be finalised in SDS/BBS alignment workshops, in Schedule 23, Appendix 4.

In the case of trackform, there are no relevant items in Sch 23, App 4, so the matters to be resolved in the Development Workshop are as set out in Sch 23, App 7, pt C. The relevant section of App 7, Pt C is reproduced below :-

Scope of Work	Information from BBS to SDS	Description of Design completion activities	1A	1B	1C	1D	2A	5A	5B	5C	7A	6	PB Comments
Trackform Design to be completed to IFC status, all design consents and approvals obtained and BBS will construct IFC Design			x	x	x	x	x	x	x	x	x	x	
Cross sections required to reflect BBS's selected Track System, including minimum track construction depths (top of rail to formation) with corresponding formation condition requirements.	SDS believe that loadings are required to enable them to complete this Design activity	Incorporates BBS selected Trackform on drawings and confirm minimum track construction depth and corresponding formation condition requirement as Pricing Assumption or at some other depth condition measure to be agreed/approved by SDS, BBS, tie and CEC											
			x	x	x	x	x	x	x	x	x	x	All Trackform design and development issues are to be the responsibility of BBS. PB provides the horizontal and vertical alignment design together with Civils infrastructure design within the Trackform envelope. All design within the envelope is assumed to be the responsibility of BBS. PB (SDS) will not engage in agreement and approval in relation to the BBS Trackform design.
			x	x	x	x	x	x	x	x	x	x	

In respect of trackform cross section, CEC agreement to the report conclusions is also required, as noted in the table above.

This report is structured as follows :-

- Identified misalignments are detailed in section 2
- Conclusions are scheduled in section 3
- The notes of the workshop, in minute form, are provided in section 4
- Supplementary information is provided as Appendices in section 5

## 2 MISALIGNMENTS

### 2.1 General

Misalignments arise due to differences between the Base Date Design Information and the Infraco Proposals, which are bound into the ETN Infraco Contract as Schedule 30. The Schedule of Infraco Proposals is essentially the same information as is contained in Sch 23, App7, Pt C, but repeated for each relevant section of the project. The table of Trackform misalignments for section 1A is reproduced below; the information is repeated for other sections.

Infraco Proposals and Requirements for Development and Finalisation of SDS Design					
Section 1A					
			Information from BBS to SDS	Description of Design completion activities	
<b>1A.1</b>	<b>Trackform</b>				
<b>1A.1.1</b>	Design to be completed to IFC status, all design consents and approvals obtained and BBS will construct IFC Design				
<b>1A.1.2</b>	Cross sections required to reflect BBS's selected Track System, including minimum track construction depths (top of rail to formation) with corresponding formation condition requirements.		SDS believe that loadings are required to enable them to complete this Design activity	Incorporate BBS selected Trackform on drawings and confirm minimum track construction depth and corresponding formation condition requirements Pricing Assumption or at some other depth condition measure to be agreed/approved by SDS, BBS, tie and CEC	

### 2.2 Misalignment No 1 : Rail Sections

Part of the Infraco Agreement Schedule Part 30; Section 3; Part 1 Trackwork superstructure Chapter 3.2 are following rail profiles: S49, 59 R2 and 60 R2. These rail profiles are not identical with the rail profiles as described within the SDS design.

SDS Design	Infraco Proposal
54 E3	49 E1
52 R2	59 R2
53 R2	60 R2

The misalignment is the different rail sections proposed.

## 2.3 Misalignment No 2 : Vibration Performance

2.3.1 Trackform : Infraco Proposals for embedded track are contained in Schedule 30, section 3.1. 1. Rheda City track, in two variants (City –C and City – D) is proposed. One of the attributes of this proven track system is the use of resilient pads under the rail foot which provide an overall rail stiffness in service of 60MN/m. This value is selected to provide an effective compromise between maintainability/serviceability of the track-road surface joint and vibration damping.

The reference design is based on a track stiffness of 30MN/m, which satisfies the requirements of the Project Noise & Vibration Policy in terms of ground transmitted vibration without the need for additional mitigation, but is not compatible with the use of Rheda City trackform and appropriate maintainability performance.

It is likely that the higher levels of ground transmitted vibration resulting from the use of a stiffer trackform will require additional vibration damping or isolation measures to be provided within the trackform. Outline proposals for a floating track system are identified in Schedule 30, section 3.1.1.6.

2.3.2 Trackform : Schedule 4, Pricing Assumption 29 states :-

“There shall be no special floating track measures required for vibration”.

2.3.3 Misalignments on Ground Improvement Layer are :-

- Infraco Proposals for track system require a rail stiffness of 60MN/m which is likely to result in ground transmitted vibration levels in excess of the Project Noise & Vibration policy, and thus in mitigation measures
- Effective mitigation will require the construction of floating track in certain areas
- Any mitigation by provision of floating track is excluded from current price.

## 2.4 Misalignment No 3 : Ballast Shoulder Dimensions

SDS trackwork design identifies a ballast shoulder width for straight tracks and horizontal radii larger than 2000 m of 375 mm. For radii of 2000 m and less, 450 mm ballast shoulder width is identified. SDS Design includes a very light twin block sleeper. It is not clear on which basis the ballast shoulder width is defined.

BSC (Siemens) proposal includes a much heavier mono block sleeper, and the corresponding ballast shoulder width is 400 mm. Standard sleeper distance is 750 mm in horizontal curves below 400 m the sleeper distance will be reduced to 600 mm.

The misalignment is the different dimensions of ballast shoulder width.

## 2.5 Misalignment No 4 : Ground Improvement Layer

### 2.5.1 Trackform : Infraco Proposals, contained in Schedule 30, section 3.1.1.2 are :-

“ The thickness of the concrete slab containing the sleepers will be 23 cm for Edinburgh Tram resulting in a total dimension of 40 cm from the top of rail to formation. The deformation or stiffness modulus at formation will be in off-street sections  $E_{v2}$  (stiffness) = 80MN/m<sup>2</sup> and in on-street section  $E_{v2}$  (stiffness) = 120 Mn/m<sup>2</sup>”

It is apparent from site investigation that this condition is unlikely to be satisfied, in many locations, by the existing formation at 400mm depth below top of rail. Therefore a Ground Improvement layer is likely to be required.

### 2.5.2 Trackform : Schedule 4, Pricing Assumption 11 states :-

“That in carrying out the Infraco Works in accordance with this agreement, it shall not be necessary to undertake any works outwith the “Earthworks Outline” (as defined in paragraph 3.6 below). The Infraco shall not encounter any below ground obstructions or voids, soft material or any contamination however the price for excavation and earthworks is inclusive of any differences between differing subsoils that may prevail within the Earthworks Outline.

Schedule 4, paragraph 3.6, states :-

“Earthworks Outline in this Schedule Part 4 means :

3.6.1 the finished earthworks levels and dimensions (prior to topsoiling) for the construction, where specified, of

- (a) ...
- (b) the underside of (i) trackslab, (ii) grasstrack concrete, and (iii) ballast;
- (c) ...

Schedule 4, Pricing Assumption 28 states :-

“Trackslab depth is 385mm with formation condition of 10% CBR”

### 2.5.3 Misalignments on Ground Improvement Layer are :-

- Infraco Proposals for track system require 400mm depth and formation stiffness of 120 MN/m<sup>2</sup> (~40% CBR)
- Price currently based on 385mm depth and 10% CBR
- Any improvement below underside of trackslab (i.e to formation) is excluded from current price.



## 2.6 Guided Busway Track

The Infraco Proposal for track on the Guided Busway is 'Direct Fixation Fastening track' direct fixed on top of the existing guided busway as noted in Schedule 30, section 3.1.2 (see sketch Guided Busway (1) of presentation at Appendix 2 of this document).

Schedule 30, section 3.1.2 states :-

"The existing guided bus way is assumed to be capable for a Tram system in terms of alignment, tolerances and bearing capacity. Adjustments in terms of grouting of the structure at its surface may become necessary to meet the alignment criteria. The selection of grouting material will be subject to approval. It is assumed that coring of fixings into the guided bus way concrete is possible."

It is possible that the structural condition and construction tolerances of the existing Guided Busway are not suitable for direct fixation track. The possible misalignment here is the confirmation that the guided busway is suitable to carry the Direct Fixation Track.

### **3 CONCLUSIONS**

#### **3.1 General**

Meeting outcome as follows

#### **3.2 Misalignment No 1 : Rail Sections**

Confirmation of no objection to the use of the proposed rail sections will be sought from Tie as part of System design development. This resolution has no cost implications and is not part of the Development Workshop Process.

Modification of existing drawings to incorporate Infraco trackform proposals (ie cross sections), will include identification of the rail sections. No additional instruction is required.

#### **3.3 Misalignment No 2 : Vibration Performance**

An instruction is required for SDS to investigate the consequences of the change of the trackform, identify any areas of non compliance with the Project Noise & Vibration Policy limits and design specific floating track mitigation measures as required.

In this case an instruction to BSC to provide and install this floating track mitigation is necessary.

#### **3.4 Misalignment No 3 : Ballast Shoulder Dimensions**

Confirmation of no objection to the proposed ballast shoulder dimensions will be sought from Tie as part of System design development. This resolution is not part of the Development Workshop Process.

Modification of existing drawings to incorporate Infraco trackform proposals (ie cross sections), will include ballast shoulder dimensions. No additional instruction is required.

#### **3.5 Misalignment No 4 : Ground Improvement Layer**

- To the extent that 120 MN/m<sup>2</sup> is not available at excavated formation level, improvement layer will be required.
- BSC/tie/CEC to establish parameters for improvement layer (void spanning, Utility Diversion backfill etc)
- SDS to design "menu" of improvement layers to be instructed on site as excavation proceeds.

- SDS design to include for vibration isolation if required (see item 3.3 above)
- Instruction to SDS to undertake redesign required.
- Implementation of any Ground Improvement Layer will be a Change, to be evaluated and instructed in accordance with the Contact Change Procedure.

### 3.6 Guided Busway Track

In abeyance, pending review of Guided Busway construction. To be resolved in a future issue of this report.

#### 4 DEVELOPMENT WORKSHOP NOTES



**REVIEW COMMENTS**

Package No.:		Package Title: Trackform		Status: IFC	Responded by:
Issued by: BSC		Date of Response:			
Date of Comments: 19 Nov. 2008		Doc. no.: DWRC-002		Ver. 2	
No.	Comment	Response			
	Doc. Ref.	Action			
0.1	Tie requests the identification of mis-alignments shall follow the Infraco Contract, Schedule 23, Appendix 4 an Appendix 7, Part C.				
0.2	Siemens gave a presentation of the track design as attached to these minutes: Comparison of different Trackforms of the SDS design and of the INFRACO agreement (see attached Presentation) Embedded Trackform SDS (2 stage concrete): overall construction depth 430 mm SDS (FB rails): overall construction depth 610 mm Rheda City "C": overall construction depth: 400 mm Rheda City "D": overall construction depth: 417 mm SDS "Grass Track": overall construction depth 480 mm Rheda City "Green": overall construction depth 466 mm SDS Direct Fixation: 200 mm plus 200 mm concrete slab BAM Direct Fixation: 189 mm plus concrete slab (thickness not defined) SDS Ballasted Track: includes concrete twin block sleeper BAM Ballasted Track: includes concrete mono block sleeper				
0.3	The target date for actions shall be one week after this meeting unless it is stated something else.				
General					

**REVIEW COMMENTS**

Package No.:		Package Title: Trackform		Status: IFC	Responded by:								
Issued by: BSC				Date of Response:									
Date of Comments: 19 Nov. 2008			Doc. no.: DWRC-002		Ver. 2								
No.	Doc. Ref.	Comment	Action	Response									
1.1		<p>Part of the Infraco agreement Schedule Part 30; Section 3; Part 1 Trackwork superstructure Chapter 3.2 are following rail profiles: S49, 59 R2 and 60 R2. These rail profiles are not identical with the rail profiles as described within the SDS design.</p> <table border="0"> <tr> <td>SDS Design</td> <td>INFRACO Agreement</td> </tr> <tr> <td>54 E3</td> <td>49 E1</td> </tr> <tr> <td>52 R2</td> <td>59 R2</td> </tr> <tr> <td>53 R2</td> <td>60 R2</td> </tr> </table> <p>Tie will confirm the proposed rail sections if BSC (Siemens) bring evidence via the traction power simulation that in particular the rail profile 49 E1 is sufficient. Tie asked furthermore about the Stray Current Corrosion Strategy, this is also part of the general approach of BSC.</p>	SDS Design	INFRACO Agreement	54 E3	49 E1	52 R2	59 R2	53 R2	60 R2	BSC		
SDS Design	INFRACO Agreement												
54 E3	49 E1												
52 R2	59 R2												
53 R2	60 R2												
1.2		Track resistivity and stray current requirements to be confirmed. Acceptance letter of this technical deviation from ER to be provided.	BSC										
		Part of the Infraco Agreement is the Stray Current Concept. Working groups are established to gain Utility provider's consent.	BSC										
1.3		<p>Noise and Vibration: Infraco Agreement includes a standard track system which is defined within Schedule Part 30. Vibration Measures are excluded (Schedule 30, Cl. 3.1.1.6). Reason: It was in tender phase not clear where mitigation measurements were necessary.</p>	tie										

**REVIEW COMMENTS**

Package No.:		Package Title: Trackform		Status: IFC	Responded by:
Issued by: BSC					Date of Response:
Date of Comments: 19 Nov. 2008		Doc. no.: DWRC-002		Ver. 2	
No.	Doc. Ref.	Comment	Action	Response	
		<p>In the meantime Rupert Taylor report is available, here 10 locations are identified, The information included within this report are not sufficient to design additional track improvements. Furthermore additional locations are under discussion.</p> <p>It is unknown if the values given in the Noise and Vibration Policy are achievable without additional measures.</p> <p>SDS Trackwork Specification (ULE90130-SW-SPN-00050) specified a track stiffness of 30 MN/m per m of rail for all trackform sections.</p> <p>This track stiffness results in a rail deflection of more than 2 mm under wheel passage. According to German light rail experience the track stiffness will be adjusted, that the rail deflection is less than 1.5 mm. The design of the Rheda City system is based on German light rail experience, therefore a track stiffness which results to a rail deflection of more than 1.5 mm is not a proven system. Presumably a track provided with 30 MN/m per metre of rail requires a high maintenance effort.</p> <p>BSC (Siemens) propose to prepare a track stiffness of 60 MN/m per metre of rail, according to German light rail experience.</p> <p>SDS is requested to bring evidence that the trackform described in their design fulfil the described performance under operational condition.</p> <p>TIE will instruct BSC (SDS) to investigate the effects of the change to the Rheda Track System in regard to vibration at all sections where Rheda will used and in particular at Vibration sensitive area's</p> <p>A possible mitigation measure could be the utilisation of a Getzner Sylomer mat beneath the concrete Rheda slab.</p>			

**REVIEW COMMENTS**

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Issued by: BSC				Date of Response:	
Date of Comments: 19 Nov. 2008			Doc. no.: DWRC-002		Ver. 2
No.	Doc. Ref.	Comment	Acción	Response	
1.5		<p>SDS trackwork design identifies a ballast shoulder width for straight tracks and horizontal radii larger than 2000 m of 375 mm. For radii of 2000 m and less 450 mm ballast shoulder width is identified with 450 mm. SDS Design includes a very light twin block sleeper. It is not clear on which basis the ballast shoulder width is defined.</p> <p>BSC (Siemens) proposal includes a much more heavier mono block sleeper, chosen ballast shoulder width is 400 mm. Standard sleeper distance is 750 mm in horizontal curves below 400 m the sleeper distance will be reduced to 600 mm. BSC(Siemens/BAM) has to provide evidence that the ballast shoulder is sufficient.</p>	Siemens/ BAM		





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Date of Comments: 19 Nov. 2008				Doc. no.: DWRC-002	Ver. 2
No.	Doc. Ref.	Comment	Action	Response	
1.9		<p>The Infraco Proposal for Trackform requires formation condition shall be <math>E_{v2}=120 \text{ MN/m}^2</math> (~40 % CBR) for on-street sections and <math>80 \text{ MN/m}^2</math> on off-street sections (Schedule 30, Cl. 3.1.1.2)</p> <p>Schedule 4, Pricing assumption 11 confirms 'That in carrying out the Infraco Works in accordance with this agreement, it shall not be necessary to undertake any works outwith the 'Earthworks Outline' (as defined in Schedule 4, cl. 3.6, 'Earthworks outline in this Schedule 4 means: cl. 3.6.1 the finished earthworks levels and dimensions (prior to topsoiling) for the construction, where specified, of (b) the underside of (i) trackslab, (ii) grasstrack concrete and (iii) ballast.</p> <p>Schedule 4, Pricing assumption 28 confirms that the basis of the current price is 'trackslab depth is 385mm with formation condition CBR 10% '.</p> <p>Where the condition <math>120 \text{ MN/m}^2</math> is not achieved an improvement layer is required. It can be omitted if testing indicates sufficient strength at the Trackform base. However this layer shall be designed for the entire tram line to reduce time loss for design and consent in case testing does require the improvement layer.</p> <p>Unreinforced concrete, geo textiles, fiber mesh or reinforced concrete are design alternatives initially proposed, SDS to confirm.</p> <p>Surveys indicated ground has voids or backfill wasn't done adequately and spanning is required. Also there are indications that utilities are not cleared.</p> <p>TIE accepted the difference between the Rheda ground soil requirements and the defined ground soil condition defined in the SDS design. TIE will instruct BSC (SDS) to perform the further design in regard the Rheda requirements, this means ground improvement to <math>120 \text{ MN/m}</math> for in street sections and <math>80 \text{ MN/m}</math> for off street sections.</p>	tie		

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No.	Doc. Ref.	Comment	Action	Response	
1.13		<p>The SDS drainage design for road incl. track drainage is with Scottish Water for approval. SDS proposed a spacing of 50-55m.</p> <p>Assumption of the Infraco Agreement (Schedule Part 30; Section 3 Technical Descriptions; Part 1 Track Superstructure, is a drainage box every 60 m.</p> <p>Difference of the total amount will be counted at the end of track installation and will be charged than.</p>	SDS		
1.21		<p>BSC originally offered 'Direct Fixation Fastening track' direct fixed on top of the guided busway (see sketch Guided Busway (1) of presentation).</p> <p>INFRACO agreement includes assumption as written below:                      "The existing guided bus way is assumed to be capable for a Tram system in terms of alignment, tolerances and bearing capacity. Adjustments in terms of grouting of the structure at its surface may become necessary to meet the alignment criteria. The selection of grouting material will be subject to approval. It is assumed that coring of fixings into the guided bus way concrete is possible."</p> <p>Based on the as-built documentation and our own on-site investigation we assume in the meantime, that the guided busway doesn't meet these defined requirements. Two options are possible now:                      Following further on the DFF solution than an improvement of the guided busway is necessary by preparing an additional concrete slab on top of the guided busway, DFF should than fixed on the concrete slab (see sketch Guided Busway (2) of presentation).                      Alternatively the guided busway could be fitted with Rheda City ((see sketch Guided Busway (3) of presentation)                      Both solutions are associated with additional costs compared to the INFRACO</p>	BSC		

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		Proposal., but from commercial point of view the Rheda solution is the more economic solution. BSC will provide a commercial proposal for the Rheda system.			
<b>Reports</b>					
2.1	Basic design report	Present preliminary design report will not be submitted formally to TIE, because the next design step "Basis of design report" is available in short term (First internal revision is already done). This report will be submitted official. Nevertheless a few things have been discussed and will be considered by BSC (Siemens/BAM) within the next design steps. SDS has given detailed comments on Preliminary Design Report.			
2.2		Tie raised the question whether alignment needs to be amended in regards to use standard turnout design. SDS confirmed and will review the design accordingly.	SDS		
2.3		Cl. 8.1, tie raised the question why the SDS designs specified cant in straight tracks and also negative cants in curves. SDS confirmed to review the design.	SDS		
2.4		tie raised the question whether BSC (Siemens/BAM) to confirm the current SDS groove drainage detail. BSC (Siemens/BAM) will stay with the SDS drainage design concept. Details of grooved rail will be sorted out in technical coordination meetings.	BSC		

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2.5		Specific basic design reports for each track form will be submitted by BSC (Siemens/BAM) and will provide details therefore (incl. radii to bend). Track forms are as follows: Rheda City C and D Direct Fixation Track Green Track Ballasted Track	BSC		
2.6		Within the preliminary design report a back to back dimension of 1386 mm is indicated based on the information given by CAF. Due to concerns of the S&C supplier and BAM engineering this topic is under discussion. TIE will kept informed about further development of this interface.	BSC		
2.7		Skip resistance of rails will not be lower than adjacent material.			
2.8		Rheda City C requires 4 cm of fill concrete to make up the reduced Trackform depth compared to current SDS design.			
2.9		There shall be free drilling zones for direct fixation those ensure that reinforcement doesn't get damaged or if then additional bars are provided. This clarification will be part of the specific design development workshops.			

Rev.	Date	Reference
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**REVIEW COMMENTS**

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Date of Comments: 19 Nov. 2008		Doc. no.: DWRC-002		Ver. 2	
No.	Doc. Ref.	Comment	Action	Response	
0	17 Nov. 2008	Meeting 17 Nov. 2008, 13:00 – 17:00, SDS-Participants: Dolan, Ennion, Kelly, BSC-Participants: Honeck, Wilutzky, Homsby, Geervliet, Meijvis, van Wingerden plus post meeting notes 1.4, 1.19 and 1.20			
1	19 Nov. 2008	Prepared as an Agenda for workshop 19 Nov. 2008.			
2	10 Dec. 2008	Meeting 19 Nov. 2008, 12:00 – 15:00, tie-Participants: McFadden, Biggins, Bateman, Murray, Murphy, TSS-Participants: Steel, SDS-Participants: Dolan, Kelly, Chandler, BSC-Participants: Honeck, Wilutzky, Rotthaus, Brueckmann, Geervliet, Meijvis, Wilken, Dieker, Brady			

Comments agreed

BB:	SPM:	CAF:	SDS:
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**Bilfinger Berger – Siemens – CAF Consortium : Edinburgh Tram Network  
Meeting Notes**

<b>Subject</b>	Roads and Trackform Development Workshop Issues	<b>Location</b>	Project Office
<b>Date</b>	5 <sup>th</sup> February 2009	<b>Time</b>	
<b>Attendees</b>	<b>Representing</b>	<b>Attendees</b>	<b>Representing</b>
Frank McFadden	Tie	Steve Reynolds	SDS
Robert Bell	Tie	Jason Chandler	SDS
Colin Brady	BSC	Alan Dolan	SDS
Stefan Rotthaus	BSC	Kate Shudall	SDS
Baltazar Ochoa	BSC		
<b>Distribution</b>	Attendees R Brueckmann M Wilken		

		<b>Action</b>	<b>Date</b>
<b>1</b>	<p><b>General</b></p> <p>The meeting was held to review the design estimates produced in response to Tie Instructions arising from the Development Workshop process for Roads &amp; Drainage and for Trackform (Tie letters no INF CORR 548 and INF CORR 547 respectively, both dated 18<sup>th</sup> December 2008), and further necessary work not covered by these instructions (see section 2.4 below).</p> <p>The meeting resulted in agreement to proceed to issue of instructions by Tie to implement the design activities (which relate to civil works scope only), and these notes will therefore be incorporated into the relevant Development Workshop Reports.</p>		
<b>2</b>	<p><b>Roads &amp; Drainage</b></p>		
2.1	Status of current documentation reviewed and format explained (see attached notes).	<b>Note</b>	
2.2	<p>Proposed process for road design is described on flowchart (attached). SDS to remove references to CEC on flowchart and reissue.</p> <p>CEC acceptance of process will be managed by Tie. Approval of detailed road design in different locations will be by discharge of conditions to existing approval, a full resubmission for approval is not required.</p>	<p><b>KSh</b></p> <p><b>FMcF</b></p>	<p><b>asap</b></p> <p><b>ongoing</b></p>
2.3	SDS confirmed that, if instructed, roads design will be undertaken by additional resources, that resource is available to meet the likely		

	programme and that resource will not be reallocated from other tasks already in progress.	JCh	Ongoing
2.4	<p>SDS explained the basis of their estimates no DCR 0126 and DCR 0140 (attached).</p> <p>DCR 0126 covers the work described in letter no CORR INF 548, but the bulk of the design work necessary is to assess test information for each specific area, select the appropriate solutions and produce construction drawings which provide clear direction for implementation, and will be updated by the site team to reflect as-built details. This scope is detailed in estimate no DCR140.</p> <p>BSC will collate the workscope to be instructed, including any necessary clarifications, and produce a draft instruction for Tie consideration.</p> <p>Tie agreed that the overall workscope covered by DCR126 and DCR140 is required, and will issue instructions accordingly.</p>	<p>CBR</p> <p>FMcF</p>	<p>w/c 9/2/09</p> <p>w/c 9/2/09</p>
2.5	<p>SDS will commence work on the overall scope prior to issue of formal BSC instruction, on basis of email confirmation from BSC that initial work carried out on this basis will be reimbursed in event instruction from Tie is not received.</p> <p>Initial priority is Princes Street, working eastwards from Charlotte Street junction. Assess existing rest information and advise any further testing required.</p>	<p>JCh</p> <p>ADo</p>	<p>6/2/09</p> <p>6/2/09</p>
2.6	Testing will be carried out in accordance with scope identified by SDS, but procured and managed by BSC. Testing is not included in existing SDS estimates, and BSC to advise costs when scope known. This will require additional instruction from Tie.	<p>CBR</p> <p>FMcF</p>	<p>asap</p> <p>asap</p>
3	<b>Trackform</b>		
3.1	<p>SDS estimate no DCR125 comprises three distinct work streams :-</p> <ul style="list-style-type: none"> <li>▶ Revision of existing drawings to incorporate Infraco trackform proposals</li> <li>▶ Production of a suite of ground improvement design solutions and Production of a construction methodology for the process of implementation of ground improvement</li> <li>▶ Analysis of vibration performance of Infraco trackform proposals</li> </ul>		

.../2

	and Production of vibration mitigation design solutions		
3.2	<p>Revision of Existing Drawings</p> <p>BSC/SDS agreed that the drawings would show all relevant details of the Siemens trackform, including any physical infrastructure provided for track drainage etc, and in particular details such as the road surface-track joint. The drawings will not be the record of EMC or stray current design, but will show relevant details (such as connection points) if any.</p> <p>Tie agreed to instruct the drawing revision scope as contained in estimate DCR125.</p>	<p><b>CBr/JCh</b></p> <p><b>FMcF</b></p>	<p><b>ongoing</b></p> <p><b>w/c 9/2/09</b></p>
3.3	<p>Ground Improvement Design</p> <p>Design Parameters are confirmed to be 120MN/m<sup>2</sup> on-street and 80MN/m<sup>2</sup> off-street, as shown on relevant drawings.</p> <p>Void spanning design criterion is confirmed as 1m span in any direction at any location, as advised by SDS.</p> <p>It was confirmed that no reinforcement is to be provided for stray current collection/containment. All reinforcement is to be protected against stray current corrosion, in same way as any other structural reinforcement.</p> <p>Tie agreed to instruct the ground improvement design scope as contained in estimate DCR125.</p>	<p><b>Ado</b></p> <p><b>Ado</b></p> <p><b>Ado</b></p> <p><b>CBr</b></p> <p><b>FMcF</b></p>	<p><b>ongoing</b></p> <p><b>ongoing</b></p> <p><b>ongoing</b></p> <p><b>ongoing</b></p> <p><b>w/c 9/2/09</b></p>
3.4	<p>Vibration Analysis and Mitigation Design</p> <p>SDS confirmed that the reference design, which does not include any specific mitigation measures other than the identified rail and coating) satisfied the requirements of the Project Noise and Vibration Report.</p> <p>SDS are to analyse the Infraco Proposal for trackform, and identify any exceedences, above the requirements of the Project Noise and Vibration Report. They are then to produce construction designs to mitigate these exceedences, such that the requirements of the Report are achieved.</p> <p>Tie agreed to instruct the ground improvement design scope as</p>	<p><b>Note</b></p> <p><b>Ado</b></p>	<p><b>ongoing</b></p>

.../3



	contained in estimate DCR125.	<b>FMcF</b>	<b>w/c 9/2/09</b>
	Tie advised that they might instruct further vibration mitigation in specific locations, to satisfy other undertakings. Tie to advise BSC when requirements are known.	<b>FMcF</b>	<b>ongoing</b>

**5 tie CHANGE ORDERS**



For The Attention of Colin Brady  
Project Director  
Bilfinger Berger Siemens CAF Consortium  
9 Lochside Avenue,  
Edinburgh Park,  
Edinburgh EH12 9DJ

Our Ref: INF CORR 548

Date: 18<sup>th</sup> December 2008

Dear Sirs,

**Edinburgh Tram Network**  
**“Infraco – Instructions arising from Trackform Development Workshop”**

Following our recent Trackform Development Workshop, we hereby instruct you to carry out the following;

**1 Ground Improvement to Trackform**

Revise existing IFC drawings to incorporate the trackform details as shown on drawing nos:-

Rheda City C: ETN(TRW=TD&ATB#55703

Rheda City D: ETN(TRW=TD&ATB#55702

Rheda City Green: ETN (TRW=TD&ATB#55701

Ballasted Track: ETN (TRW=TD&ATB#55704

Direct Fixation Track: ETN (TRW=TD&ATB#55705

Produce a suite of ground improvement design solutions for applicable ground conditions, to provide specified stiffness at underside of track slab as shown on the above drawings.

Generic ground improvement design solutions are to consider provision for spanning voids or local areas of weakness such as inadequate trench backfill. Produce a construction methodology statement describing the process of testing ground conditions at base of track slab, selection and implementation of any necessary ground improvement, to be utilised on site by Tie, BSC and SDS.

**2 Assessment of Vibration Mitigation Requirement**

Analyse vibration damping performance of basic Rheda City trackform system, using existing analysis of SDS trackform and Taylor report as a comparator.

tie limited

Citypoint 65 Haymarket Terrace Edinburgh EH12 5HD  
tel: +44(0)131 622 8300 fax +44(0)131 622 8301 web www.tie.ltd.uk  
Registered in Scotland No. 230949 at City Chambers, High Street, Edinburgh EH1 1YJ

CEC00771984\_0027

**2 Assessment of Vibration Mitigation Requirement (cont)**

If above analysis shows areas where specified vibration limits are likely to be exceeded, produce a suite of vibration mitigation design solutions (assumed to be based on utilisation of Getzner Sylomer mat, or similar, as proposed by Siemens), specifying chainages, extent and construction details, including mat density, details of transitions from normal trackform to vibration mitigation trackform and sealant detail at road surface level.

Please forward an Estimate for these works in accordance with clause 80.4 and on receipt we will review and issue a change order.

Yours faithfully

  
Steven Bell  
Project Director – Edinburgh Tram

KRu, - 1 Challenge Prelims adjustment  
2 Issue to SDS a.sap

INSTE 269



Billing - Berger UK Limited ED1	
Date Received	16 FEB 2009
File Name	Scanned
Author	
Distribution	

For The Attention of Colin Brady  
Project Director  
Bilfinger Berger Siemens CAF Consortium  
9 Lochside Avenue  
Edinburgh EH12 9DJ

Our Ref: INF CORR 756

Date: 13<sup>th</sup> February 2009

Dear Sirs,

**Edinburgh Tram Network – Infraco  
Trackform Development – Design Only  
Change Order Number 20**

We refer to your letter dated 6<sup>th</sup> February 2009 reference 25.1.201/BOc/1510 enclosing your Estimate associated with additional design works arising from the Trackform Development Workshop


In response please find attached Change Order Number 20 for gross £371057.96 (Breakdown attached).

Please acknowledge receipt of this Change Order and confirm the timescales to implement this additional work with specific reference to Leith Walk and Princess Street.

Yours faithfully



Steven Bell  
Project Director – Edinburgh Tram

the CHANGE ORDER	
Project:	INFRACO
Date:	13th February 2009
Change Estimate No:	
Change Order No:	20
Change Description:	Change Arising from Trackform Development Workshop
Change Value	£371057.96 (Excl VAT)
	Final value of Consortium Prelims to be reviewed on completion of the Contract Head Office Overhead and Profit to be determined in accordance with Clause 4.7.2 of Schedule Part 4
Scope of Works:-	Additional works arising from the Trackform Development Workshop As detailed within SDS Change Estimate (SDS Change Estimate Number DCR01215, copy attached)
Relief required from compliance with Infraco obligations under the contract:-	None
Programme Impact and required Extension of Time:-	None
Impact on Performance:-	None
Any additional Consents, Land Consents and/or Traffic Regulation Orders:-	None Required
Any amendment or revision required to existing Consents, Land Consents and/or Traffic Regulation Orders:-	None Required
Any new agreements with third parties:-	None Required
Any amendment required to the Agreement or the Key Subcontracts as a result of this Change:-	None
Proposed Method of Delivery of this Change:-	Method Statements / Risk Assessments to be submitted for approval.
Any Changes required to the terms of the Agreement and/or the SDS Contract:-	None
Effect on Milestone Payments:-	BSC to update Milestone Schedule
Authorised:	Date: 13/2/09
Title/Name: DENNIS MURRAY	Signature: 
Received:	Date:
Name:	Signature:

Item	Description	Qty	Unit	Rate	Amount
A	SDS Estimate Costs			Sum	£380.00
B	SDS Estimate DCR0125 attached			Sum	£315,683.00
<b>Total</b>					£316,063.00
	Consortium Overheads Prelims	*	7.4% 11.20%	£316,063.00	23388.66 £35,899.66
	Sub-total				£354,462.66
	Head Office Overheads and Profit	*	10.00%	£316,063.00	£31,606.30
<b>Total</b>					£371,057.96 £383,066.96

\* Consortium Prelims to be reviewed on completion of the contract  
 \* HO Overheads & Profit to be determined in accordance with clause 4.7.2 (Schedule 4)

<b>Project:</b>	Edinburgh Tram Network		
<b>Date:</b>	16 <sup>th</sup> January 2009	<b>Issue:</b>	1
<b>Change Estimate Number:</b>	DCR0125		
<b>Change Notice Number</b>	RDC076		
<b>Change Estimate Title:</b>	Instructions arising from Trackform Development		

**Change Estimate Description:**

**Item 1 of Change – Ground Improvement to Trackform:**

Incorporation of Trackform design into SDS current trackform drawings (SW-DRG-00400, 00500 and 00600 series). No meetings are included in this cost.

**Structures Assumptions regarding trackforms excluding Direct Fix**

- Assume **stray current** protection is to be provided in the concrete within the Rheda track form, except where a lower reinforced concrete slab solution is included within the formation improvement layer.
- Other assumptions are described in text below.

**Proposed Approach**

1. PB to formalise design parameters with a view to seeking agreement from all parties, resulting in the certification of the design by both designer and checker to accept design liability.
2. Production of Approval in Principle Document and discussions with CEC TAA, to cover all solutions. This will be the "construction methodology statement" required by the scope. Checker involvement required to agree principles at outset.
3. Production of Specification for testing. Checker involvement required to agree principles at outset.
4. Assume results are presented by contractor to SDS in an agreed format. Assumed that the testing house can process the test data in such a way that the actual Ev2 value encountered is computed and presented. Checker involvement required to agree principles at outset. Ultimately, onus on Contractor to deliver required results.
5. SDS appraisal of results.
6. Assume **generic** solutions are provided for ground improvement to allow for both void spanning and non-void spanning alternatives appropriate to the perceived level of risk and consequence of voids forming in a particular section of the track. Exact areas of void spanning requirements to be agreed.

Assume "Void spanning requirement" to be in City centre. No void spanning for out of town areas – subject to confirmation & agreement.

**Generic** solutions to comprise of dig out existing material and replace with varying solutions. Assume 3 no solutions in the following manner:

Notionally granular fill - 1 drawing per Rheda type  
Reinforced grid in fill - 1 drawing per Rheda type  
RC Slab - 1 drawing per Rheda type

Potentially up to 15 drawings.

1 drawing with tabular look up to provide solution based upon results.



Details of the proposed generic solutions to be developed are:

**Track Foundation:** SDS will produce a schedule of formation treatment solutions that will form the basis of the selection of the improvement layer as the construction progresses. SDS will prepare a testing methodology to be adopted during construction. This will be used to determine the appropriate improvement layer where necessary from the schedule of treatments. Design schemes to provide either  $E_{v2} \geq 120$  MPa at U/S of track slab for Rheda City-C & D systems, or  $E_{v2} \geq 80$  MPa for Rheda Green or ballasted track, where  $E_{v2}$  is stiffness in second loading cycle of plate bearing test.

- For soil at formation level capable of providing  $E_{v2} \geq 45$  MPa, provide a design for a capping layer of well graded granular material. This layer will incorporate a basal layer of geogrid to span incidental soft spots or voids. Where substantial weaknesses such as poorly compacted service trenches are encountered these will be subject to local treatment below the capping layer with a weak foamed concrete infill that will be wider and shallower than the original trench.
- For soil at formation level not providing  $E_{v2} \geq 45$  MPa, provide a design for each of three ranges of stiffness ( $E_{v2} \geq 30$  MPa,  $E_{v2} \geq 20$  MPa,  $E_{v2} \geq 10$  MPa) using a dual layer capping incorporating an upper layer of well graded granular material and a lower layer of ground improved in situ by a soil mixing treatment. Two thicknesses will be provided for the upper layer of the capping, one with and one without a basal layer of geogrid. In this case the geogrid is not required to span soft spots or voids as the ground improvement process should mitigate the effect of such defects in the formation. Instead the geogrid is to provide an alternative form of construction that will use a lesser quantity of imported material.
- Where there is a perceived requirement to provide a more robust solution to address void spanning capability, a reinforced concrete slab solution will be developed, capable of spanning a notional void of 1m x 1m.

Design a construction quality control programme using dynamic plate bearing test apparatus.

7. IDC - assume two rounds of IDC, as all interfaces are involved.
8. Category 2 check to confirm detail of solution (principles already independently checked).
9. Design and check certs against AIP.
10. IFC drawings and specification.

#### Structures Assumptions regarding trackforms - Direct Fix

It is assumed that the track form shown on the bridge decks will require reinforcement (there is reference to a reinforcement free drilling zone).

It is assumed that adjustments will need to be made to the "Direct Fixation Track" concrete outline shown in order to meet the design loading assumptions for the bridge decks, as currently designed, such that bridge deck re-design and independent checking is avoided.

It is assumed that BSC (Siemens) will provide Earth Bonding requirements in line with their design approach.

It is assumed BSC will provide locations of pre-drilling zones, and base plate details including bolts. It is assumed that Structures will receive this via the SDS Permanent Way Team.

#### Proposed Approach

The following approach is proposed:

1. Determine standard solutions in section. Assume 3 no. standard solutions - full slab width with side upstands, full slab width with central upstand, and small L's with side upstand. Determine standard length solution which all parties agree will not stiffen deck (approx 3m). Build in height flexibility within reinforcement detailing to account for difference between finished track levels (which are often on a vertical curve), and top of deck which is on an inclined plane.
2. Provide concrete outline and rc details for standard sections. Assume BSC (Siemens) will provide Earth Bonding requirements in line with their design approach. Provide concrete outline and rc details for each of the three solutions. Assume 3 no. drawings.
3. Gain agreement in principle to the cross sections from BSC, supplemented with informal discussions with CEC TAA for information.
4. Cat 1 check of detail prior to use in multiple structures.
5. BSC to provide locations of pre-drilling zones, and base plate details including bolts, which Structures assume will be received via SDS Permanent Way Team. Assume reinforcement in track upstands to be locally displaced at bolt locations.
6. Assume bridge drawings will be updated to include a cross reference to the number of standard upstand units required, via a tabulated schedule.
7. Determine "specials" required for each bridge deck - typically 2 no. per track, i.e. 4 no. per bridge, at deck ends. Actual number of specials will be determined by bridge deck geometry and complexity (eg skew, large movements). Assume additional concrete outline and rc detail drawings will be required for each bridge to portray details of specials. 8. Determine any specials required above run-on slabs, and provide concrete outline and rc details. Up to 4 no. per bridge.
9. Determine bars to be cast into deck to accommodate direct fix track, and reschedule decks accordingly.
10. IDC against Permanent Way discipline
11. Submit revised and new drawings and reinforcement schedules to BSC for approval.
12. Issue for Construction.

**Item 2 of Change – Assessment of Vibration Mitigation Requirement:**

Re-running the model with the revised stiffness value. Estimating and reporting the impacts of the change on the Noise and Vibration. Defining any mitigation required as a result of the updated model outputs. Up to 2no. meetings are included in this cost.

If above analysis shows areas where specified vibration limits are likely to be exceeded the scope of this change includes the design of mitigation measure which are assumed to be the introduction of a vibration damping mat.

**Basis for the Change Estimate:**

RDC076 and tie letter dated 18<sup>th</sup> December 2008

**Schedule Impact:**

To be confirmed upon instruction of Change



**CHANGE ESTIMATE  
SDS CONTRACT**

**Cost Impact:**  
 Preparing Estimate: £380.00 This amount to be paid irrespective of work being instructed  
 Change Work: £316,075.50

**Other Impacts/Issues:**  
 This Change will not utilise any staff which are currently being utilised under Design and Construction Support.  
 This Change includes for 2no. meetings regarding Vibration only.  
 In preparing the estimate SDS have considered amendments required to the SDS outline design for direct fix Trackform on structures and also the additional work to complete the fully detailed drawings for the Trackform component selection as proposed by BSC.

<b>SDS Authorisation</b> (print name and function below)		<b>Date:</b>	29/1/09
Jason Chandler Project Manager		<b>Signature:</b>	
<b>BSC Authorisation</b>		<b>Date:</b>	
Change cancelled <input type="checkbox"/>	SDS to revise Estimate <input type="checkbox"/>	Refer to tie board <input type="checkbox"/>	Prepare Change Order <input type="checkbox"/>
Colin Brady		<b>Signature:</b>	



Bilfinger Berger-Siemens- CAF Consortium

Our ref: 25.1.201/JHi/1647

BSC Consortium Office  
9 Lochside Avenue  
Edinburgh Park  
Edinburgh  
EH12 9D  
United Kingdom

18 February 2009

Parsons Brinckerhoff  
CityPoint  
65 Haymarket Terrace  
Edinburgh  
EH12 5HD

Bilfinger Berger Civil-EDI			
Date Sent	9 FEB 2009	BY	
File Number			
Action			
Distribution			

Phone: +44 (0) 131 452 2800

For the attention of Jason Chandler

Dear Sirs,

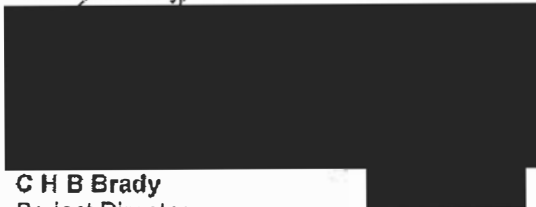
**Edinburgh Tram Network Infraco**  
**INTC 269 –Changes arising from Trackform Design**  
**Your Reference DCR0125**

We refer to your Estimate Reference DCR0125 issue 1 dated 16 January 2009 relating to the design portion of changes arising from Trackform Design.

We hereby authorise you to proceed with the design works as detailed in the SDS Design Change Estimate and enclose our Design (Client) Change Order No DC0-018.

Please acknowledge receipt of this Change Order and confirm the timescales to implement this additional work with specific reference to Leith Walk and Princess Street.

Yours faithfully,



**C H B Brady**  
Project Director  
Bilfinger Berger Siemens CAF Consortium



## Design (Client) Change Order

<b>Project: Edinburgh Tram Network</b>		<b>Date: 17 February 2009</b>
<b>From: Bilfinger Berger Siemens CAF Consortium</b>		<b>Ref. Number: DCO-018</b>
<b>To: Parson Brinckerhoff - Jason Chandler</b>		
<b>INTC No. 269</b>	<b>Change Estimate No.</b>	<b>DCR0126</b>
<b>Scope of Change</b>	Incorporation of Trackform Design into SDS current trackform drawings (SW-DRG-0400,00500 and 00600 series)	
<b>Reason for Change</b>	Change arising from Trackform Development Workshop	
<b>Change Value (Programme Implications are Included in the Value)</b>	Change £ 315,683.00	
<b>Relief required from compliance with SDS obligations under the agreement</b>	None	
<b>Impact on Performance of the Services</b>	None	
<b>Impact on Master Programme and Programme</b>	None	
<b>Any additional Consents, Land Consents and/or Traffic Regulation Orders</b>	None	
<b>Any amendment required to the Agreement or the Key Subcontracts as a result of this Change</b>	None	
<b>Any new agreements with third parties</b>	None	
<b>Proposed Method of Delivery of this Change</b>	Additional Design Resources	
<b>Effect on Milestone and / or lump sum Payments</b>	Lump Sum Payment	
<b>Proposals to mitigate</b>	None	
<b>Period for Delivery of Change Order</b>	TBA	
<b>Authorised:</b>	<b>Date: 17 February 2009</b>	
<i>ew</i> <b>Title/Name: Stefan Rolthaus - Engineering Manager</b>	<b>Signature:</b>	
<b>Received:</b>	<b>Date:</b>	
<b>Name:</b>	<b>Signature:</b>	

## 6 APPENDICES

## 6.1 Development Workshop Process

Extract from Schedule 23, clauses 4.6, 4.7. 4.8

4.6 tie warrants that it has received a report from the SDS Provider (annexed at Part B of Appendix Part 7) setting out the misalignments between the Deliverables completed prior to the date of this Agreement and the Employer's Requirements and that it has issued initial instructions (in the form of the letter annexed at Part A of Appendix Part 7) to the SDS Provider in relation to addressing all such misalignments. Upon completion of the work entailed to resolve the misalignments, the SDS Provider confirms to tie and the Infraco that such Deliverables shall be consistent with the Employer's Requirements.

4.7 As soon as reasonably practicable, the Parties shall commence and expeditiously conduct a series of meetings to determine the development of the Infraco Proposals and any consequential amendment to the Deliverables (the "Development Workshops"). The matters to be determined at the Development Workshops shall be those set out in the report annexed at Part C of Appendix Part 7 (the "Misalignment Report"), together with any items identified as "items to be finalised in the SDS/BBS alignment workshops" in Appendix 4 to be dealt with in the following order of priority and objective unless otherwise agreed:

- 1 Roads and associated drainage and vertical alignment with the objective of minimising the extent of full depth reconstruction for roads thus minimising cost and construction programme duration
2. Structures value engineering, including track fixings to structures with the objective of enabling BBS to realise the Value Engineering savings for the structures identified in Schedules 4 and 30 of the Infraco Contract (Pricing and Infraco Proposals respectively)
3. OLE Design with the objective of identifying and agreeing the actions, responsibilities and programme to enable Infraco to implement their proposals for OLE as identified in the Infraco Proposals
4. Trackform with the objective of completing an integrated design to enable BBS to implement their proposals for trackform
5. Sub-station buildings with the objective of resolving the misalignment between Infraco Proposals and SDS Design with the minimum of changes to accommodate the Infraco Proposals for substations.

The following to be reviewed at the end of the Development Workshop to identify any issues arising from the above items:

1. Earthworks

2. Landscaping
3. OLE Foundations
4. Alignment
5. Site Clearance
6. Tramstops
7. all other items in the Misalignment Report together with any items identified as "items to be finalised in the SDS/BBS alignment workshops" in Appendix 4.

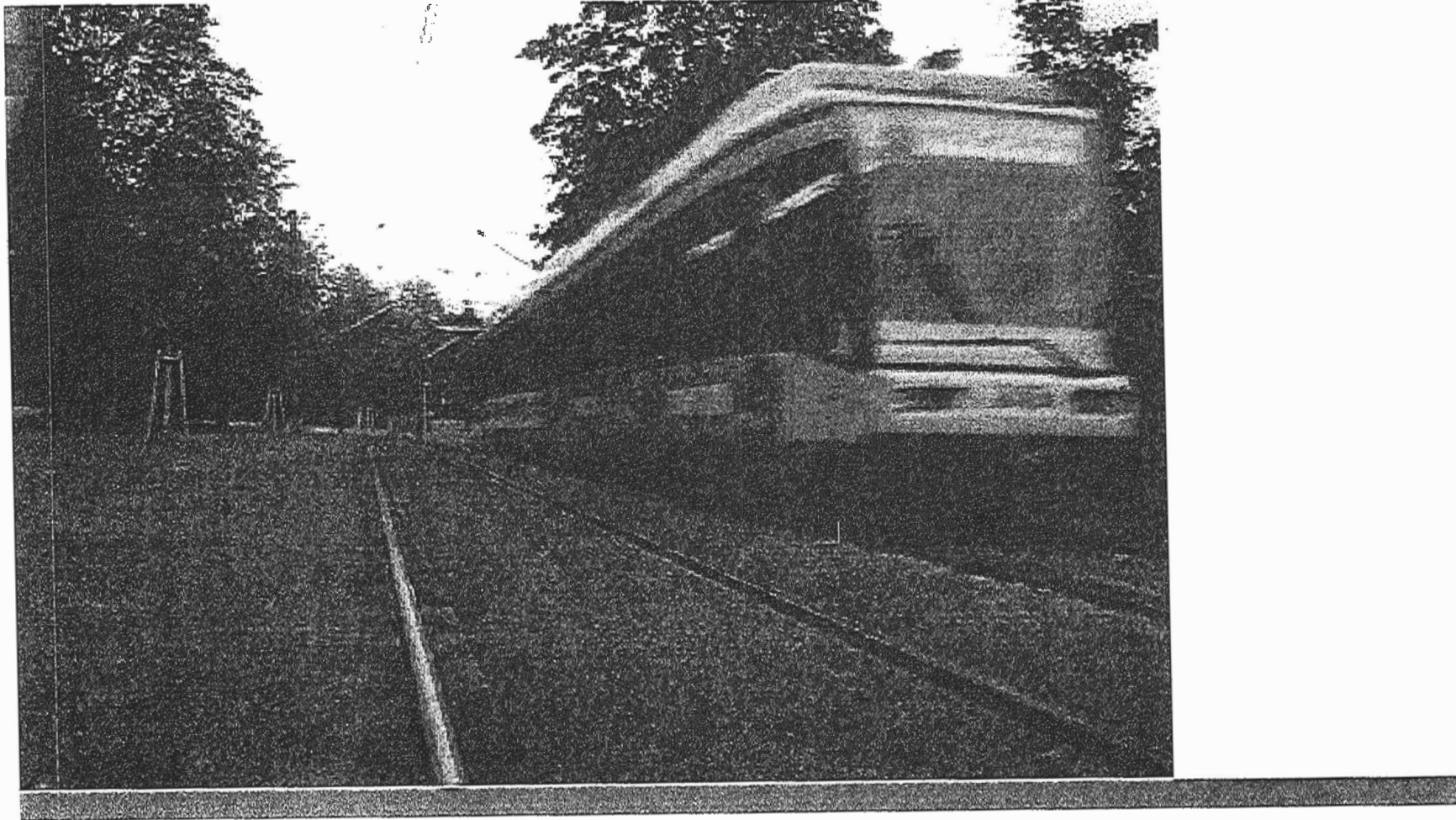
At the Development Workshop, the Parties shall also develop a strategy for co-operation between the SDS Provider and the Infraco to manage design development and the necessary interface between the Infraco's design and the design developed by the SDS Provider.

- 4.8 The product of the Development Workshops shall be a report signed by each of the Parties to detail the conclusions in respect of each matter and the payments to be made to the SDS provider in respect of the work to be carried out by the SDS Provider as a result of the conclusions set out in the report. Any consequential tie Change Orders or instructions shall be appended to such report as and when the same are issued. tie shall pay the SDS Provider for the work required for the Development Workshop on an hourly rate basis in accordance with the hourly rates set out in Appendix Part 8 and the SDS Provider agrees that the Infraco shall not be liable to make such payments to the SDS Provider. For the avoidance of doubt, the Infraco and tie agree that any amendment to the Deliverables completed prior to the date of this Agreement as set out in this report will be a Mandatory tie Change under the Infraco Contract, and a Client Change under the SDS Agreement.



## 6.2 Trackform Presentation : Presentation

# Edinburgh Tram Network Comparison Trackforms SDS - BSC



# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

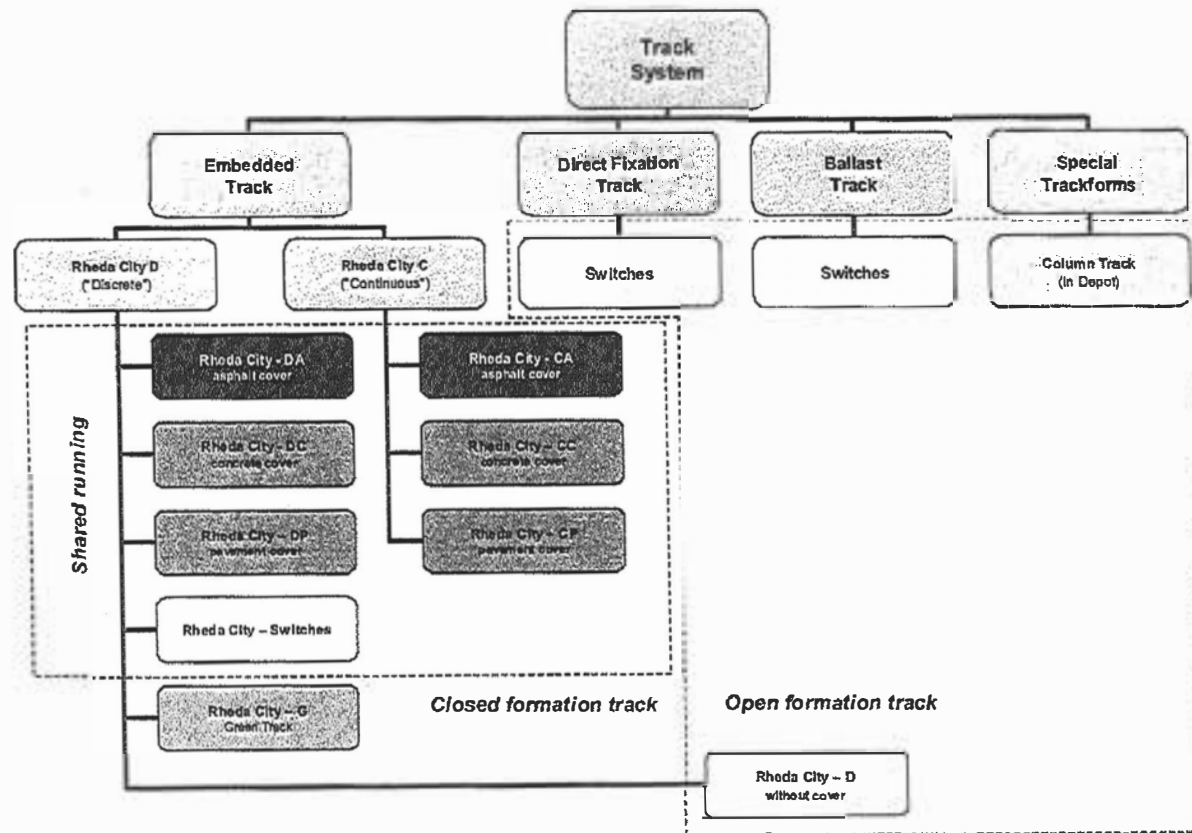
## Introduction

1. Track System Breakdown Structure BSC
2. Embedded Trackforms
  - SDS Trackforms
  - Rheda CITY “C” track
  - Rheda CITY “D” track
  - Rheda CITY “Green” track
3. Direct Fixation Trackforms
  - SDS Direct Fixation Track
  - BAM Direct Fixation Track
4. Ballasted Trackforms
  - SDS Ballasted Track
  - BAM Ballasted Track
5. Guided Busway options (3)

# Edinburgh Tram Network Comparison of Trackforms SDS – BAM

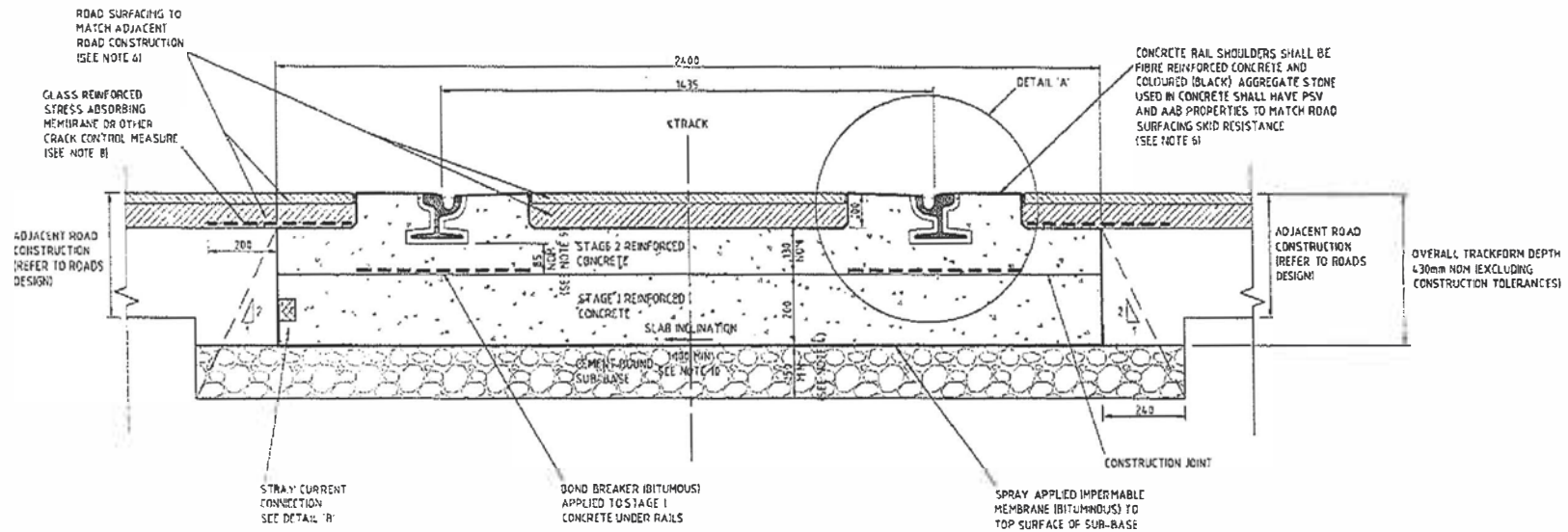


## 1. Track Breakdown Structure BSC



# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

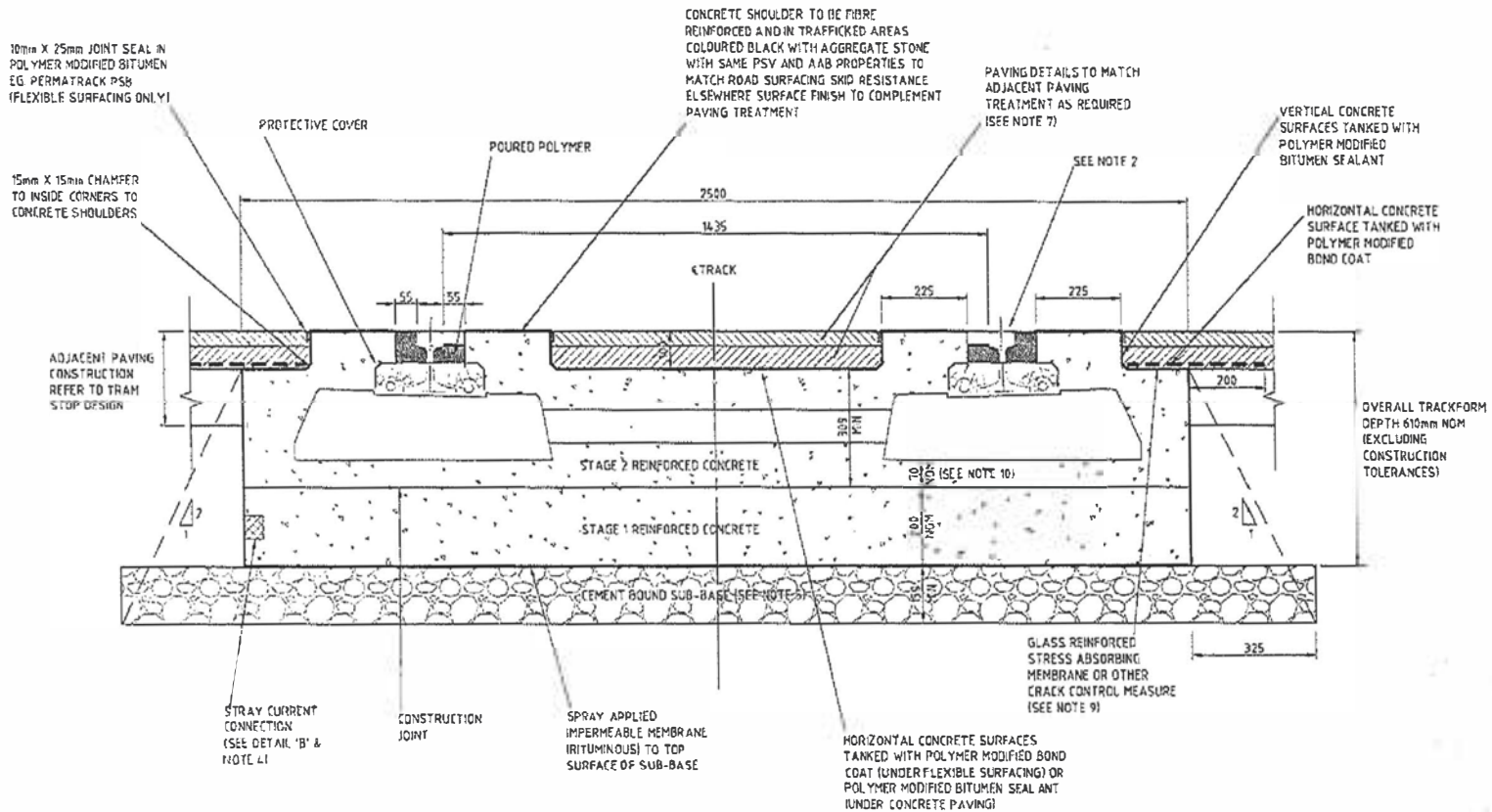
## 2. Embedded Trackforms – SDS (2 stage concrete)



# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

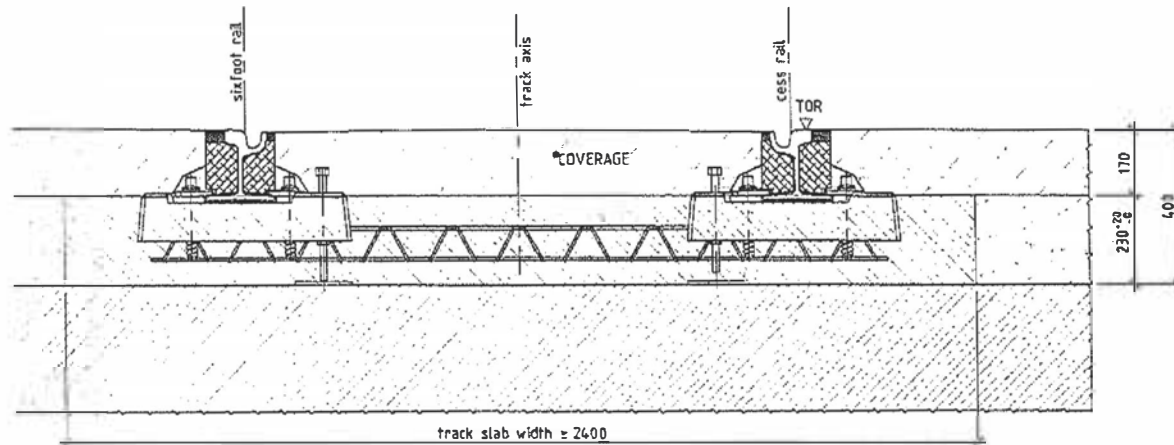
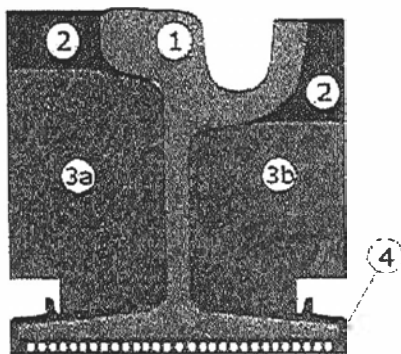
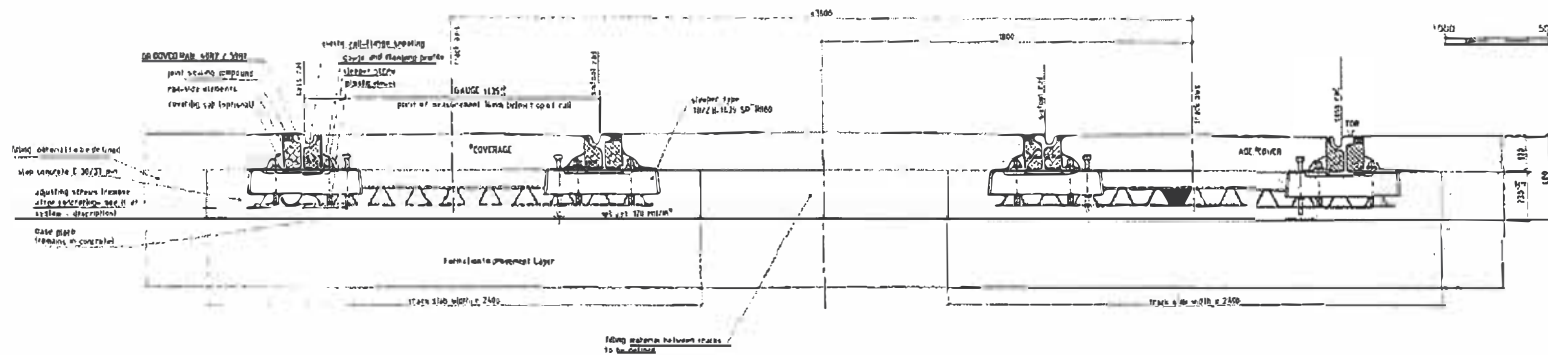


## 2. Embedded Trackforms – SDS (FB rails)



# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

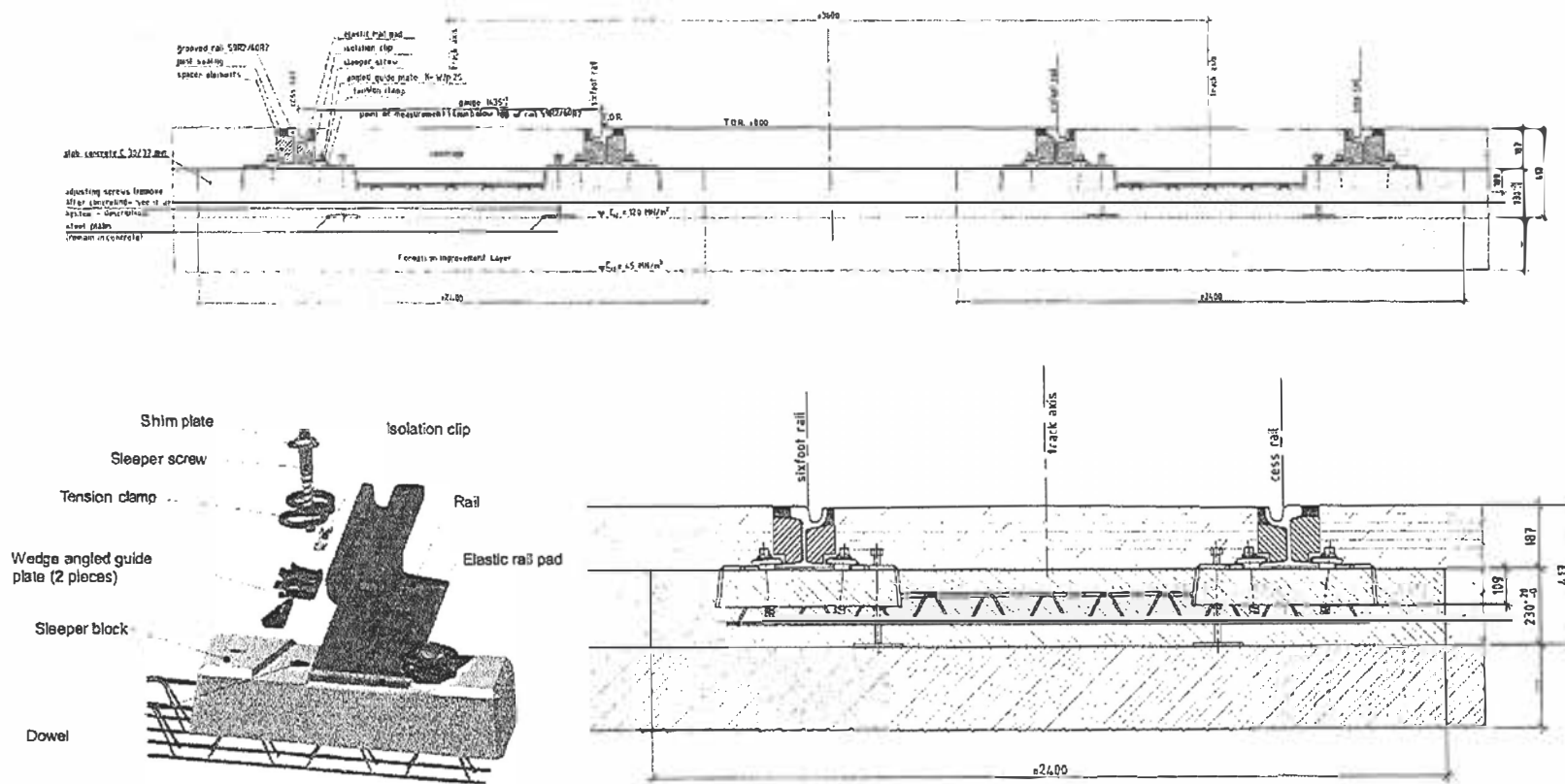
## 2. Embedded Trackforms – Rheda CITY “C” (R≥100m)



19 Nov 2008: F&M Rail rev

# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

## 2. Embedded Trackforms – Rheda CITY “D” (R<100m)

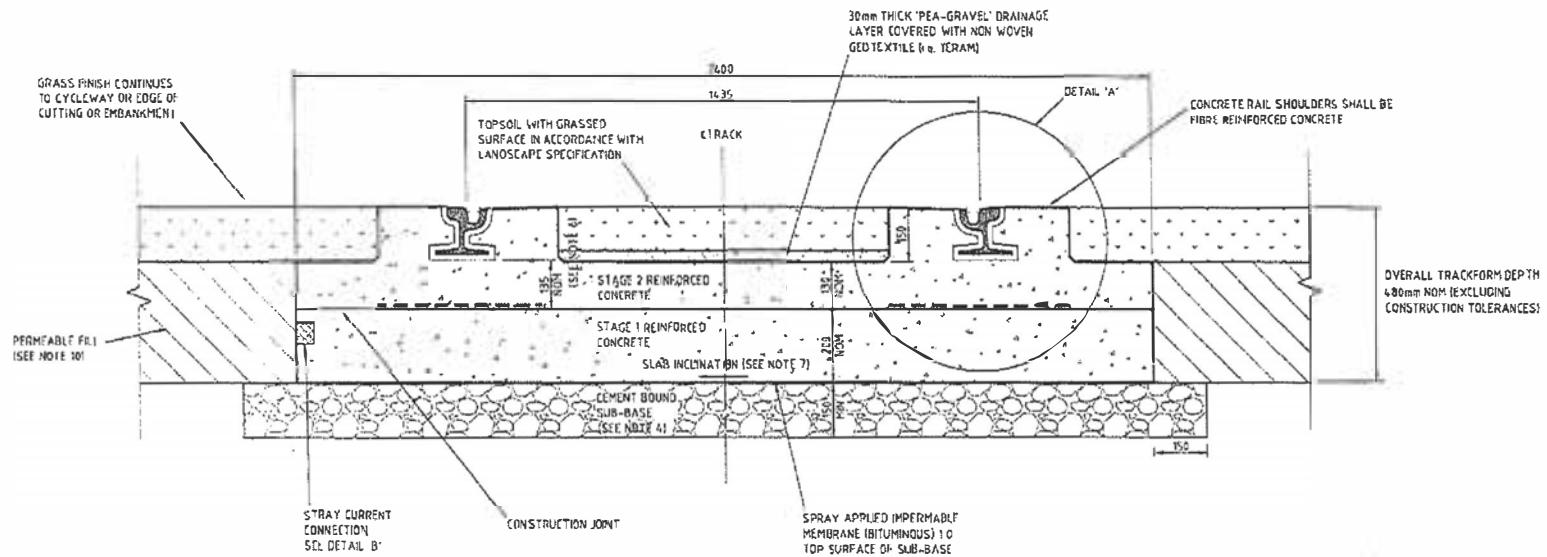


19 Nov 2008 SAM Rail by



# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

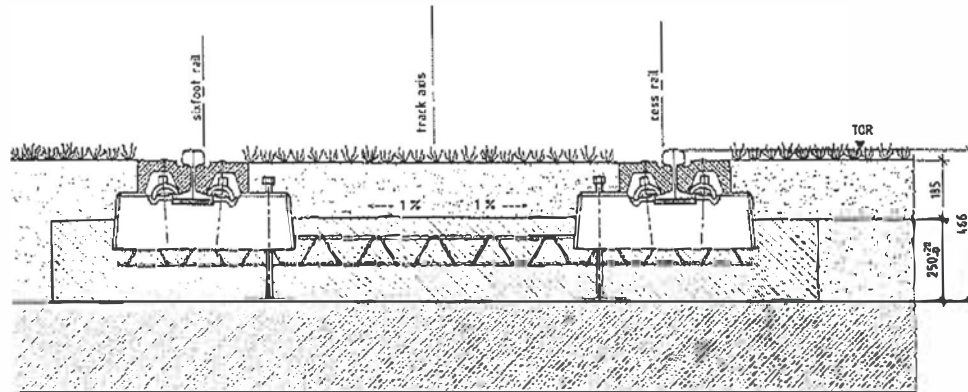
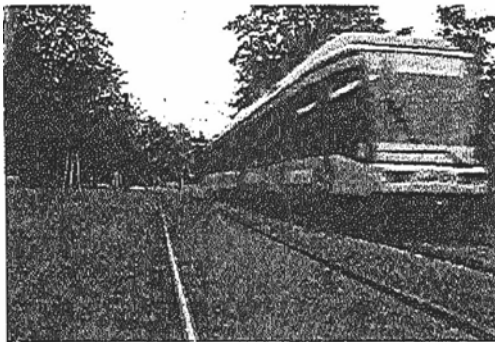
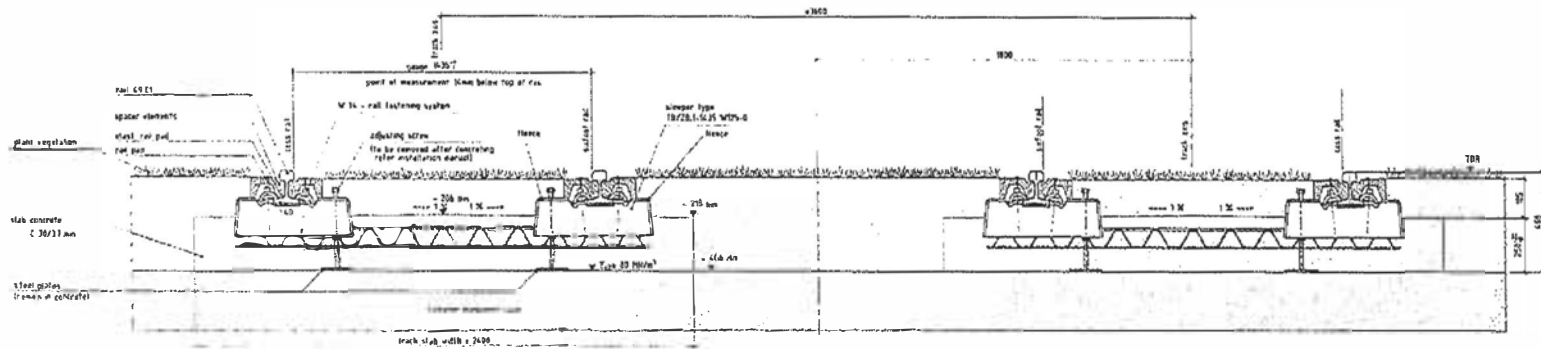
## 2. Embedded Trackforms – SDS “Grass Track”



# Edinburgh Tram Network Comparison of Trackforms SDS – BSC



## 2. Embedded Trackforms – Rheda CITY “Green”

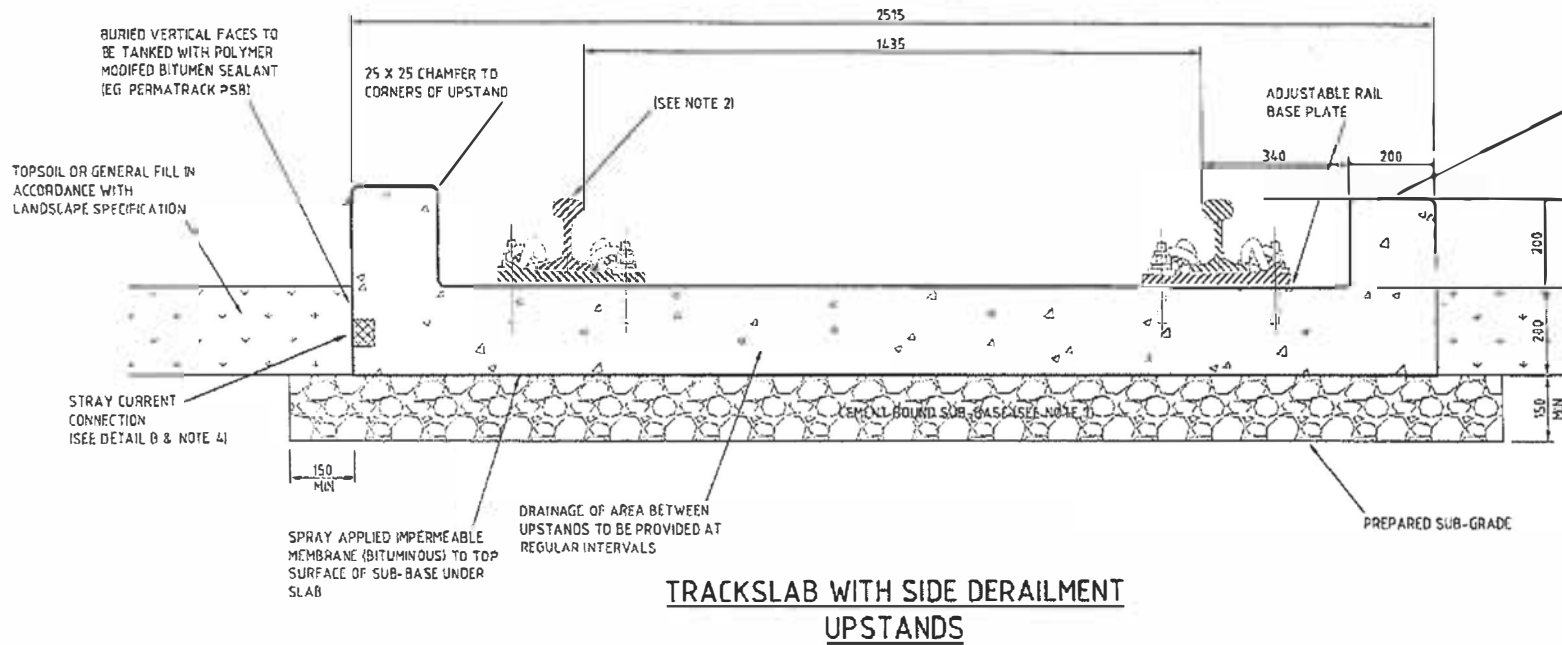


19 Nov 2008 BAV Rail by

# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

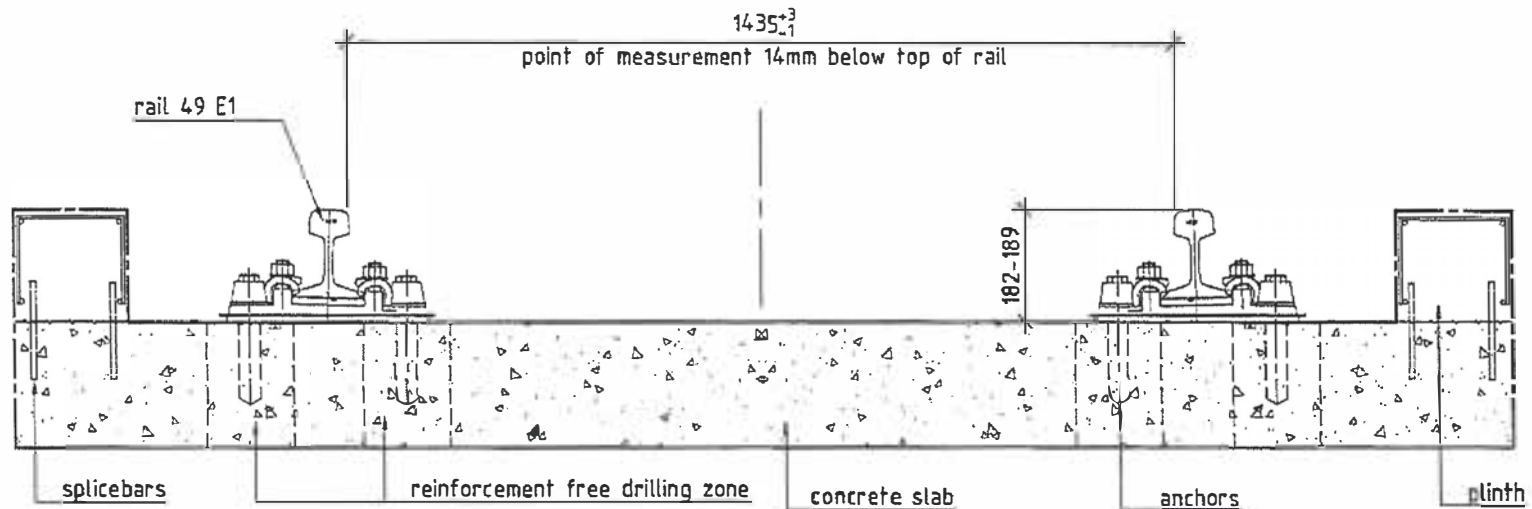


## 3. Direct Fixation Track – SDS



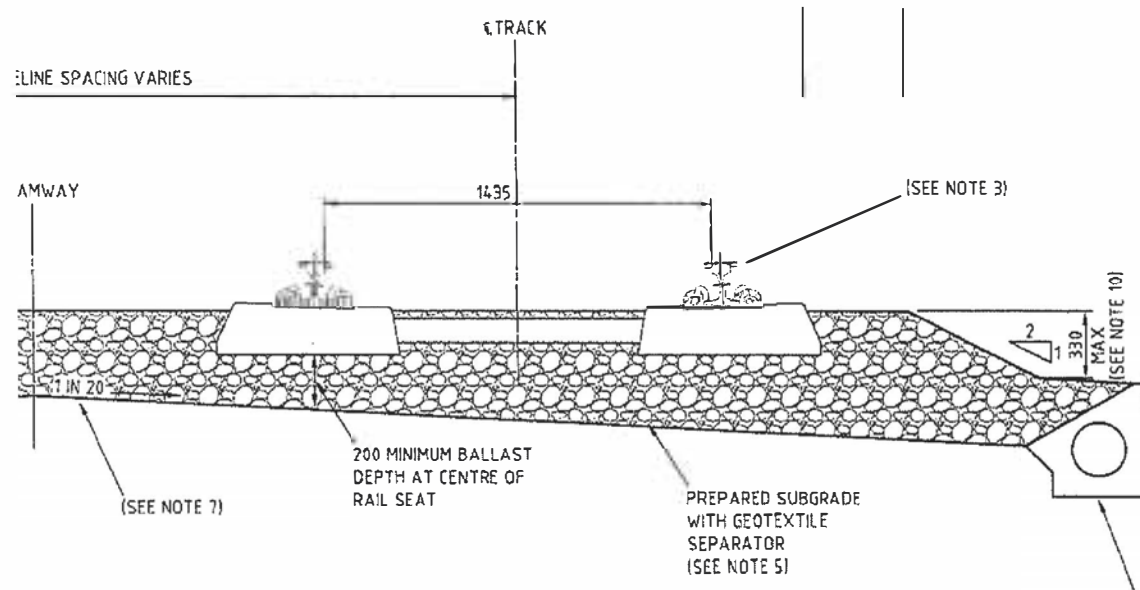
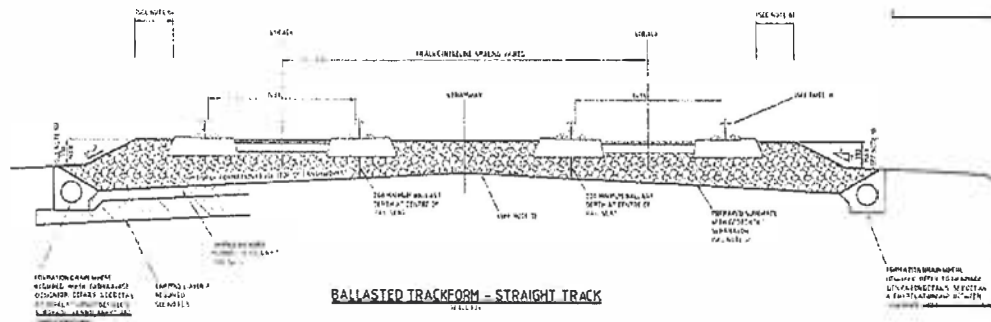
Edinburgh Tram Network  
Comparison of Trackforms SDS – BSC

3. Direct Fixation Track – BAM



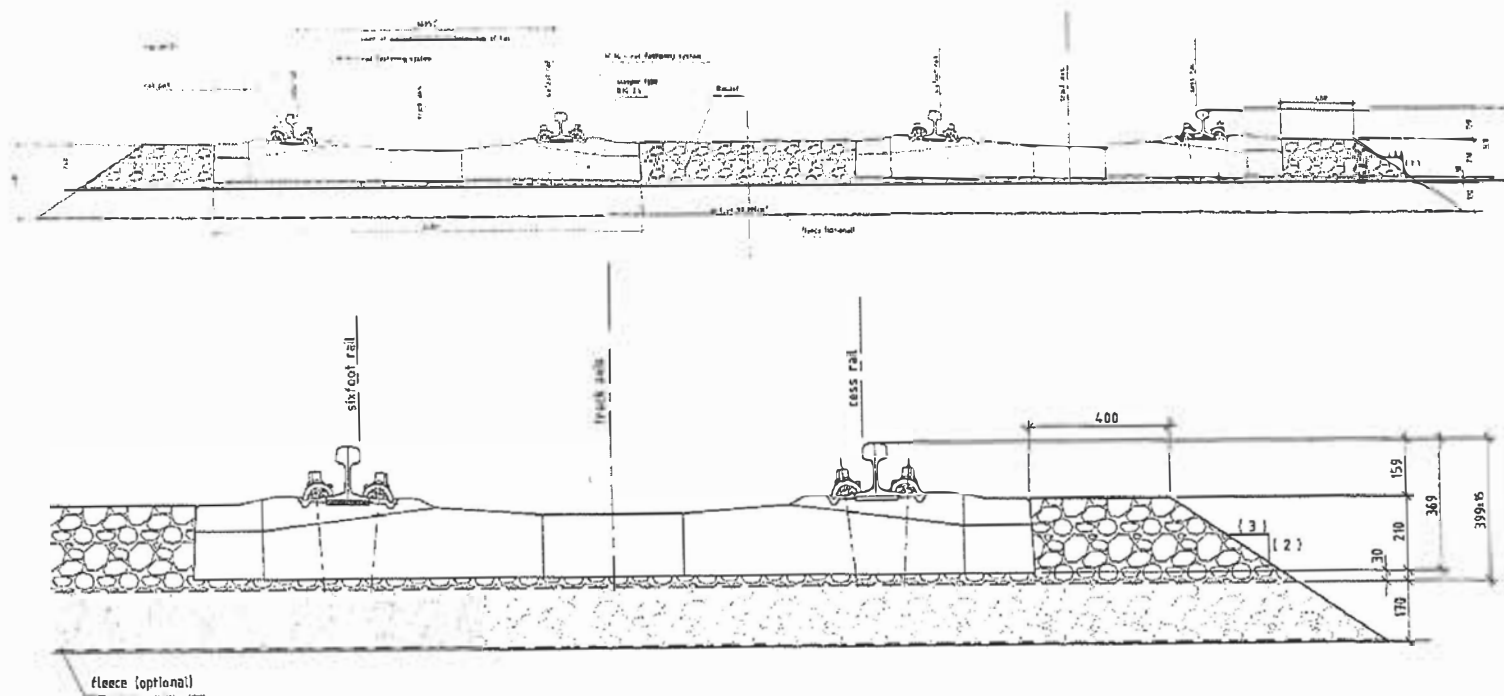
# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

## 4. Ballasted Track – SDS



# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

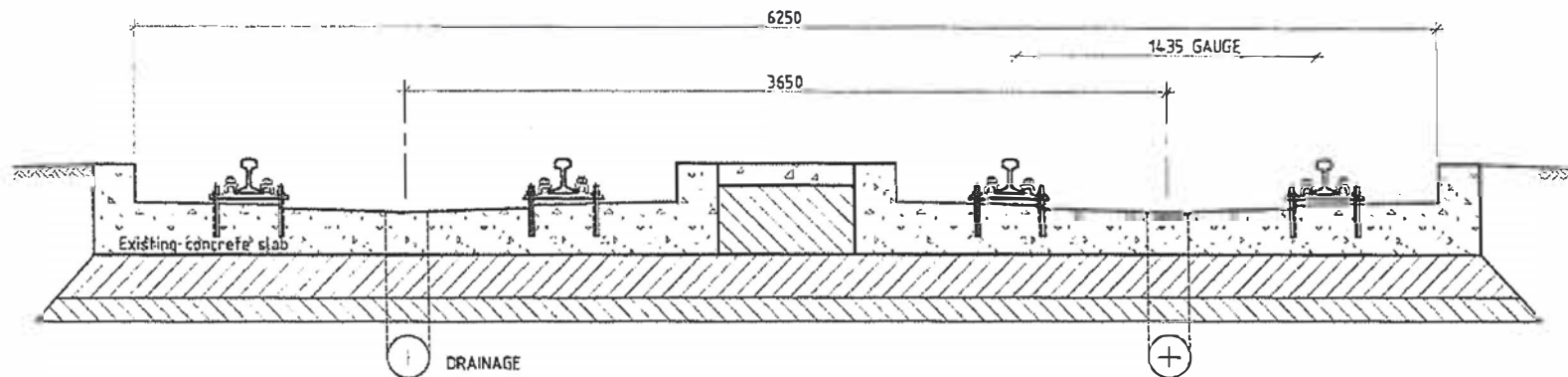
## 4. Ballasted Track – BAM



18 Nov. 2008 BAM (Rail) 1/1

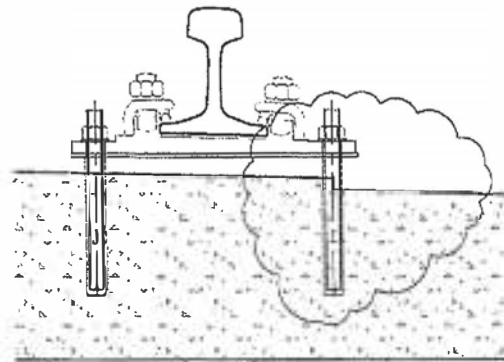
# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

## 5. Guided Busway (1) BSC Proposal



Direct Fixation on Guided Busway

( scale 1:20 )

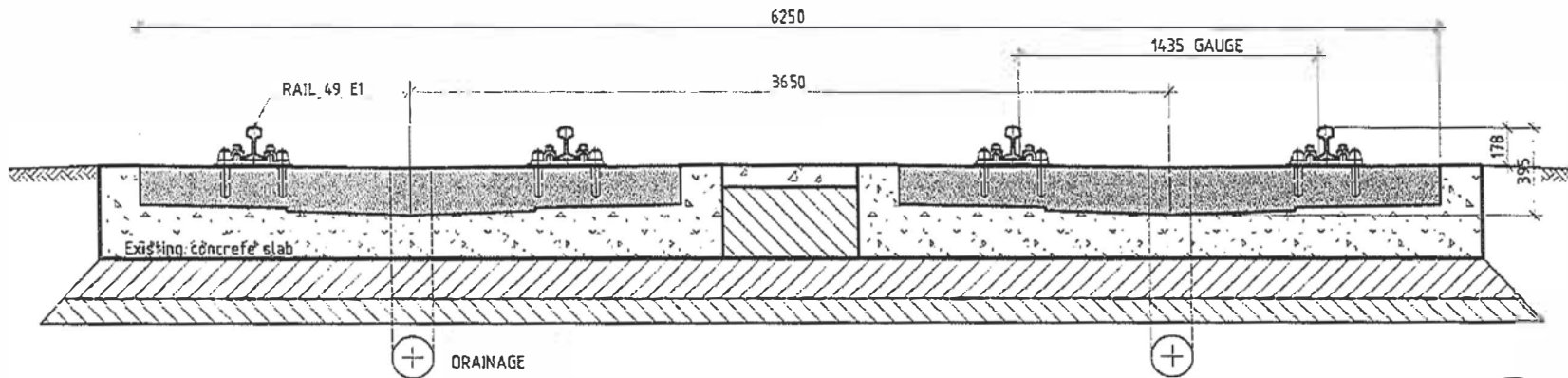


Detail drilling hole location

( scale 1:5 )

# Edinburgh Tram Network Comparison of Trackforms SDS – BSC

## 5. Guided Busway (2)



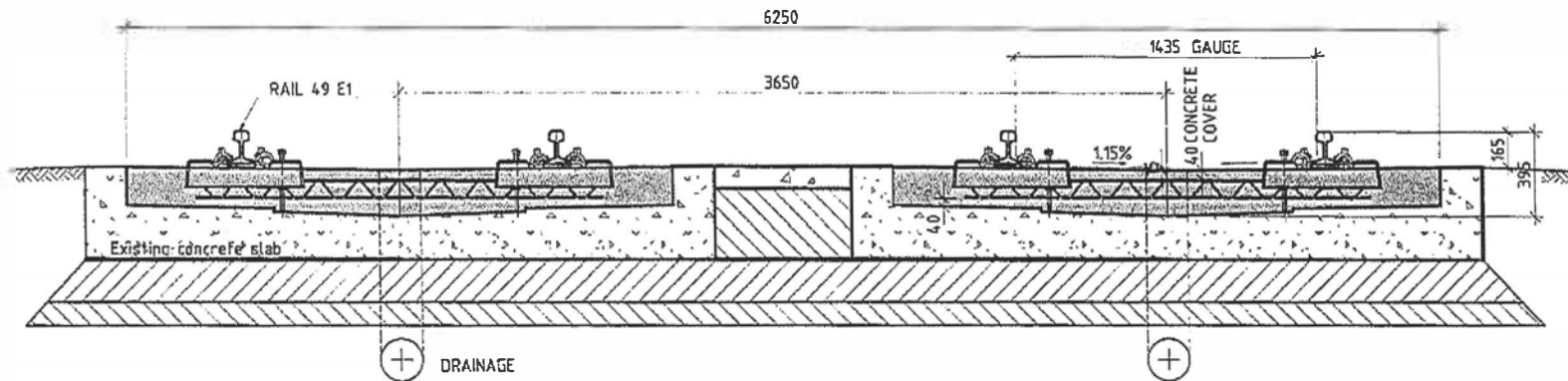
Direct Fixation Track on Guided Busway

0.2  
18-11-08



Edinburgh Tram Network  
Comparison of Trackforms SDS – BSC

5. Guided Busway (3)



Rheda City D on Guided Busway

Bi-block sleeper TB/ZB-1435 W49

-3  
11-07-08

