THE DESIGN OF ST JAMES INTERCHANGE

by

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- The Aberdeen Association of Civil Engineers

PRESENTED TO

- The Institution of Civil Engineers
  The Institution of Structural Engineers
  The Institution of Highways & Transportation
  at the Moir Hall, Mitchell Theatre, Glasgow.
  Thursday 14 January 1993

- The Institution of Highways & Transportation
  at Lochardil House Hotel, Inverness.
  Tuesday 26 January 1993

- The Institution of Civil Engineers
  Graduates, Students and Associate Members
  spring conference
  University of Stirling
  Saturday 30 January 1993

- The University of Strathclyde
  Geotechnical & Highways Division Post Graduates January 1993
  Glasgow
  Thursday 18 March 1993

INTRODUCTION

Chairman, Ladies & Gentlemen, many thanks for inviting me to talk to you this evening about the Design of St James Interchange. This is, of course a major Design and Construct Project involving several parties so, I should first of all, ~~wish~~ like to thank the Roads Directorate of the Scottish Office and the Director of Roads Strathclyde Regional Council, the Joint Promoters of this Project, and Balfour Beatty the Contractor, for giving me their permission to make this presentation.

I also acknowledge the assistance of the many individuals in SRC Roads, Balfour Beatty and SWK who have allowed me to make use of their excellent slides and photographs of the Works under construction.

Most of all, I wish to thank my colleagues at SWK for making such a success of the design and for their assistance in preparing material for this talk.

I shall be talking to a large number of slides which will illustrate the design problems, concepts and realisation much more effectively, I trust, than a monologue from a prepared script.

The subject matter will be from the specific point of view of the Designer and will cover:-

- The ~~Tender~~ selection ~~process~~ of Tenderers
- The Tender and Contract requirements for Design/Construct
- How we responded to those requirements
- The Tender assessment methodology
- The design of - Structures
  - Geotechnics
  - Roads
  - Drainage etc

and will conclude with illustrations of construction to date.

Needless to say, I shall be concentrating on broad concepts rather than minute technical detail.

I shall, of course, be pleased to answer questions at the end, but am pleased to advise you that the Scottish Office, the Director of Roads SRC and Balfour Beatty as well as the SWK design team are all represented here this evening and will, I am sure, be pleased to respond to any questions directed specifically to them or to which a response from them might, in my view, be appropriate.

WHY ST JAMES' INTERCHANGE?

- This has more to do with Chairman Bill Stewart than perhaps he realises.
- The interchange takes its name from St James Park through which it passes. The park was formerly a race course.
- Paisley has three Patron Saints : St Mirrin, St James & St Mary.
- St Mirrins tomb is in Paisley and St James the apostle's in Santiago de Compostella on the North coast of Spain.
- The Fitzalans of Dol in Brittany would certainly have made the pilgramage to Santiago de Compostella for they took St James as their Patron.
- After 1066 and all that, the Fitzallans settled in Shropshire and later at Renfrew, where they became stewards to the Scottish Kings.
- Walter Fitzalan became the High Steward and, in 1163 founded the Monastery of St Mirrin, St James and St Mary over the tomb of Mirrin with the help of Benedictine Monks from Shropshire and Clugny in France.
- In 1315, after Bannockburn, the 6th High Steward married Marjory daughter of Robert Bruce and their son eventually became King Robert Stewart the founder of that dynasty.

- During the major building phase Abbot Morrow was in charge while John Morrow of Paris was the master mason or civil engineer/architect. This was, of course, in the more leisurely days before fee competition and design/construct.
- It is recorded that the first monks arrived in 1169, having been misinformed as to the State of Progress of the works, and had to be put up in temporary accommodation for 2 years before they were able to take partial possession.

The Design of St James Interchange

Slides : Data

No	Title	Ref
10	Project Signboard	StJ7
11	BB/SWK Signboard	S5/15
12	Site Plan	S11/1
13	Layout : Existing	StJ4
14	Traffic : Existing	StJ4
15	Layout : Proposed	StJ4
16	Traffic : Proposed	StJ4
17	Aerial : from S.E.	StJ7
18	" : from E	BB
19	Programme : to Award	StJ4
20	The Construction Process (Cartoon)	StJ4
21	Heath Robinson Bridge (Cartoon)	StJ4
22	Aerial : Woodside 2	StJ4
23	" : Renfrew 1	StJ4
24	" : Tuen Mun Road	StJ6
25	" : Tsuen Wan Bypass	StJ4
26	" : P1/P2 Interchange	StJ4
27	Data Supplied by SRC	StJ2
28	Main Differences from ICE 5th Edition	StJ2
29	Settlement Criteria	StJ2
30	NCE Cover : Ground Conditions (Cartoon)	StJ6
31	Ground Investigation	StJ2
32	Outline Structural Proposals to Client	StJ2
33	Photomontages **[moved to between 53 + 54]**	S11/17
34	Pre-tender Submission	StJ2
35	Tender Submission	StJ2
36	Tender Assessment	StJ2
37	Works by SRC	StJ2
38	Project Organisation	StJ2
39	Site Organisation	StJ2
40	Overall Programme	StJ4
41	Monks - deadline (Cartoon)	StJ4
42	Design Programme	StJ4
43	Structures : Layout	StJ4
44	" : Deck Type	StJ4
45	" : Section	StJ4
46	" : Steel Plate Dimensions	StJ5
47	" : Articulation	StJ4
48	" : Piers : Basic Shapes	StJ4
49	" : Piers : Holfords	StJ5
50	" : The Final Choice	StJ4
51	" : Pier	StJ5
52	" : Viaducts : W	StJ4
53	" : Viaducts : E	StJ6
33	Photomontages*	
54	" : Alterations to Geometry	StJ4
55	" : Abutment	StJ5
56	" : Piled Foundations	StJ5
57	" : Route A Wall	StJ5
58	" : Route B Piled Wall	StJ5

Slides : Data

No	Title	Ref
59	Services	StJ4
60	Drainage	StJ4
61	Railway Bridge : Plan	StJ6
62	" " : Sections	StJ6
63	Geotechnical Works : Plan	StJ6
64	" " : W Embankment	StJ5
65	" " : Route D. W Embankment	StJ6
66	" " : Section 1	StJ5
67	" " : Section 2	StJ5
68	" " : Route B. E Embankment	StJ5
69	" " : Section 1	StJ5
70	" " : Section 2 & 3	StJ5
71	" " : Instrumentation	StJ6

Slides : Photographs

No	Title	Ref
81	Railway Bridge : from E - Piles etc	StJ7
82	" " : " W - Piers	StJ7
83	" " : " S - Beams	StJ7
84	" " : " Viaduct - Copes etc	StJ7
85	" " : " N.W. - Deck Waterproofing	SRC4
86	" " : " S.E. - P6 Parapet	SRC1
87	" " : P6 Parapet	StJ1
88	" " : Approaching Viaducts	StJ1
89	Geotechnical : Band Drains - Ramp B	StJ7
90	" : Piled Embankment - Ramp D	StJ5
91	" : Drainage Blanket + Band Drains - Ramp C	S6/18
92	" : Benching for widened embankment - Ramp F	StJ7
93	" : Horizontal Profile Guage	S4/13
94	" : Piled Embankment - W Abutments	SRC2
95	" : " " - E Abutments + Ramp F Wall	BB
96	" : -ditto- (later)	StJ7
97	" : E Abutment - Ramp A	StJ7
98	" : E Abutment - Ramp B	SRC1
99	Piles : Driving	StJ7
100	" : Slip Coating	StJ1
101	" : Footing	S3/7
102	" : Congested Footing	S3/8
103	" : Trimming	StJ7
104	Aerial : from N	StJ7
105	" : Over Paisley Rd	StJ7
106	Piles : W Abutments	StJ1
107	" : " "	StJ1
108	Piers : Viaduct A - at skew	DRW7
109	" : Column Formwork	S6/32
110	" : Paisley Rd	StJ7
111	" : Crossbeam Reinforcement	StJ6
112	" : " Formwork	S6/5
113	" : Tall	SRC4
114	" : Pair	SRC4
115	" : Skew Pair	SRC4
116	" : Small	SRC4
117	Aerial : from E	BB
118	" : from W	StJ7
119	Beams : First Lift	BB
120	" : Splice at Pier	S1/7
121	" : Bearing	S1/10
122	Beams : At skew	SRC4
123	" : From S at Paisley Rd	S1/1
124	" : Splice 1	S2/12
125	" : Splice 2	S4/15
126	" : At Railway	SRC1
127	Deck : Steel fixing	SRC1
128	" : Shear Connectors etc	S5/2
129	" : At Pailsey Rd	SRC4
130	Aerial : From E. Deck On	StJ7
131	" : " " " " Close Up	StJ7
132	Skew : Traffic Management	SRC3

Slides : Photographs

No	Title	Ref
133	Skew : Beam Lift 1	S1/6
134	" : " " 2	S1/13
135	" : " " 3	S1/9
136	Skew : Man at Bearing	S2/16
137	" : Beams Placed	S2/8
138	" : At Night	StJ6
139	" : Complete	S4/6
140	Deck : From E at Paisley Rd	S1/5
141	" : From W at Railway	S4/8
142	" : Lift at Ramp D 1	SRC2
143	" : " " " " 2	SRC2
144	" : " " " " 3	SRC2
145	" : At Railway 1	SRC2
146	" : " " 2	SRC3
147	Deck Slab : Construction	SRC3
148	" " : " Copes	StJ1
149	Viaduct A : At W Abutment	SRC3
150	" " : From W Abutment	SRC3
151	Photomontage : From W Abutment	BB
152	" : From S	BB
153	Viaducts : From S 1	StJ1
154	" : " " 2	StJ1
155	" : " " 3	StJ1
156	BB/SWK Signboard	BB
157	Santa	StJ7
158	Aerial. From SW. Nov 92	StJ7
159	" From NW Nov 92	

GENERAL

- **People**

Engineer	SRC Director or Roads - D Carruthers
Engineers Representative	SRC Roads - John Ferguson
Purchasers Resident Representative	SRC Roads - Bill Shearer
BB Site Agent	Shaun Nesbitt
SWK Designers Site Representative	Alex Bickett

- **Tenderers**
  - initially 13
  - interviewed 6
  - Tenderers 3

- **Variations**
  - very few
  - white lines and signs

- **Was this fastest way to procure?**

  Doubtful but was dictated by SRC decision to procure land during tender period.

- **Cheapest way to procure?**

  Perhaps in the short term but high tendering costs must work through to higher tenders in the end.
  Additional risk being taken by Contractors must have a cost.
  Promoters must be pleased with fixed price. No claims even if fixed price is higher.

- **What are feelings about Design Contruct?**

  Promoter - Likes it, fixed price, less discord/hastle, no claims

  Contractor - Testing the water. They will need to get risk pricing and design costs understood and correct.
  In theory they can input into the design.
  In practice at present this is more like fiddling with detail after design is done.
  May need long term relationship with a few designers.

  Consultant - Will respond to the challenge, but status being eroded to that of sub contractor. There is a need for the new contractual relationship between contractor and consultant to be clearly set out to protect both.
  Fees are likely to be squeezed further.
  Consultants may be the biggest losers in the long term especially if they are forced down the no win no fee route.

- **Quality Assurance**

  - If something is found to be incorrect BB are informed.
  - BB or their sub contractor then issue a Departure Notice.
  - This goes to DSR asking for concession or approval of remedial works or request for designed remedials.
  - On completion of remedials, if required, BB resubmit to DSR for signature then to PRR for endorsement.

- **Variations**

  - If ordered by Purchaser, he pays.
  - If required by Contractor to suit his purposes or to deal with a problem arising, contractor pays.
  - If change to checked/approved design is required, SWK/BB decide if new design/check certificate is required. If so that procedure is adopted before issuing drawings for construction. If a minor matter, drawings are changed and issued for construction.

VIADUCT DESIGN

- Length of Viaduct a trade-off between deck cost and wall + BASP cost.
- Span length was partly decided upon by the obstacles that had to be crossed, partly by relative cost of deck and substructure.
- Contractor was unclear about which pile system was to be adopted and this made comparison of deck and substructure costs difficult.
- Graphs can be drawn of cost v span for substructure and deck - where they cross give optimum span. This was attempted.
- In the end, there were two spans of 63 and 67m which couldn't be avoided. These in conjunction with relative cost of substructure and other factors resulted in standard spans of about 50m.
  Variations in span were then accommodated by varying flange widths and thicknesses rather than depth.
- Plate sizes were give to nearest mm and some standardisation of widths was adopted where possible.
- Piles chosen were 350 x 350 precast driven piles because they proved to be the most economical of the various types investigated.
- Near the railway 600 diameter bored piles were adopted and constructed using tripod rigs.
- Piles driven to refusal in till using specialist contractors piles and plant sometimes failed to pass static load test. In such cases, additional piles had to be installed to provide adequate factors of safety for the group.
- Piles driven to rock provided higher than expected load carrying capacity when tested. In these areas, pile numbers were reduced to provide the most cost effective design.

RAILWAY BRIDGE DESIGN

- Most obvious solution was extension of the existing abutments with beam deck over.
- We could not talk to ScotRail before Tender and had to put forward proposals that we know would be acceptable.
- Headroom over railway was extremely tight making longer simply supported deck impossible.
- We looked at raising Ramp D profile but there was not enough headroom over. This would have required realignment of Viaducts A & B, longer columns and either longer viaducts or longer Abutment walls.
- It was decided best to leave geometry as it was.
- A three span continuous steel beam deck was adopted using very shallow fabricated steel plate girders 600 deep.
- This allowed fail safe construction of piles and columns and reduced to a minimum potential interference with the railway. We were also able to keep the columns clear of the train impact zone.

EMBANKMENT DESIGN

- To eliminate the problem of settlement of fill embankments behind the abutments a BASP system was adopted with a transition zone to band drains and preconsolidated embankment.

- Settlements of 350 - 550 mm were expected.

- Horizontal earth pressures on piled abutments and walls were reduced by transferring such loads into the piles supporting the embankments using geosynthetics.

- Embankments are supported on granular layers spanning between small pile caps. The granular layers were reinforced using geosynthetics. These geosynthetics were also used to prevent lateral spread of the embankments and to stitch widened embankments onto exiting slopes.

- Preconsolidation of transition zones and band drained areas was achieved by overfilling for up to 20 weeks.

- Settlement measurements combined with piezometer readings were used to achieve 90% of predicted settlement prior to removal of overfill and completion of overlying works.

WHAT WENT WRONG?

Piling Problems

Piles driven to refusal in till using specialist contractors piles and plant etc sometimes failed to carry the required loads under test. In such cases additional piles had to be added - this sometimes required increased base sizes.

BASP

There were differences in approach between designer and checker concerning the design of geosynethetics for the reinforced granular layers over the piles supporting embankments.
This could only be resolved by adopting a more expensive and conservative approach.

Permanent Formwork

At tender it was stated that permanent formwork would be adopted over existing roads and railway.
During production, SRC & SO objected to the use of this approach throughout. This had not been precluded in the specification. In the end, SO & SRC accepted the use of EMJ GRP non participating formwork.

Services Diversions

Documentation stated that all services affected by the Works would be diverted. Some services crossing the line of the works were affected by the works but had not been diverted. The Works (mainly drainage) were altered to suit.

Footbridge

An existing footbridge crossing the road was hit by a high vehicle and had to be demolished earlier than planned by the Contractor.

Steel P6 Parapets

This new type of parapet caused some difficulties in the design of deck slabs.

STRUCTURES - FACTS etc

- **Steel Grade** 50D

- **Plate Thicknesses** given to nearest mm at request of Contractor & FM. In the end some plates had to be thickened up to nearest 5mm because of rolling problems.

- **Pile Capacities** 180T in till
  140T in rock

- **Changed Pile Capacities** 110T - 135T in till
  180T on rock

- **Anchor Piers** had to be designed for contractors chosen construction sequence which required 6 spans of Beams out of balance
  2 spans of Deck out of balance

  Calculations were based on bearing supplier guaranteeing max 3% bearing friction during erection.

- **Tallest Pier** 14.5m

- **Pile Lengths** 14m min 43m max

- **Paint System** 'Inland B' Difficult Access

- **Permanent Formwork** Omnia planks out because of cost

  EMJ GRP non participating with steel flats for bending strength.

- **Bearings** Glacier. Max load 500T

- **Joints** Mageba modular joint

- **Piles** Mainly Hercules 365 x 365 with special reinforcement for bending. Some Hercules H1300 octagonal piles also used.

- **Pile Joints** All had to be at least 6m below pile caps.

- **Slip Coats** Used where settlement would occur.

- **Pre boring** Used where granular made ground restricted driving.

- **Penetration of Piles into Till.** Required 10m min
  Achieved 8 - 10m

- **Deck Waterproofing** Chevron Industrial Membrane
  (a Eurethane liquid proprietary system)

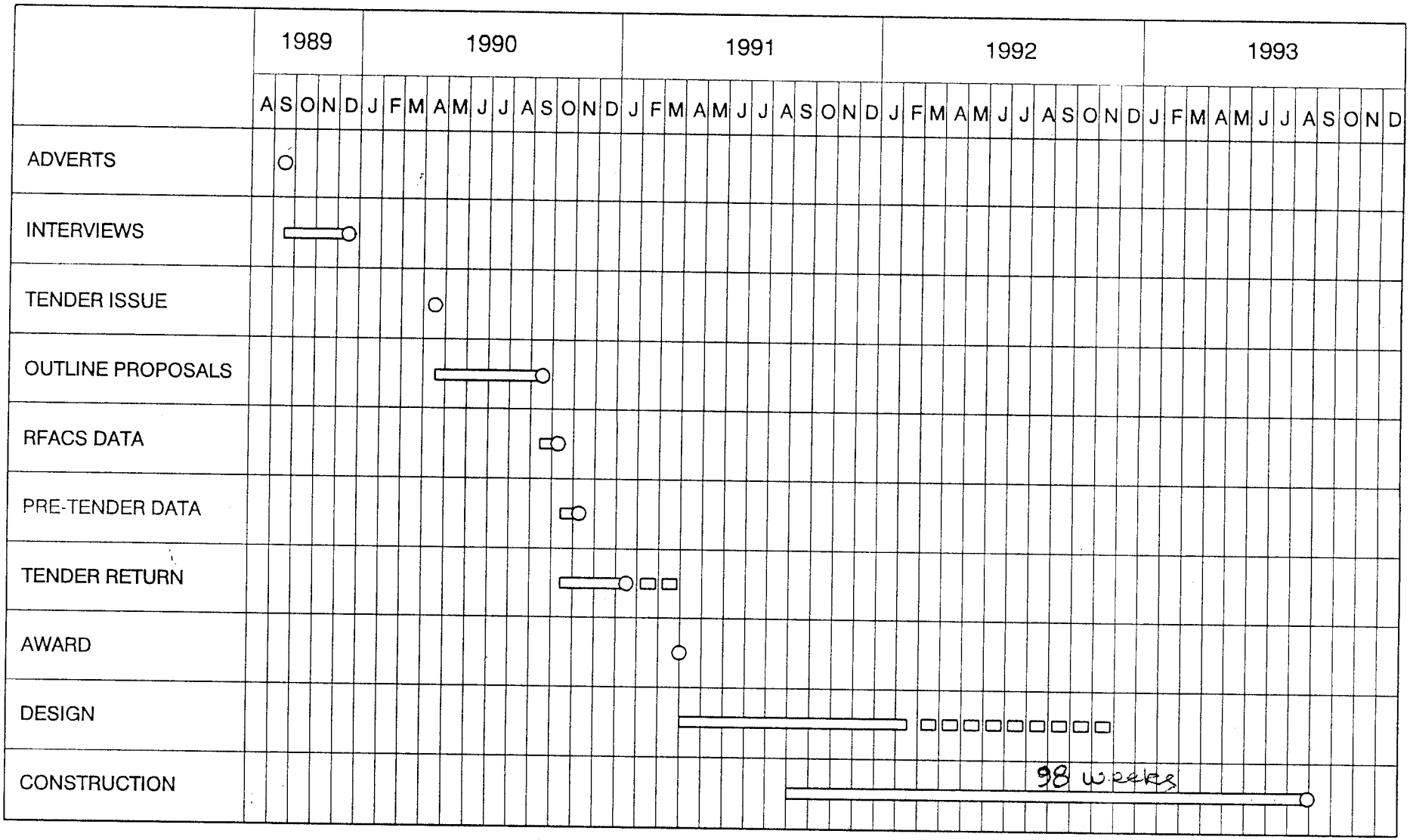
- **Pile Costs**

365 x 365	Precast	£30/M
305 x 305	Steel	£80/M
2·0 dia	Bored pile	£1000/M?

GEOTECHNICS

° Rock	- Mudstone or Sandstone
° Groundwater etc	- Sulphate resisting cements in piles - Bituminous paint to all concrete in contact with ground - Natural gas encountered in boreholes - Methane gas encountered in boreholes
° Geosynthetics	- Netlon Geodrid - Stabilenka Geofabric
° Preconsolidation Time	- 10 - 20 weeks
° Max Settlements	- 350 to 550mm.

OVERALL PROGRAM



24
4
96

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DATA SUPPLIED BY SRC

- DOCUMENTATION
- PLAN
- GEOMETRY
- MOSS GROUND MODEL
- PHOTOGRAPHS & SLIDES FOR PHOTOMONTAGE

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27

CONDITIONS OF CONTRACT
MAIN DIFFERENCES FROM I.C.E. 5th EDITION

- CONTRACTOR DECIDES CONTRACT PERIOD
- LUMP SUM CONTRACT
- V.O.P. FROM 42 DAYS BEFORE TENDER TO START OF WORK
- CONTRACTOR PAYS ALL FEES (e.g. Rail Possessions)
- CONTRACTOR TO DESIGN AND BUILD
- CONTRACTOR RESPONSIBLE FOR ASSESSING GROUND
- NO PAYMENT FOR UNFORESEEN CONDITIONS
- 20 YEARS MAINTENANCE PERIOD FOR SETTLEMENT
- CONTRACTOR PAYS FOR ALL TESTING
- QUALITY ASSURANCE REQUIRED

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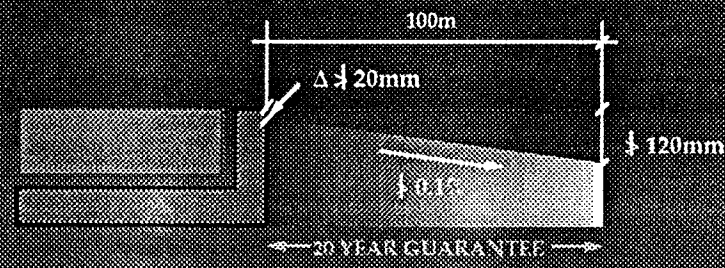
28

SETTLEMENT CRITERIA



- STRUCTURES TO BE PILED
- A COMPLETE BEFORE OPENING
- NO DIFFERENTIAL Δ OR DAMAGE TO EXISTING WORKS
- DIFFERENTIAL Δ ON NEW WORKS NOT TO AFFECT DRAINAGE
- NO CRACKS, DEPRESSIONS, LANDSLIP

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29

GROUND INVESTIGATION

• PRE TENDER	90 BOREHOLES
	33 TRIAL PITS
• POST TENDER *	94 BOREHOLES
	64 TRIAL PITS

* JOINT GROUND INVESTIGATION
* MANAGED FOR SRC BY CROUCH HOGG WATERMAN
* 3 TENDERERS SHARED TOTAL COST
* CLIENT PAID TOTAL COST TO WINNING TENDERER
* WINNER REIMBURSED THE TWO LOSING TENDERERS

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30

OUTLINE STRUCTURAL PROPOSALS TO CLIENT

- FOUNDATION TYPE
- STRUCTURAL FORM
- ARTICULATION
- ARRANGEMENTS FOR INSPECTION & MAINTENANCE
- MATERIALS & FINISHES
- CONSTRUCTION PROPOSALS
- EMBANKMENTS: SETTLEMENT CONTROL
- DRAINAGE PROPOSALS
- PROPOSED GEOMETRY CHANGES

32

PRE TENDER SUBMISSION

- DESIGN CHECK PROPOSALS
- GEOMETRY
- GEOTECHNICAL DETAILS
- STRUCTURAL LOADS
- ARTICULATION PROPOSALS
- BEARINGS AND JOINTS

34

TENDER SUBMISSION

- FIXED PRICE
- CONSTRUCTION PERIOD
- PRELIM PROGRAMME
- PRELIM DRAWINGS
  - * Plans & GA's of Structures
  - * Elevations of End & Internal Spans
  - * Typical Sections
  - * Geotechnical Details
  - * Fencing & Safety Barriers
  - * Drainage System
  - * Landscaping (Halfords)
  - * Lighting (Balfour Kilpatrick)
- [illegible]

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35

TENDER ASSESSMENT

- FIXED TENDER SUM
- Add £43,750 per Week for Time for Completion
- Add £200,000 for Steel Composite Deck
  - £100,000 for Partial Enclosure
  - £ Zero for Complete Enclosure
  - £ Zero for P.C. or R.C. Deck
- Liquidated Damages for Delay £12,500 per day
- Period of Maintenance 52 Weeks
- Period of Guarantee (for A.) 10 Years

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36

WORKS BY SRC

- PROJECT MANAGEMENT
- GEOMETRIC DESIGN
- ROAD ORDERS & LAND PLANS
  (InParallel With Tender Period)
- SERVICES DIVERSIONS (Pre Tender) £0.7m
- ACCOMMODATION WORKS £0.8m
  - Construction of 21 football pitches
  - Drainage Outfall
  - Protection Work to Paisley Moss (SSSI)

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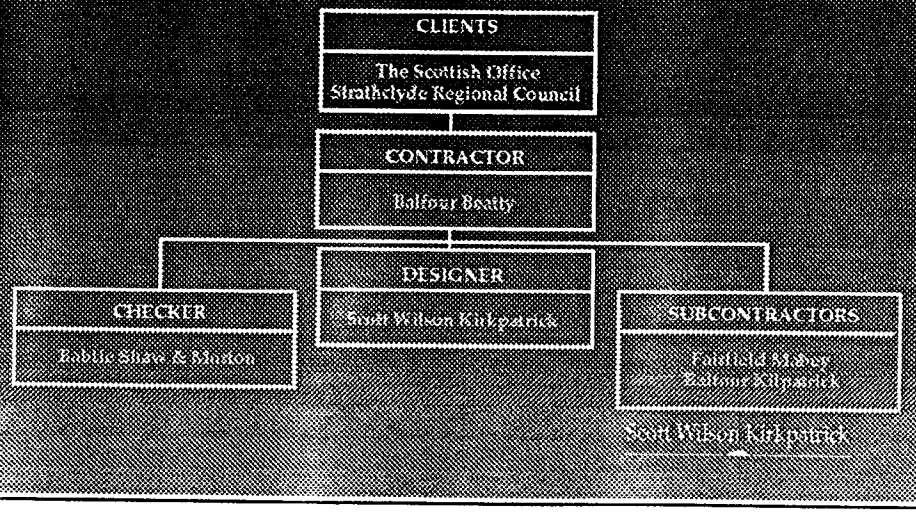
37

PROJECT ORGANISATION



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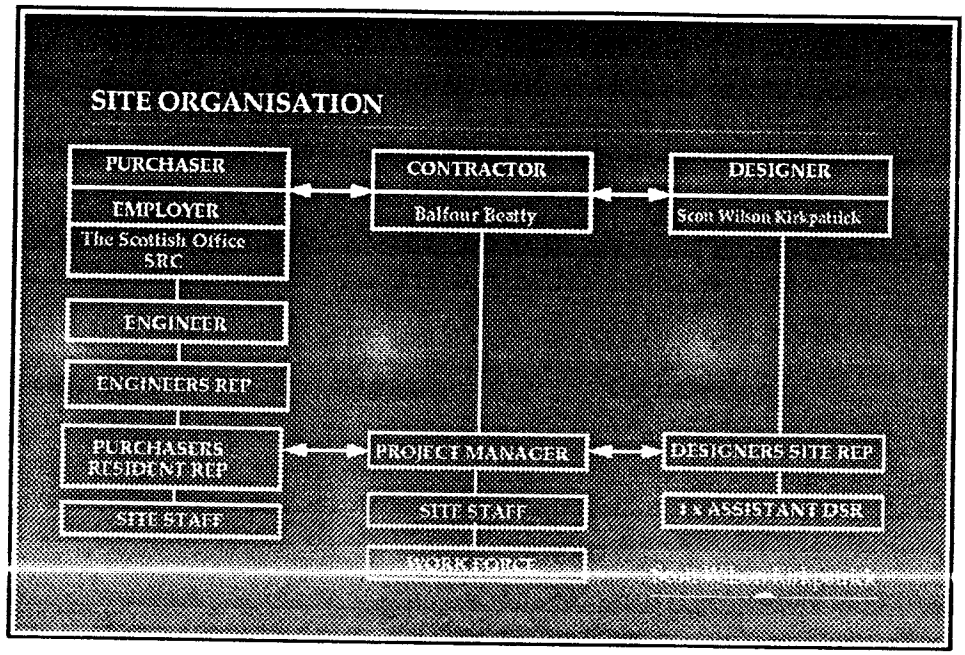
38


SITE ORGANISATION
PURCHASER
EMPLOYER
The Scottish Office SRC
ENGINEER
ENGINEERS REP
PURCHASERS RESIDENT REP
SITE STAFF
CONTRACTOR
Balfour Beatty
PROJECT MANAGER
SITE STAFF
DESIGNER
Scott Wilson Kirkpatrick
DESIGNERS SITE REP
1 x ASSISTANT DSR

Notes on
Data Slides

No	Title	Notes
10	Project Signboard	-
11	BB/SWK Signboard	-
12	Site Plan	-
13	Layout : Existing	-
14	Traffic : Existing	◦Figures from SRC
15	Layout : Proposed	◦Dedicated Ramps. Reduced flow on Roundabout
16	Traffic : Proposed	-
17	Aerial	◦From SE
18	Aerial	◦From E
19	Programme to Award	◦Advert Important job - got fixed up with BB 13 Showed interest 6 Interviewed (completed questionnaire) 3 Invited to tender Tarmac/Gibb Norwest Holst/Acer BB/SWK ◦Before Interview Questionnaire required details of experience on viaducts & foundations ◦At interview Opportunity to explain experience of BB/SWK individually + together ◦During Tender Period Most important to get BB/SWK joint input to the design Also important to get Fees and Agreement sorted out.
20	Construction Process	◦Client must be precise as to his requirements (a) to protect his own interests (b) to ensure even playing field for tenderers
21	Heath Robinson	◦Heath Robinson Consultant and ACME Const Co Proposal for Canting Basin Bridge - Garden Festival ◦Promoters wanted to be sure that they would get a Design/Build team with the capability to produce the job.

Notes on
Data Slides

No	Title	
22	Woodside 2) 500m	◦ SWK & BB could demonstrate extensive experience together and separately. ◦ The individuals who would be involved had the experience rather than others in London or elsewhere.
23	Renfrew 1) –	
24	Ting Kau Viaduct) 800m	
25	Tsuen Wan Bypass) 2000m	
26	P1/P2 Tuen Mun) 450m	
27	Data from SRC	-
28	ICE 5th:Differences)	◦ Important for BB & SWK to consider the effects on Design, Programme, Costs, Construction sequence etc to ensure most cost effective tender
29	Settlement Criteria)	
30	NCE cover	◦ BB responsible for ground conditions. No Clause 12
31	Ground Investigation	◦ SWK:less than 30% of new boreholes. ◦ There was some rationalisation. ◦ Watched out for false trails of information ◦ More interest in the embankment areas
32	Outline Proposals	◦ Sept 1990
33	Photomontages *	◦ Move to between 53 + 54
34	Pre Tender Submission	◦ Interviewed Nov 1990
35	Tender Submission	◦ Jan 1991 (Extended)
36	Tender Assessment	-
37	Works by SRC	-
38	Project Organisation	◦ Holfords sub consultants to SWK
39	Site Organisation	◦ Engineer D Carruthers SRC (Director) Engineers Rep J Ferguson SRC Purchasing Res Rep Bill Shearer SRC BB Project Manager Shaun Nesbitt SWK Designers Site Rep Alex Bickett

vary thickness

- flats max 650 tops + bottoms some intspans
- Plates on bigger spans with thickness to nearest mm.
  sized to suit code requirements
- Full strength butt welds where FM wanted to join plates.
- Fillet welds ~ 8mm automatic welding has 'deep throat' system.

Notes on
Data Slides

No	Title	Notes
40	~~Programme to Award~~ Overall Programme	◦ Advert to Award 18 months ◦ SRC doing services diversions Land acquisition Accommodation works Roads Orders ◦ Construction Period ≠ 98 weeks ◦ 5 month lead time for design & mobilisation (in conditi ◦ Consider : was this faster way to procure
41	Monks	◦ Reminder for Design Programme ◦ Discuss : Illuminated Manuscript Type Script Illiterate Scrawl ◦ What does the Promoter want? ◦ What will he get?
42	Design Programme	-
43	Structures Layout	◦ See 'Viaduct Design' ◦ Spans, Economic Span, Deck v Foundation Costs, Overall length, Pier positions ◦ Trade off between deck and BASP. ◦ Pile type fixed later. ◦ Dominant Spans ◦ Fixed Points ◦ Piles 14m - 43m long ◦ Railway Bridge Difficulties + effect on:- ◦ Construction sequence/Articulation/Piers
44	Deck Types	◦Looking for Continuity Light Deck Speed of Construction Economy
45	Section	-
46	Steel Plate Dimensions	◦ Support and span sections shown
47	Articulation	◦ Explain Fixity Movement on rays Joint/Parapet Movements
48	Piers)	
49	Piers)	◦ Caused more discussion than any other single topic
50	Piers)	
51	Piers)	

Notes on Data Slides

No	Title	Notes
52	Viaducts - West	◦ Dominant 67m span ◦ Effect of Railway Bridge on Viaduct Construction ◦ Need to get Ramps C & D open early
53	Viaducts - East	◦ Easier construction than to West ◦ Big 'out of balance' on fixed piers 8 & 9 ◦ Skew Piers at A12 A13 in nose ◦ Deck v BASP costs fixed Abutments
33	Photomontages *	◦ Required for RFACS. Rec'd comments on Pier Head
54	Alternations to Geometry	-
55	Abutment	◦ Dominant feature off shutter ◦ Bearing/Joint Gallery. Front entrance ◦ Raking piles positioned to avoid NSF
56	Piled Founds	◦ Explain bored near railway;driven elsewhere ◦ Slip coated & vertical where settlement likely ◦ Raked in other areas ◦ Piles founded in till or on rock ◦ Some problems with breakages and load capacity in till.
57	Route A Wall	◦ Vertical drains deeper than shown ◦ Eliminated need for piles ◦ Eliminated settlement problem at low cost
58	Route B Piled Wall	◦ Reinforced granular layer eliminated need for raking piles by careful engineering. H earth forces taken out by geosynthetics.
59	Services	◦ Some services remained crossing the site ◦ BB/SWK understood all affected services had been diverted. ◦ Required some redesign of drainage etc.
60	Drainage	◦ SRC had constructed a new sewer outfall to Airport area.
61	Railway Bridge	◦ See 'Railway Design'

Notes on
Data Slides

No	Title	Notes
62	Sections	◦ Not possible to speak to ScotRail pre-tender as required by SRC. ◦ Very tight headroom to railway and Viaduct A above. ◦ Most obvious thing - extend existing bridge ◦ Not possible ◦ Wanted to minimise interface with ScotRail ◦ Hence 3 span deck ◦ Weathering steel. ◦ Very shallow plate girders ◦ Tripod rigs for bored piles ◦ Cut down part of existing abutments
63	Geotech Works	◦ Areas 1, 2 & 5 examined in detail
64	West Embankment	◦ Area 1
65	Route D widened ...)	◦ Area 2
66	1 - 1)	Section 1 + 2 follow
67	2 - 2)	◦ Some problems with checkers
68	Route B East Embankment)	◦ Area 5
69	1 - 1)	◦ Section 1, 2 + 3 follow
70	2 - 2, 3 - 3)	
71	Instrumentation	◦ Monuments required by SRC ◦ Piezometers, H profile gauges required by BB/SWK to minimise stop time for surcharged areas.