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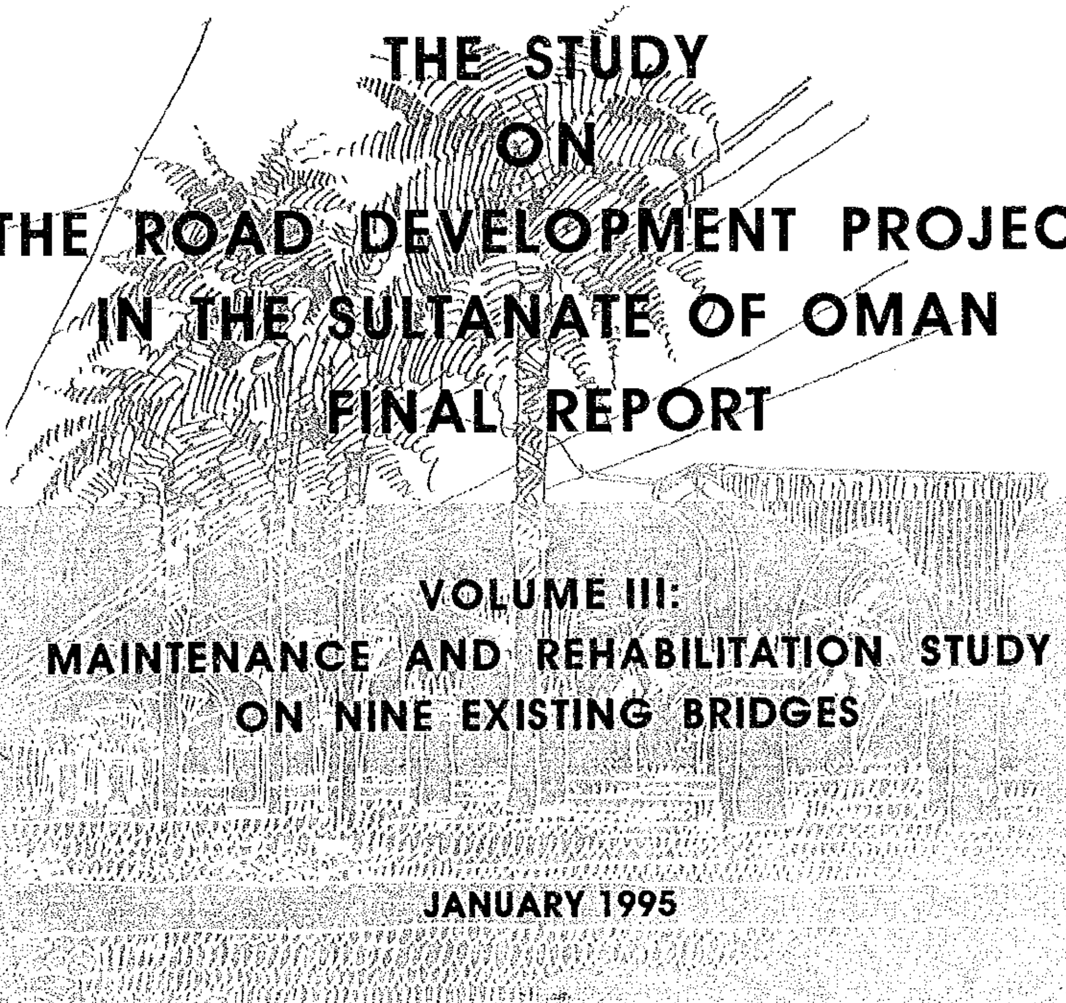

THE STUDY ON THE ROAD DEVELOPMENT PROJECT IN THE SULTANATE OF OMAN FINAL REPORT

VOLUME III: MAINTENANCE AND REHABILITATION STUDY ON NINE EXISTING BRIDGES

JANUARY 1995

PACIFIC CONSULTANTS INTERNATIONAL
FUKUYAMA CONSULTANTS INTERNATIONAL

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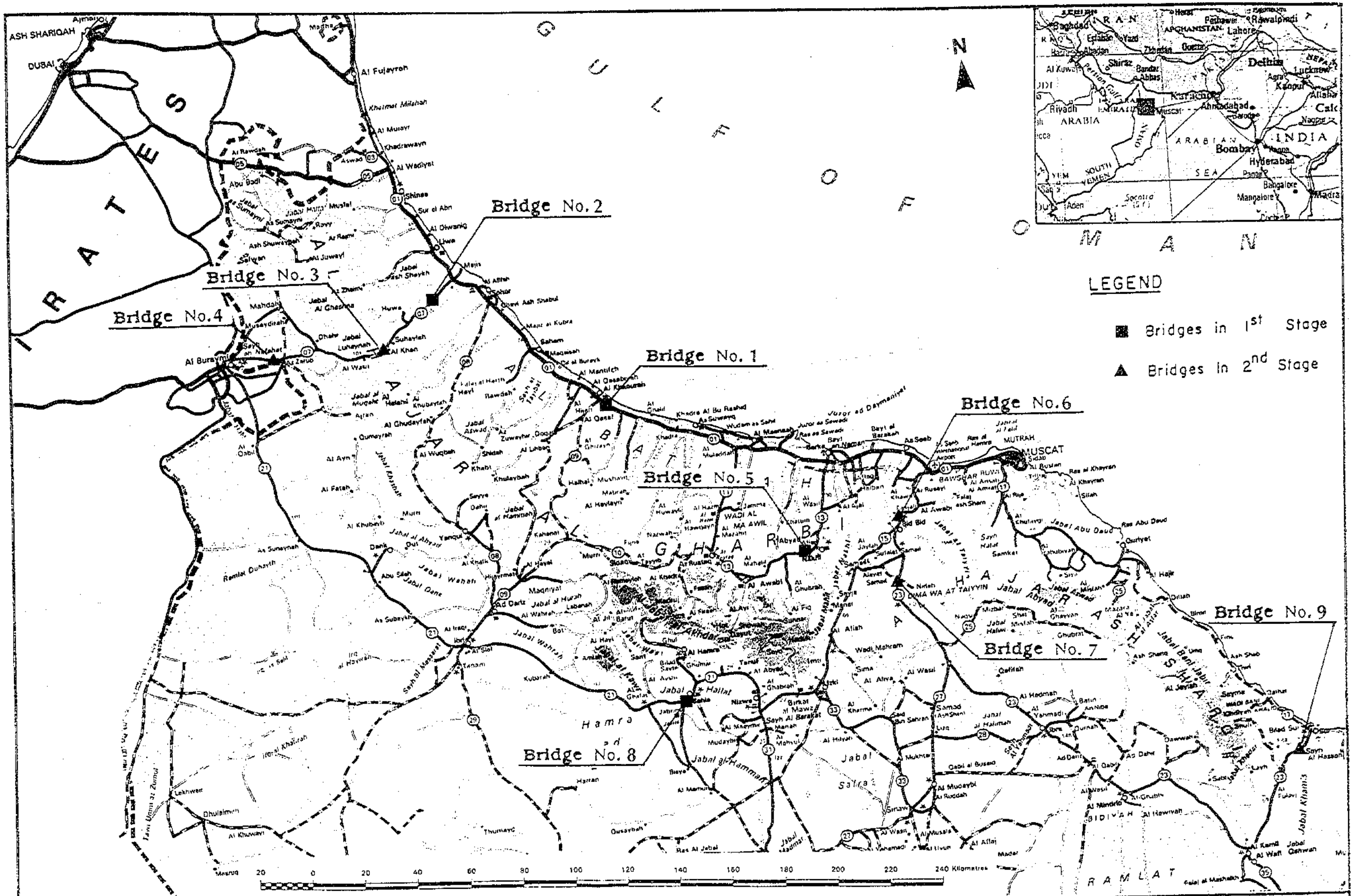


THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION MAP FOR MAINTENANCE AND REHABILITATION STUDY ON NINE EXISTING BRIDGES

CONTENTS

LOCATION MAP

Page

CHAPTER 1: INTRODUCTION 1-1

CHAPTER 2: GENERAL CONDITION OF EXISTING HIGHWAY BRIDGES IN OMAN 2-1
2.1 General 2-1
2.2 Present Condition of Reinforced Concrete Bridges and Prestressed Concrete Bridges 2-5
2.3 Circumstances of Design and Construction 2-8

CHAPTER 3: PLAN AND SCHEDULE OF INSPECTION 3-1

CHAPTER 4: INVESTIGATION OF SOUNDNESS OF EXISTING BRIDGES 4-1
4.1 Method of Investigation for Soundness Test 4-1
4.2 Results of the Investigation for Soundness 4-10
4.3 Engineering Consideration on the Result of Inspection 4-119

CHAPTER 5: LOAD TEST OF THE EXISTING BRIDGES 5-1
5.1 Method for the Load Test 5-1
5.2 Results of the Load Test 5-34

CHAPTER 6: THE EVALUATION METHOD FOR EXISTING BRIDGES 6-1
6.1 Evaluation of Soundness of Existing Bridges Based on Their Degree of Deterioration 6-2
6.2 Evaluation of Bridges Based on Test Results of Concrete and Reinforcing Bar 6-6
6.3 Evaluation of the Bridges Using Loading Tests 6-7
6.4 Evaluation of the Existing Bridges Based on Their Load Bearing Capacity 6-11

CHAPTER 7:	RESULTS OF EVALUATION OF EXISTING BRIDGES	7-1
7.1	Evaluation of Soundness of Existing Bridges Based on Their Degree of Deterioration	7-1
7.2	Evaluation of Bridges Based on the Test Results of Concrete and Reinforcing Bar	7-8
7.3	Evaluation of Bridges Using Load Tests	7-12
7.4	Evaluation of the Existing Bridges Based on the Load Bearing Capacity	7-29
CHAPTER 8:	THE OVERALL EVALUATION OF EXISTING BRIDGES	8-1
8.1	Overall Evaluation	8-1
8.2	Detailed Evaluation of Bridges	8-5
8.3	Control of Heavy Vehicle Traffic on the Bridges due to the New Design Live Load	8-14
CHAPTER 9:	PROPOSED REPAIR PLAN FOR EXISTING BRIDGES	9-1
9.1	Repair Plan	9-1
9.2	Bridge Requiring Emergency Repairs	9-17
9.3	Register of Existing Bridges	9-27
CHAPTER 10:	MAINTENANCE MANAGEMENT PLAN	10-1
10.1	Organization	10-1
10.2	Present Situation of Maintenance Management	10-3
10.3	Planning of Maintenance Management	10-3
10.4	Proposal of Bridge Inventory	10-4
10.5	Proposal for Check-up Guideline	10-7
CHAPTER 11:	CONCLUSIONS AND RECOMMENDATIONS	11-1
11.1	Conclusions	11-1
11.2	Recommendations	11-2

LIST OF TABLES

Page

CHAPTER 2

Table 2.1 Bridge List for Inspection, Examination and Load Test 2-4

CHAPTER 3

Table 3.1 Schedule of 1st Stage for Field Survey & Load Test 3-4
Table 3.2 Schedule of 2nd Stage for Field Survey & Load Test 3-4

CHAPTER 4

Table 4.1 Inspection and Examination Contents 4-2
Table 4.2 Inspection and Examination Items 4-3
Table 4.3 Inspection and Examination of Existing Bridge Condition 4-5
Table 4.4 Number of Concrete and Reinforcing Bar Test 4-6
Table 4.5 Concrete Core Test Results (Bridge No. 1) 4-68
Table 4.6 Concrete Core Test Results (Bridge No. 2) 4-68
Table 4.7 Concrete Core Test Results (Bridge No. 3) 4-69
Table 4.8 Concrete Core Test Results (Bridge No. 4) 4-70
Table 4.9 Concrete Core Test Results (Bridge No. 5) 4-71
Table 4.10 Concrete Core Test Results (Bridge No. 6) 4-72
Table 4.11 Concrete Core Test Results (Bridge No. 7) 4-73
Table 4.12 Concrete Core Test Results (Bridge No. 8) 4-74
Table 4.13 Concrete Core Test Results (Bridge No. 9) 4-74
Table 4.14 Carbonation Test Results 4-75
Table 4.15 Schmidt Hammer Test for Concrete Structure 4-76
Table 4.16 Ratio of Concrete Age 4-81
Table 4.17 Reinforcing Bar Test Results 4-83
Table 4.18 Results of Chloride Measurement of Hardened Concrete 4-90
Table 4.19 Damage Ranking List (Bridge No. 1) (1) 4-92
Table 4.20 Damage Ranking List (Bridge No. 1) (2) 4-93
Table 4.21 Damage Ranking List (Bridge No. 1) (3) 4-94
Table 4.22 Damage Ranking List (Bridge No. 2) (1) 4-95
Table 4.23 Damage Ranking List (Bridge No. 2) (2) 4-96
Table 4.24 Damage Ranking List (Bridge No. 2) (3) 4-97
Table 4.25 Damage Ranking List (Bridge No. 3) (1) 4-98
Table 4.26 Damage Ranking List (Bridge No. 3) (2) 4-99

Table 4.27 Damage Ranking List (Bridge No. 3) (3) 4-100
Table 4.28 Damage Ranking List (Bridge No. 4) (1) 4-101
Table 4.29 Damage Ranking List (Bridge No. 4) (2) 4-102
Table 4.30 Damage Ranking List (Bridge No. 4) (3) 4-103
Table 4.31 Damage Ranking List (Bridge No. 5) (1) 4-104
Table 4.32 Damage Ranking List (Bridge No. 5) (2) 4-105
Table 4.33 Damage Ranking List (Bridge No. 5) (3) 4-106
Table 4.34 Damage Ranking List (Bridge No. 6) (1) 4-107
Table 4.35 Damage Ranking List (Bridge No. 6) (2) 4-108
Table 4.36 Damage Ranking List (Bridge No. 7) (3) 4-109
Table 4.37 Damage Ranking List (Bridge No. 7) (1) 4-110
Table 4.38 Damage Ranking List (Bridge No. 7) (2) 4-111
Table 4.39 Damage Ranking List (Bridge No. 7) (3) 4-112
Table 4.40 Damage Ranking List (Bridge No. 8) (1) 4-113
Table 4.41 Damage Ranking List (Bridge No. 8) (2) 4-114
Table 4.42 Damage Ranking List (Bridge No. 8) (3) 4-115
Table 4.43 Damage Ranking List (Bridge No. 9) (1) 4-116
Table 4.44 Damage Ranking List (Bridge No. 9) (2) 4-117
Table 4.45 Damage Ranking List (Bridge No. 9) (3) 4-118
Table 4.46 Minimum Design Strength of Concrete 4-123
Table 4.47 Allowable Compressive Strength for Concrete 4-124
Table 4.48 Modulus of Elasticity for Concrete 4-124
Table 4.49 Ratio of Carbonate Components 4-125
Table 4.50 Strength of Reinforcing Bars 4-128
Table 4.51 Allowable Strength of Reinforcing Bars 4-129
Table 4.52 Chemical Composition of Steel Grade 4-129
Table 4.53 Dimension of Reinforcing Steel Bar 4-130
Table 4.54 Cross Sectional Area and Mass 4-131
Table 4.55 Chemical Composition of Steel Grade 4-131
Table 4.56 Tensile Properties 4-131
Table 4.57 Steel Member Constant for Calculation 4-132
Table 4.58 PC Wire and PC Strand Standard by Freyssinet Method 4-133

CHAPTER 5

Table 5.1 Number of Measurement Equipment 5-5
Table 5.2 Actual Set Numbers of Measurement Equipment 5-9
Table 5.3 Summary of Loading Test Result for Br. No. 1 5-35
Table 5.4 Detail of Loading Test Results for Br. No. 1 Case I 5-35

Table 5.5	Detail of Loading Test Results for Br. No. 1 Case II	5-36
Table 5.6	Summary of Loading Test Result for Br. No. 2	5-37
Table 5.7	Detail of Loading Test Results for Br. No. 2 Case I	5-37
Table 5.8	Detail of Loading Test Results for Br. No. 2 Case II	5-38
Table 5.9	Detail of Loading Test Results for Br. No. 2 Case III	5-38
Table 5.10	Detail of Loading Test Results for Br. No. 2 Case IV	5-39
Table 5.11	Summary of Loading Test Results for Br. No. 3	5-40
Table 5.12	Detail of Loading Test Results for Br. No. 3 Case I	5-40
Table 5.13	Detail of Loading Test Results for Br. No. 3 Case II	5-41
Table 5.14	Summary of Loading Test Results for Br. No. 4	5-42
Table 5.15	Detail of Loading Test Results for Br. No. 4 Case I	5-42
Table 5.16	Detail of Loading Test Results for Br. No. 4 Case II	5-43
Table 5.17	Detail of Loading Test Results for Br. No. 4 Case III	5-43
Table 5.18	Detail of Loading Test Results for Br. No. 4 Case IV	5-44
Table 5.19	Summary of Loading Test Results for Br. No. 5	5-45
Table 5.20	Detail of Loading Test Results for Br. No. 5 Case I	5-45
Table 5.21	Detail of Loading Test Results for Br. No. 5 Case II	5-46
Table 5.22	Detail of Loading Test Results for Br. No. 5 Case III	5-46
Table 5.23	Detail of Loading Test Results for Br. No. 5 Case IV	5-47
Table 5.24	Summary of Loading Test Results for Br. No. 6	5-48
Table 5.25	Detail of Loading Test Results for Br. No. 6 Case I	5-48
Table 5.26	Detail of Loading Test Results for Br. No. 6 Case II	5-49
Table 5.27	Detail of Loading Test Results for Br. No. 6 Case III	5-49
Table 5.28	Detail of Loading Test Results for Br. No. 6 Case IV	5-50
Table 5.29	Summary of Loading Test Results for Br. No. 7	5-51
Table 5.30	Detail of Loading Test Results for Br. No. 7 Case I	5-51
Table 5.31	Detail of Loading Test Results for Br. No. 7 Case II	5-52
Table 5.32	Detail of Loading Test Results for Br. No. 7 Case III	5-52
Table 5.33	Detail of Loading Test Results for Br. No. 7 Case IV	5-53
Table 5.34	Summary of Loading Test Results for Br. No. 8	5-54
Table 5.35	Detail of Loading Test Results for Br. No. 8 Case I	5-54
Table 5.36	Detail of Loading Test Results for Br. No. 8 Case II	5-55
Table 5.37	Detail of Loading Test Results for Br. No. 8 Case III	5-55
Table 5.38	Detail of Loading Test Results for Br. No. 8 Case IV	5-56
Table 5.39	Summary of Loading Test Results for Br. No. 9	5-57
Table 5.40	Detail of Loading Test Results for Br. No. 9 Case I	5-57
Table 5.41	Detail of Loading Test Results for Br. No. 9 Case II	5-58
Table 5.42	Detail of Loading Test Results for Br. No. 9 Case III	5-58

Table 5.43	Detail of Loading Test Results for Br. No. 9 Case IV	5-59
Table 5.44	Value of Crack Width due to Truck Loading (No. 1)	5-60
Table 5.45	Value of Crack Width due to Truck Loading (No. 2)	5-61
Table 5.46	Value of Crack Width due to Truck Loading (No. 3)	5-62

CHAPTER 6

Table 6.1	Establishment of Weight Factors (bt) for Evaluation Items	6-4
Table 6.2	Evaluation Element (at) and Weight Factor (bt)	6-5
Table 6.3	Evaluation Based on the Testing of Concrete and Reinforcing Steel	6-7
Table 6.4	Calculation Method of Load Bearing Capacity	6-12
Table 6.5	Summary of Calculation Case (Grid Analysis)	6-20

CHAPTER 7

Table 7.1	Summary of Heavy Vehicle Traffic by Survey Data	7-2
Table 7.2	Evaluation Element (at) and Weight Factor (bt) for Br. No. 1	7-4
Table 7.3	Evaluation Element (at) and Weight Factor (bt) for Br. No. 2	7-4
Table 7.4	Evaluation Element (at) and Weight Factor (bt) for Br. No. 3	7-5
Table 7.5	Evaluation Element (at) and Weight Factor (bt) for Br. No. 4	7-5
Table 7.6	Evaluation Element (at) and Weight Factor (bt) for Br. No. 5	7-6
Table 7.7	Evaluation Element (at) and Weight Factor (bt) for Br. No. 6	7-6
Table 7.8	Evaluation Element (at) and Weight Factor (bt) for Br. No. 7	7-7
Table 7.9	Evaluation Element (at) and Weight Factor (bt) for Br. No. 8	7-7
Table 7.10	Evaluation Element (at) and Weight Factor (bt) for Br. No. 9	7-8
Table 7.11	Judgement due to Results of Concrete Test	7-9
Table 7.12	Judgement due to Results of Reinforcing Bar Test	7-10
Table 7.13	f-Value (Calculation/Measurement)	7-22
Table 7.14	Summary of Bending Moment by Tested Load (RC. Br.) (Grid Analysis)	7-23
Table 7.15	Calculation Results (Grid) by Tested Loading (Br. No. 1)	7-24
Table 7.16	Calculation Results (Grid) by Tested Loading (Br. No. 2, 3, 4)	7-25
Table 7.15	Calculation Results (Grid) by Tested Loading (Br. No. 5, 8)	7-26
Table 7.15	Calculation Results (Grid) by Tested Loading (Br. No. 6)	7-27
Table 7.15	Calculation Results (Grid) by Tested Loading (Br. No. 7, 9)	7-28
Table 7.20	Results of Bending Moment by AASHTO HS-20 (RC, PC)	7-31
Table 7.21	Results of Strength and Deflection for Bridge No. 1	7-32
Table 7.22	Results of Strength and Deflection for Bridge No. 2	7-33
Table 7.23	Results of Strength and Deflection for Bridge No. 5, 8	7-34
Table 7.24	Calculation Results of Slab for the Bridge	7-35

Table 7.25 Results of Safety Ratio of Ultimate Bending Moment and Load Bearing Capacity 7-38
Table 7.26 Safety Ratio of Load Bearing Capacity for Bridge No. 6 (PC Bridge) 7-39
Table 7.27 Safety Ratio of Load Bearing Capacity for Bridge No. 7, 9 (PC Bridge) 7-40
Table 7.28 Calculation Results (Grid) by OMAN Design Standard (RC) 7-42
Table 7.29 Calculation Results (Grid) by OMAN Design Standard (PC) 7-43

CHAPTER 8

Table 8.1 Summary of Overall Evaluation and Judgement for Bridges 8-2
Table 8.2 Detailed Evaluation for Bridge No. 1 8-5
Table 8.3 Detailed Evaluation for Bridge No. 2 8-6
Table 8.4 Detailed Evaluation for Bridge No. 3 8-7
Table 8.5 Detailed Evaluation for Bridge No. 4 8-8
Table 8.6 Detailed Evaluation for Bridge No. 5 8-9
Table 8.7 Detailed Evaluation for Bridge No. 6 8-10
Table 8.8 Detailed Evaluation for Bridge No. 7 8-11
Table 8.9 Detailed Evaluation for Bridge No. 8 8-12
Table 8.10 Detailed Evaluation for Bridge No. 9 8-13
Table 8.11 Capacity of Axle Load and Total Truck Load for 9 Bridges 8-16

CHAPTER 9

Table 9.1 Concrete Bridge Components and Damages Sustained 9-6
Table 9.2 Methods to Correct Damage to Concrete Members 9-7
Table 9.3 Foundation Corrective Method 9-8

CHAPTER 10

Table 10.1 Evaluation Standard of Routine Inspection 10-9
Table 10.2 Evaluation Standard of Recurrent Inspection 10-9
Table 10.3 Evaluation Standard of Emergency Inspection 10-10
Table 10.4 The Combination of Inspection Frequency and Inspection Items .. 10-10
Table 10.5 Daily Inspection Items 10-14
Table 10.6 Judgement Standard of Daily Inspection 10-14
Table 10.7 Judgement Rank of Daily Inspection 10-15
Table 10.8 Inspection Items 10-17
Table 10.9 Judgement Standard of Recurrent Inspection 10-18
Table 10.10 Judgement Ranking of Recurrent Inspection (1), (2), (3), (4) 10-19

Table 10.11 Evaluation of Coefficient of Weight and Evaluation Factor 10-23
Table 10.12 Judgement Standard of Emergency Inspection 10-26

LIST OF FIGURES

			Page
CHAPTER 2			
	Fig. 2.1	Bridge Location in Study Area	2-3
	Fig. 2.2	Span Length for RC and PC Simple Beam Bridge	2-6
	Fig. 2.3	Superstructural Type for Existing 9 Bridges	2-7
CHAPTER 3			
	Fig. 3.1	Flow Chart for 1st Study	3-2
	Fig. 3.2	Flow Chart for 2nd Study	3-3
CHAPTER 4			
	Fig. 4.1	Core Sampling Position	4-7
	Fig. 4.2	Core Sampling	4-8
	Fig. 4.3	Measurement of Re-Bar Position by Sensor	4-8
	Fig. 4.4	List of 9 Existing Bridges	4-11
	Fig. 4.5	General View of Bridge No. 1	4-13
	Fig. 4.6	General View of Bridge No. 1	4-14
	Fig. 4.7	General View of Bridge No. 1	4-15
	Fig. 4.8	Cracking Conditions	4-16
	Fig. 4.9	General View of Br. No. 2	4-17
	Fig. 4.10	General View of Br. No. 2	4-18
	Fig. 4.11	General View of Br. No. 2	4-19
	Fig. 4.12	Cracking Conditions	4-20
	Fig. 4.13	Cracking Conditions	4-21
	Fig. 4.14	General View of Br. No. 3	4-22
	Fig. 4.15	General View of Br. No. 3	4-23
	Fig. 4.16	General View of Br. No. 3	4-24
	Fig. 4.17	General View of Br. No. 3	4-25
	Fig. 4.18	Cracking Conditions	4-26
	Fig. 4.19	Cracking Conditions	4-27
	Fig. 4.20	Cracking Conditions	4-28
	Fig. 4.21	General View of Br. No. 4	4-29
	Fig. 4.22	General View of Br. No. 4	4-30
	Fig. 4.23	General View of Br. No. 4	4-31
	Fig. 4.24	Cracking Conditions	4-32

Fig. 4.25	Cracking Conditions	4-33
Fig. 4.26	General View of Br. No. 5	4-34
Fig. 4.27	General View of Br. No. 5	4-35
Fig. 4.28	General View of Br. No. 5	4-36
Fig. 4.29	Cracking Conditions	4-37
Fig. 4.30	Cracking Conditions	4-38
Fig. 4.31	Cracking Conditions	4-39
Fig. 4.32	Cracking Conditions	4-40
Fig. 4.33	General View of Br. No. 6	4-41
Fig. 4.34	General View of Br. No. 6	4-42
Fig. 4.35	General View of Br. No. 6	4-43
Fig. 4.36	General View of Br. No. 7	4-44
Fig. 4.37	General View of Br. No. 7	4-45
Fig. 4.38	General View of Br. No. 7	4-46
Fig. 4.39	General View of Br. No. 8	4-47
Fig. 4.40	General View of Br. No. 8	4-48
Fig. 4.41	General View of Br. No. 8	4-49
Fig. 4.42	Cracking Conditions	4-50
Fig. 4.43	Cracking Conditions	4-51
Fig. 4.44	Cracking Conditions	4-52
Fig. 4.45	Cracking Conditions	4-53
Fig. 4.46	General View of Br. No. 9	4-54
Fig. 4.47	General View of Br. No. 9	4-55
Fig. 4.48	General View of Br. No. 9	4-56
Fig. 4.49	Profile and Camber of Br. No. 1	4-58
Fig. 4.50	Profile and Camber of Br. No. 2	4-59
Fig. 4.51	Profile and Camber of Br. No. 3	4-60
Fig. 4.52	Profile and Camber of Br. No. 4	4-61
Fig. 4.53	Profile and Camber of Br. No. 5	4-62
Fig. 4.54	Profile and Camber of Br. No. 6	4-63
Fig. 4.55	Profile and Camber of Br. No. 7	4-64
Fig. 4.56	Profile and Camber of Br. No. 8	4-65
Fig. 4.57	Profile and Camber of Br. No. 9	4-66
Fig. 4.58	Curve Graph for Reaction Degree - Concrete Strength	4-81
Fig. 4.59	Detailed Structural Section for Br. No. 1	4-85
Fig. 4.60	Detailed Structural Section for Br. No. 2, 3, 4	4-86
Fig. 4.61	Detailed Structural Section for Br. No. 5, 8	4-87
Fig. 4.62	Detailed Structural Section for Br. No. 6	4-88

Fig. 4.63 Detailed Structural Section for Br. No. 7, 9 4-89
Fig. 4.64 Subparagraph for Deterioration of Concrete Cracks 4-120
Fig. 4.65 Cracking of Girders due to Ultimate Bending Test
(Laboratory Test) 4-122
Fig. 4.66 Relation between Depth of Carbonation and Time 4-126
Fig. 4.67 Deterioration of Concrete Structures by Carbonation 4-126

CHAPTER 5

Fig. 5.1 Loading Position of Bridges 5-2
Fig. 5.2 Load Condition of Each Case 5-3
Fig. 5.3 Flow of Static Strain Load Test 5-4
Fig. 5.4 Setting Point of Strain Gauge (RC Bridge) 5-8
Fig. 5.5 Setting Point of Strain Gauge (PC Bridge) 5-8
Fig. 5.6 Setting Point of Deflection Meter (RC, PC) 5-9
Fig. 5.7 Setting Position of Measurement Equipment (Br. No. 1) 5-10
Fig. 5.8 Setting Position of Measurement Equipment (Br. No. 2) 5-11
Fig. 5.9 Setting Position of Measurement Equipment (Br. No. 3) 5-12
Fig. 5.10 Setting Position of Measurement Equipment (Br. No. 4) 5-13
Fig. 5.11 Setting Position of Measurement Equipment (Br. No. 5) 5-14
Fig. 5.12 Setting Position of Measurement Equipment (Br. No. 6) 5-15
Fig. 5.13 Setting Position of Measurement Equipment (Br. No. 7) 5-16
Fig. 5.14 Setting Position of Measurement Equipment (Br. No. 8) 5-17
Fig. 5.15 Setting Position of Measurement Equipment (Br. No. 9) 5-18
Fig. 5.16 Setting Position of Measurement Equipment (Br. No. 1, 5) 5-19
Fig. 5.17 Setting Position of Measurement Equipment (Br. No. 2) 5-20
Fig. 5.18 Setting Position of Measurement Equipment (Br. No. 3) 5-21
Fig. 5.19 Setting Position of Measurement Equipment (Br. No. 4) 5-22
Fig. 5.20 Setting Position of Measurement Equipment (Br. No. 8) 5-23
Fig. 5.21 Setting Position of Measurement Equipment (Br. No. 1, 8) 5-24
Fig. 5.22 Setting Position of Measurement Equipment (Br. No. 2, 5) 5-25
Fig. 5.23 Setting Position of Measurement Equipment (Br. No. 3) 5-26
Fig. 5.24 Setting Position of Measurement Equipment (Br. No. 4) 5-27
Fig. 5.25 Setting Position of Measurement Equipment (Br. No. 6) 5-28
Fig. 5.26 Setting Position of Measurement Equipment (Br. No. 7) 5-29
Fig. 5.27 Setting Position of Measurement Equipment (Br. No. 9) 5-30
Fig. 5.28 Setting Position of Measurement Equipment (Br. No. 1, 2, 5, 8) 5-31
Fig. 5.29 Setting Position of Measurement Equipment (Br. No. 3) 5-32
Fig. 5.30 Setting Position of Measurement Equipment (Br. No. 4) 5-33

Fig. 5.31 Relation between Live Load & Stress, Deflection for
Br. No. 1 (RC) 5-63

Fig. 5.32 Relation between Live Load & Stress, Deflection for
Br. No. 2 (RC) 5-64

Fig. 5.33 Relation between Live Load & Stress, Deflection for 65
Br. No. 3 (RC) 5-65

Fig. 5.34 Relation between Live Load & Stress, Deflection for 67
Br. No. 4 (RC) 5-66

Fig. 5.35 Relation between Live Load & Stress, Deflection for 69
Br. No. 5 (RC) 5-67

Fig. 5.36 Relation between Live Load & Stress, Deflection for
Br. No. 6 (PC) 5-68

Fig. 5.37 Relation between Live Load & Stress, Deflection for
Br. No. 7 (PC) 5-69

Fig. 5.38 Relation between Live Load & Stress, Deflection for
Br. No. 8 (RC) 5-70

Fig. 5.39 Relation between Live Load & Stress, Deflection for
Br. No. 9 (PC) 5-71

CHAPTER 6

Fig. 6.1 Composite Evaluation Diagram for Soundness 6-6
Fig. 6.2 Relation between Rear Wheel Load and Deflection Stress 6-8
Fig. 6.3 Distribution of Stress and Strain 6-14
Fig. 6.4 Stress and Strain Diagram of 7 mm PC Cable 6-14
Fig. 6.5 Comparison of Bending Moment by Each Specification 6-17
Fig. 6.6 Loading Condition by OMAN Design Standard 6-18
Fig. 6.7 Loading Condition by OMAN Design Standard 6-19

CHAPTER 7

Fig. 7.1 Composite Evaluation Diagram for Soundness 7-1
Fig. 7.2 Loading Case for Calculation (RC. Br.) 7-12
Fig. 7.3-1 Loading Case for Calculation (RC. Br.) 7-13-1
Fig. 7.3-2 Loading Case for Calculation (PC. Br.) 7-13-2
Fig. 7.4 Relation between Live Load & Stress, Deflection for
Br. No. 1 (RC) 7-14

Fig. 7.5 Relation between Live Load & Stress, Deflection for
Br. No. 2 (RC) 7-15

Fig. 7.6 Relation between Live Load & Stress, Deflection for
Br. No. 3 (RC) 7-16

Fig. 7.7	Relation between Live Load & Stress, Deflection for Br. No. 4 (RC)	7-17
Fig. 7.8	Relation between Live Load & Stress, Deflection for Br. No. 5 (RC)	7-18
Fig. 7.9	Relation between Live Load & Stress, Deflection for Br. No. 6 (PC)	7-19
Fig. 7.10	Relation between Live Load & Stress, Deflection for Br. No. 7 (PC)	7-19
Fig. 7.11	Relation between Live Load & Stress, Deflection for Br. No. 8 (RC)	7-20
Fig. 7.12	Relation between Live Load & Stress, Deflection for Br. No. 9 (PC)	7-21
Fig. 7.13	Calculation Results for Substructural Beam	7-36

CHAPTER 8

Fig. 8.1	Example for Sign of Axle Limit	8-16

CHAPTER 9

Fig. 9.1	Flow of Selection of Alternative Methods	9-4
Fig. 9.2	Structural Components of Bridges	9-5
Fig. 9.3	Injection Method	9-9
Fig. 9.4	Repair Method When Reinforcing Bar is not Corroded	9-10
Fig. 9.5	Repair Method When Reinforcing Bar is Corroded	9-10
Fig. 9.6	Steel Plate Application Method	9-12
Fig. 9.7	Protection with Gabions	9-16
Fig. 9.8	Protection with Concrete Block	9-16
Fig. 9.9	Protection with Concrete Slabs	9-16
Fig. 9.10	Protection with Stone Cast in Forms	9-16
Fig. 9.11	Protection with Cast Stone and Blocks	9-16
Fig. 9.12	Strengthening Method by Additional Beam	9-19
Fig. 9.13	Strengthening Method by Box Culvert	9-19
Fig. 9.14	Strengthening Method by Additional Pier	9-19
Fig. 9.15	Adding of Material Method	9-22
Fig. 9.16	Reinforcement of Cross Beam for Bridge No. 7 and No. 9 in Detail	9-23
Fig. 9.17	Strengthening of Pier	9-25

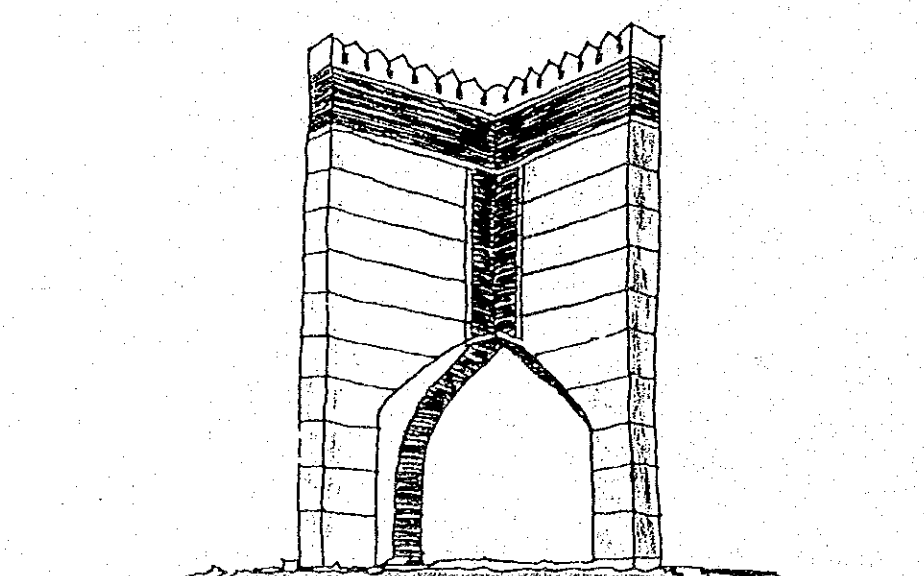
CHAPTER 10

Fig. 10.1	Organization of DGR	10-2
Fig. 10.2	Inspection Procedure	10-8
Fig. 10.3	Flow of Daily Inspection	10-13
Fig. 10.4	Inspection Flow	10-16
Fig. 10.5	Overall Soundness Evaluation Graph	10-24
Fig. 10.6	Flow of Emergency Inspection	10-25

ABBREVIATION

AAGR	Annual Average Growth Rate
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
AADT	Annual Average Daily Traffic
B/C	Benefit Cost Ratio
BS	British Standard
CTP	Central Transportation Planning
Cm3	Cubic Centimeter
Cm2	Square Centimeter
Dia. or ø	Diameter
DGR	Directorate General of Roads
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EL	Elevation
F/S	Feasibility Study
GDP	Gross Domestic Product
HUC	Highway User Cost
J/C	Junction
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
Kg	Kilogram
Km	Kilometer
LS	Lump Sum
mm	Millimeter
MOC	Ministry of Communication
MOD	Ministry of Defense
N.E.O	No Environmental Objection
NPV	Net Present Value
OD	Origin and Destination
PC	Pre-stressed Concrete
PCU	Passenger Car Unit
PD	Project Description
PDO	Petroleum Development of Oman
PU	Pedestrian Underpass
R/A	Roundabout
RC	Reinforcement Concrete
RO	Oman Rial
RTIM	Road Transport Investment Model
SD	Site Description
S/W	Scope of Work
U.A.E.	United Arab Emirates
V/C	Volume Capacity Ratio

CHAPTER 1 INTRODUCTION

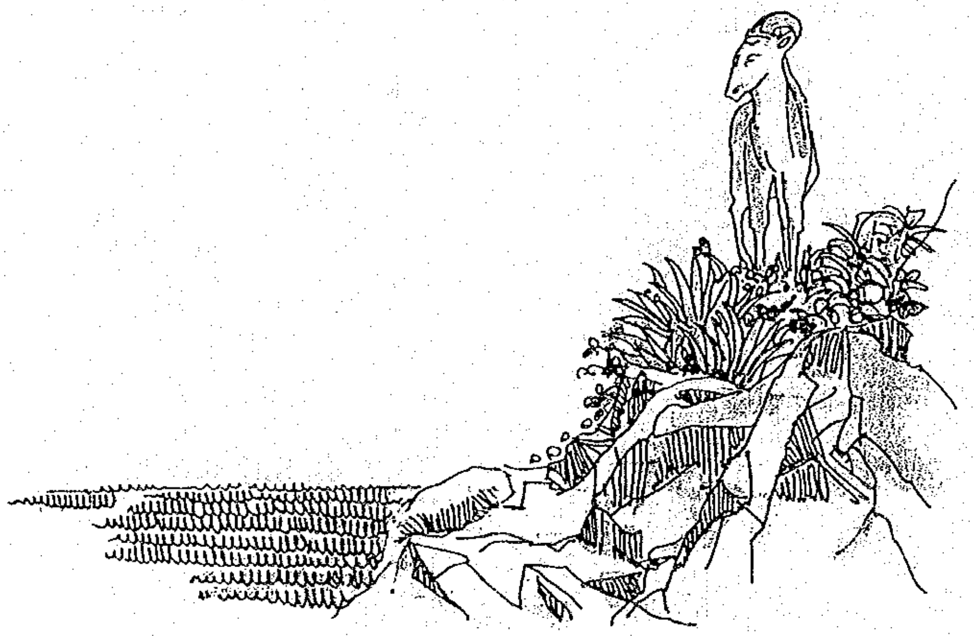


CHAPTER 1

INTRODUCTION

Contents of introduction of this volume are same as Volume II, accordingly, refer Volume II Chapter 1. Introduction.

CHAPTER 2 GENERAL CONDITION OF EXISTING HIGHWAY BRIDGES ON OMAN



CHAPTER 2

GENERAL CONDITION OF EXISTING HIGHWAY BRIDGES IN OMAN

2.1 General

The Directorate General of Roads (DGR), Ministry of Communications of the Sultanate of Oman, is currently performing maintenance of all 58 bridges. The road network in the Sultanate of Oman consists of the Batinah Highway which is the main trunk running northwest to southwest along the coast line, and the other roadway systems that intersect with it.

The main roadways requiring the study of bridges in the project area are National Roads Routes 1, 7, 13, 15, 21 and 23. Of the 58 bridges, almost all are concrete bridges (reinforced concrete and prestressed concrete bridges), and only two have superstructures of structural steel.

The improvement of road networks in the Sultanate of Oman was started in 1970, and most of the bridges were completed between 1975 and 1982. All bridges have been in service for more than 20 years, and in recent years with the increase of traffic and size of the vehicles, and due to the superannuation of existing bridges, their deterioration has progressed at an alarming rate.

This project has been discussed with the Directorate General of Roads to study the bridges of which 6 are cast-in-place reinforced concrete bridges and 3 are prestressed concrete bridges for a total of 9 bridges.

Collection of data for the bridges and analysis therefore have been conducted as follows:

1) Confirmation of bridge names, route names, location of bridges, and name of administering office.

2) Confirmation of type of bridges, type of structure, and special features.

3) Confirmation of specifications and design standards.

4) Confirmation of date of completion, design loads, strength of materials, allowable stresses, and modulus of elasticity.

5) Confirmation of design documents, records of construction, as-built drawings.

6) Confirmation of bridge records (record of repairs, strengthening).

7) Bridges dimensions;
   - General drawings
   - Cross sections

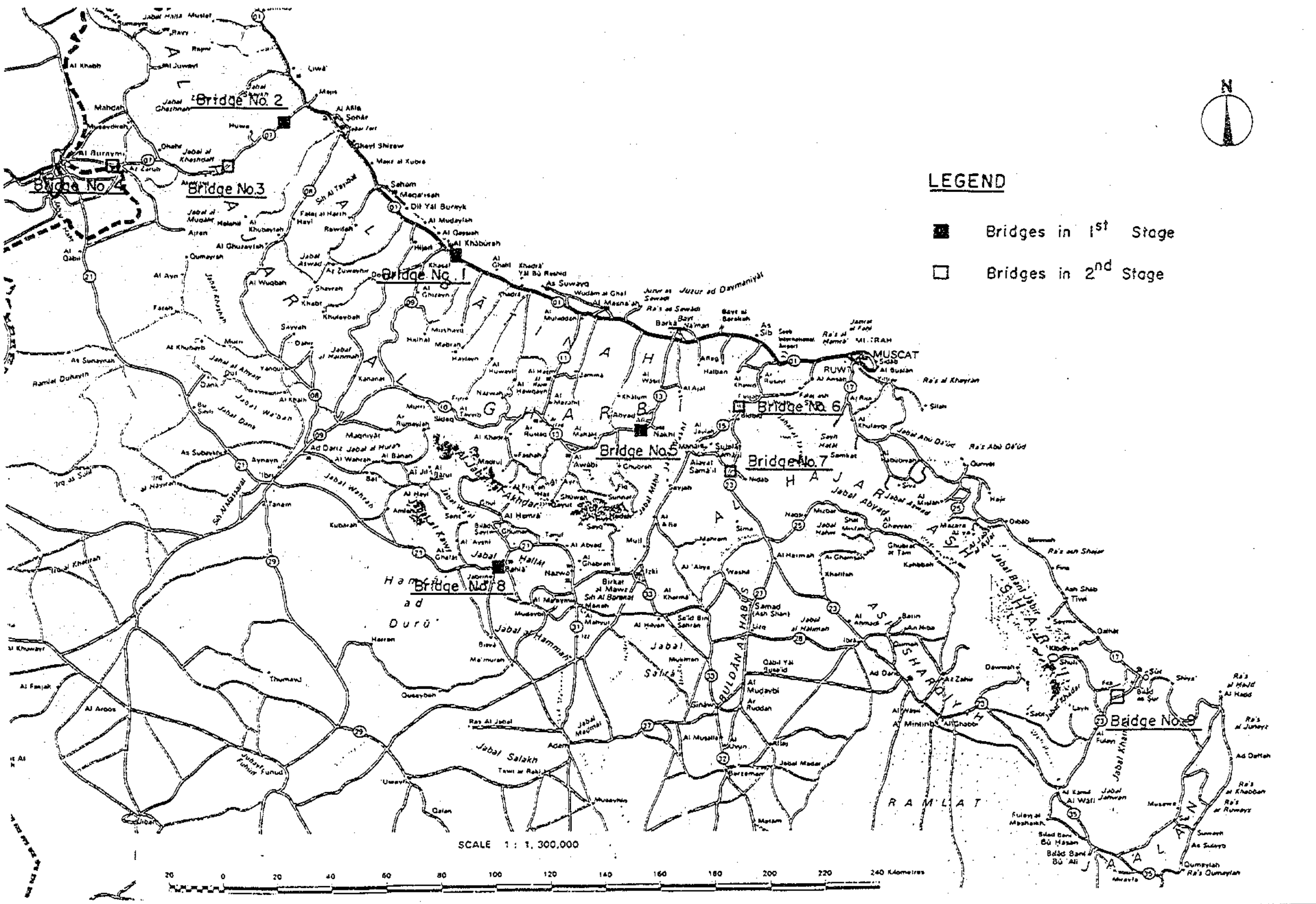
The bridge locations are given in Fig. 2.1 and bridge investigations were carried out in two stages.

Information on the bridges was collected and the dimensions of the bridges are given in Table 2.1.

General information on the bridges is as follows:

Bridge Lengths:	L = 76 m ~ 211 m	
Bridge Widths:	W = 8.60 m ~ 10.90 m	
Design Live Loads:	U.S.	AASHTO HS20-44 32 tons
	U.K.	45 HB
	France	BC-30T
Period Completed:	1975 ~ 1982	

Together with the bridge investigation, the bridge maintenance and methodologies, bridge repair planning, and bridge inspection reporting system, bridge records filing system will be recommended.



THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. 2.1 Bridge Location in Study Area**

Table 2.1 Bridge List for Inspection, Examination and Load Test

Bridge No.	Route Bridge Name	Bridge Type	Bridge Length	Span	Width (m)	Pier Height (m)	Design Live Load	Constructed Year	Remarks
1.	Batinah Coastal Highway Bat-1/308-02	R/C	90.00	6@15.0	10.50	4.20		1973	
2.	Wadi Al Jizi Bat-7/102-02	R/C	76.00	8.0 + 4@15.0 + 8.0	10.14	3.40	HS20-44 32t	1975 - 1977	
3.	Wadi Al Jizi Bat-7/105-15	R/C	211.00	8.0 + 13@15.0 + 8.0	10.10	10.64	HS20-44 32t	1975 - 1977	
4.	Wadi Al Jizi Dah-7/202-27	R/C	76.00	8.0 + 4@15.0 + 8.0	10.10	4.17	HS20-44 32t	1975 - 1977	
5.	Barka-Rustaq Bat-13/200-01	R/C	105.00	7@15.0	10.10	8.00		1980 - 1982	
6.	Rusail-Nizwa Dak-15/100-01	PC	180.00	6@30.0	10.10	15.00	45HB	1975 - 1977	
7.	Bidbid-Sur Dak-23/100-02	PC	146.90	20.95 + 5@21.0 + 20.95	10.86	10.96	BC-30t	1975 - 1977	
8.	Buraimi/Ibri/Nizwa Dak-21/600-01	R/C	135.00	9@15.0	10.10	7.54	45HB	1979 - 1981	
9.	Bidbid-Sur Srq-23/600-12	PC	146.90	20.95 + 5@21.0 + 20.95	10.86	11.00	BC-30t	1975 - 1977	

(dark shading) 1st Stage

(light shading) 2nd Stage

2.2 Present Condition of Reinforced Concrete Bridges and Prestressed Concrete Bridges

The bridges which are operated and maintained by the Directorate General of Roads (DGR) consist of 44 RC bridges, 12 PC bridges and 2 structural steel bridges.

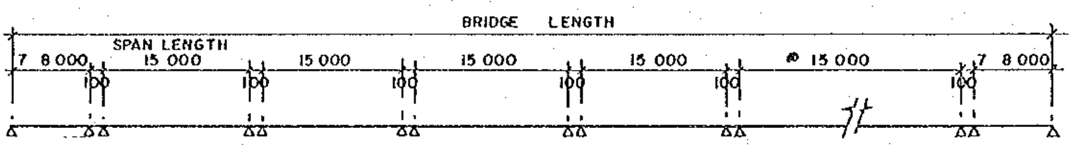
The length of RC bridges is determined by the existing river widths, and the standard spans are all 15 m each. There are some bridges with the end spans of 7 to 8 m in order to adjust the bridge lengths of RC construction. The bridge types are of the T-beam type.

The overall bridge widths are approximately 10 m wide with two lanes and pedestrian walkways on each side.

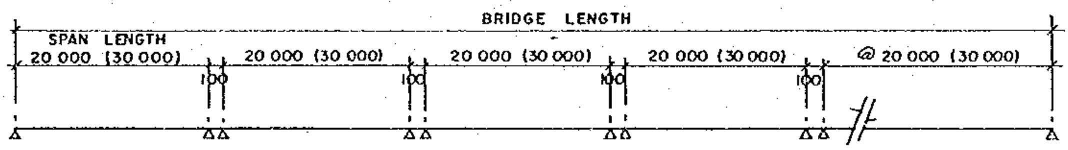
The PC bridge lengths are also determined by the river widths, and the standard spans are each 20 m and 30 m each. The bridges are of the T-beam and I-beam types. The overall bridge widths are also about 10 m wide similar to the RC bridges.

As described above, the RC and PC bridge types of this project can be generally classified into the four types indicate in Fig. 2.2 and Fig. 2.3. The cross-hatched portions in the drawings describe the main beams and the bridge deck and were most likely to have been fabricated in a factory or cast on site.

The bridge substructures are either of the two-column type or the wall type cast directly in the field in reviewing the as-built drawings.

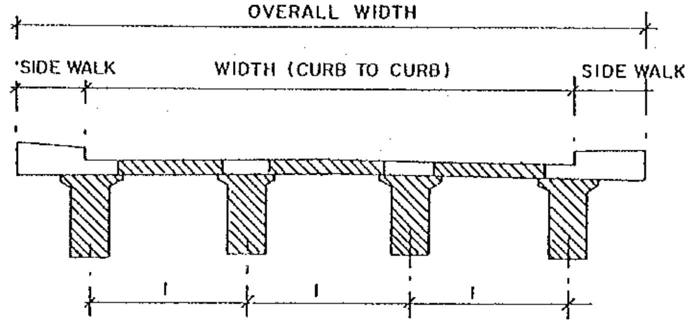


SPAN LENGTH FOR RC SIMPLE BEAM BRIDGE

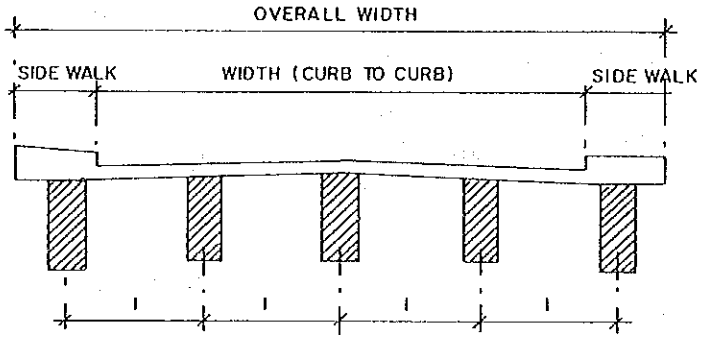


SPAN LENGTH FOR PC SIMPLE BEAM BRIDGE

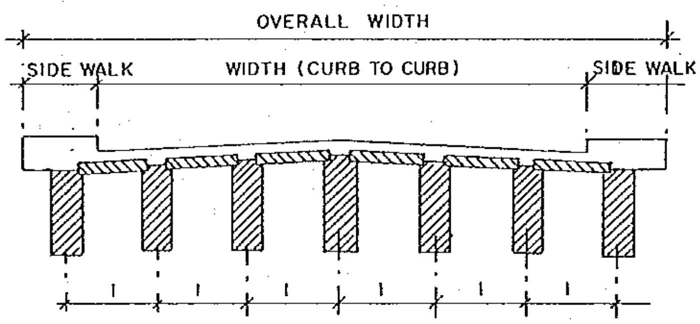
THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. 2.2 Span Length for RC and PC Simple Beam Bridge**



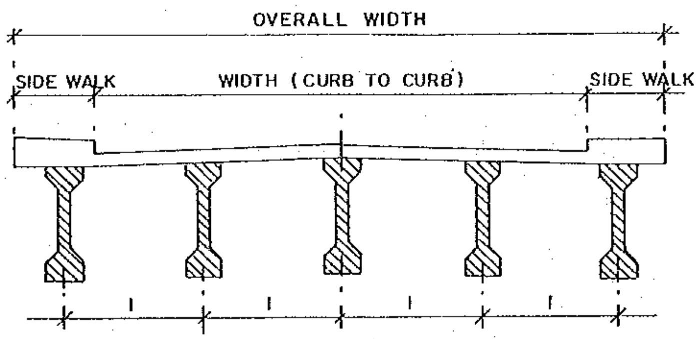
Type A: Precast R/C Beam with Precast R/C Slab



Type B: Rectangular Precast R/C Beam with Cast in Place R/C Slab



Type C: Rectangular Precast P/C Beam with Precast and Cast in Place R/C Slab



Type D: Precast P/C Beam with Cast in Place R/C Slab

THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	Fig 2.3 Superstructural Type for Existing 9 Bridges

2.3 Circumstances of Design and Construction

In reviewing the present maintenance and operation records of the bridges, the following three international standards were found to be the criteria for live load and design standard.

AASHTO	HS 20-44 32 tons
British Standard	45 HB
French Standard	BC-30 tons

The AASHTO HS 20-44 live load criteria seems to have been the most frequently cited standard.

The original as-built drawings describe the concrete design standard, reinforcing steel diameter and tensile strength, and the types of prestressing tendons.

The quality and/or load test information of the design documents have an important bearing on the test results as will be described in the following paragraphs.

Design Condition for the Bridges (As-built Drawings)

Case 1 Reinforced Concrete Bridge

1. Concrete Class: 350/20 Reinforced concrete in deck slabs, beams, piers and abutments, pier columns, breastwalls, wingwalls and buttresses of abutments, base to columns of piers. 300/40 in footings of piers and abutments.

2. Cover to all main reinforcement 50 mm generally and 80 mm to submerged parts. Cover to reinforcement of slab 30 mm.

3. Reinforcing Steel to BS 4499 and BS 4461.

4. Shoes Fixed neoprene bearing:

   Neoprene 250 x 400 allowing 12 mm movement.

Case 2 Reinforced Concrete Bridge (cast in place)

1.	Concrete Class:	Minimum Compressive strength	-	280 kg/cm^2
		Superstructure, piers and abutments	-	280 kg/cm^2
		Lean concrete for levelling under footings	-	140 kg/cm^2
2.	Reinforcing bar:	Minimum yield strength	-	4,200 kg/cm^2

3. References codes and Standards:

   Adopted by AASHO Ninth Edition 1973

Case 3 Prestressed Concrete Bridge

1. Concrete Specifications:

   Precast beam minimum cube strength at 28 days,

   430 kp/cm^2 = 430 $kg{\bullet}f/cm^2$

   or

   42.14 N/mm^2

2. Cables:

   A capacity of 86.4 MP, stressed from one end steel specifications: Ultimate strength 170 kp/mm^2 or

   Elastic limit 150 kp/mm^2 = 150 $kg{\bullet}f/cm^2$

   Elastic modules E = 21 x 10^5 kp/cm^2

   = 2.1 x 10^6 kg/cm^2

   or

   205.8 kn/mm^2

   Non-tensioned reinforcement: in precast beam, stirrups, shear connectors, etc.

   High tensile deformed steel bars.

Case 4 Prestressing Concrete Bridge

1. Concrete Specifications:

   Precast beam minimum cube strength at 28 days, 400 kg•f/cm^2

2. Cables:

   Cable 12ø8mm

* Cylinder Concrete Strength σ28 = -17.4 + 0.830 x Cube Strength (kg/cm^2)

	Cube Strength	Cylinder Concrete Strength σ28 kg/cm^2
Reinforced Concrete	350 300 (Footing)	273 → 270 232
Reinforced Concrete (Cast in Place)	280 140 (Lean Concrete)	215 99
Prestressed Concrete (Br-6) (Precast Beam)	430	340
Prestressed Concrete (Br-7, 9) (Precast Beam)	400	315

CHAPTER 3 PLAN AND SCHEDULE OF INSPECTION

CHAPTER 3

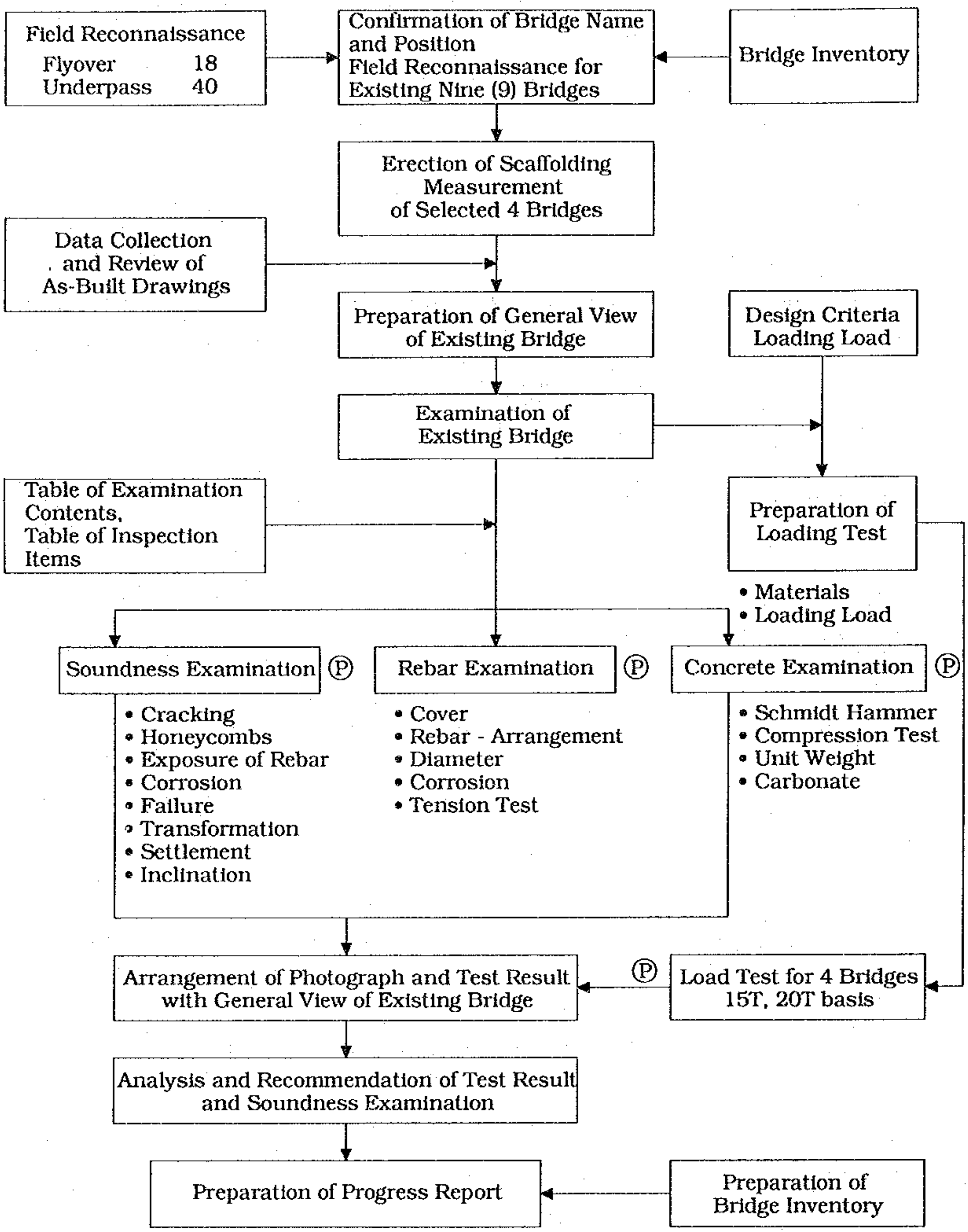
PLAN AND SCHEDULE OF INSPECTION

Investigation of all 9 bridges were made to learn their present condition by load testing during the 1st and 2nd Study Trips in two stages. During the 1st Study, investigations were made of 4 RC bridges, and during the 2nd Study 2 RC bridges and 3 PC bridges were investigated.

A Flow Chart of the investigations is given in Figs. 3.1 and 3.2.

Also a list of activities in the field during both trips are given in Table 3.1 and Table 3.2.

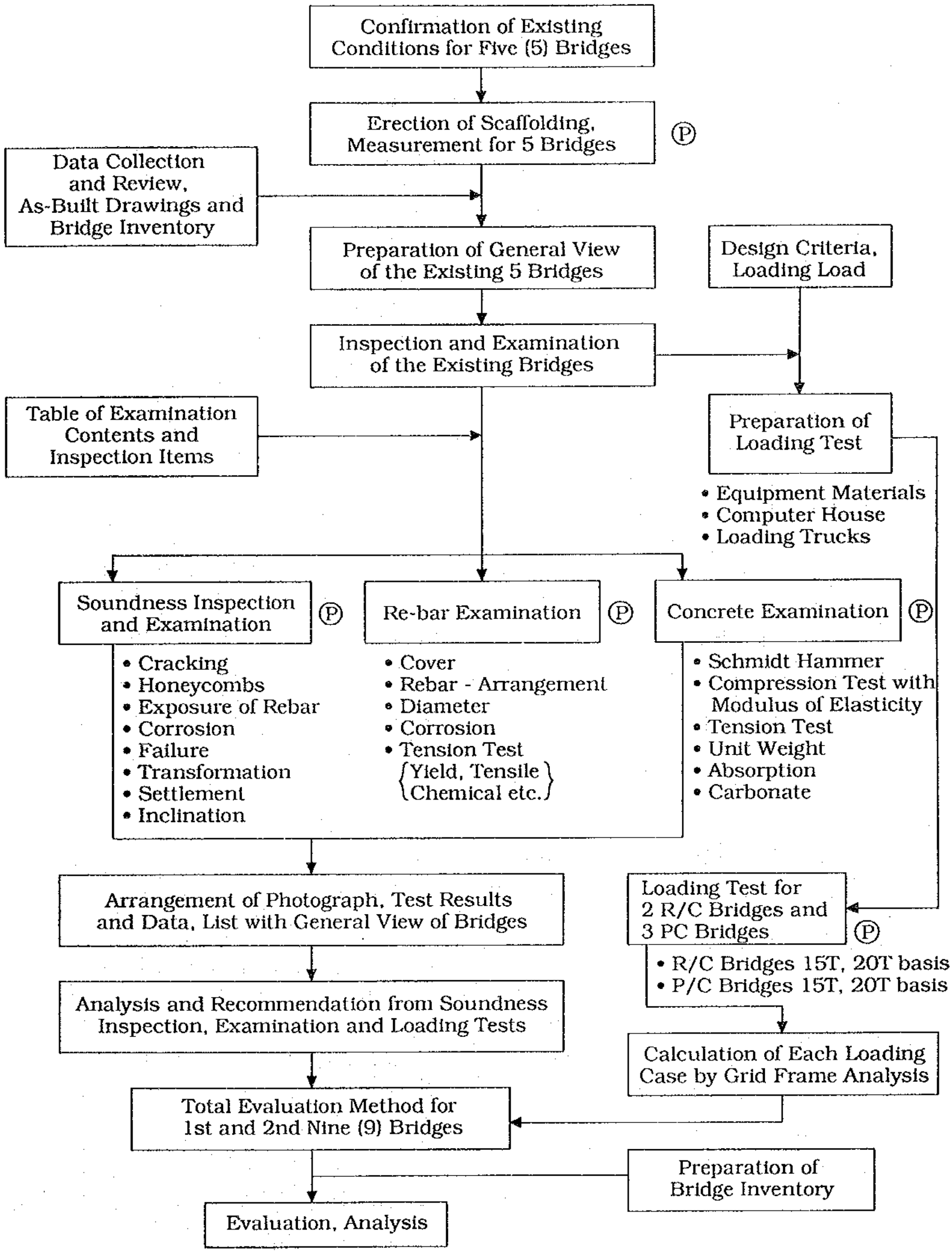
Flow Chart for 1st Field Survey



Note: (P) means with photograph

Fig. 3.1 Flow Chart for 1st Study

Flow Chart for 2nd Field Survey



Note: Ⓟ means with photograph

Fig. 3.2 Flow Chart for 2nd Study

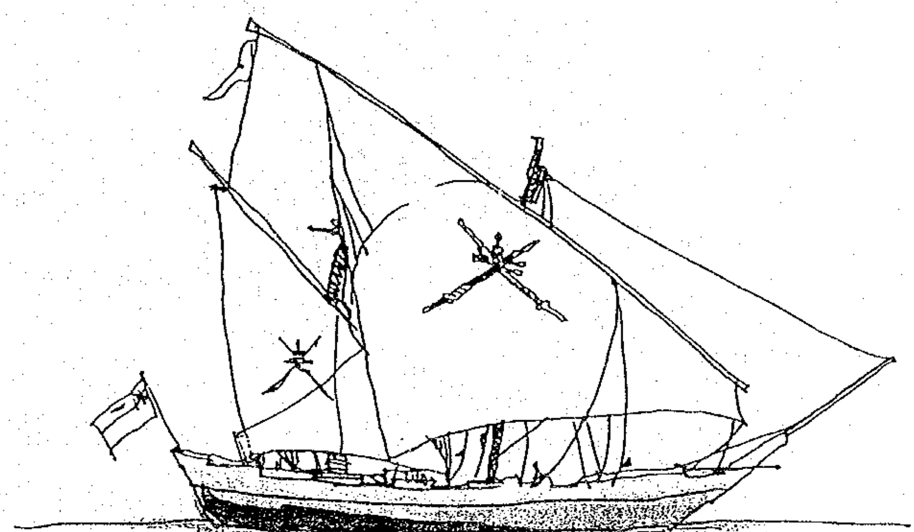
Table 3.1 Schedule of 1st Stage for Field Survey & Load Test

Bridge No.	Feb. 1 / 15 / Mar. 1 / 15 / 31	Remarks
No. 2 Wadi Al Jizi Bat-7/102-02	Preparation Load Test Inspection & Examination	
No. 5 Barka - Rustaq Bat-13/200-01	Load Test Inspection & Examination	
No. 1 Batinah Coastal Highway Bat-1/308-02	Scaffolding Load Test Inspection & Examination	
No. 8 Buraimi/Ibri/Nizwa Dak-21/600-01	Scaffolding Load Test Inspection & Examination Data, Equipment	

Table 3.2 Schedule of 2nd Stage for Field Survey & Load Test

Bridge No.	Apr. 15 / May 1 / 15 / Jun. 1 / 15	Remarks
No. 3 Wadi Al Jizi Bat-7/105-15	Preparation Scaffolding Load Test Inspection & Examination	
No. 7 Bidbid - Sur Srg-23/600-12	Scaffolding Load Test Inspection & Examination	
No. 4 Wadi Al Jizi Dah-7/207-27	Load Test Inspection & Examination	
No. 6 Rusail - Nizwa Dak-15/100-01	Scaffolding Load Test Inspection & Examination	
No. 9 Bidbid - Sur Dak-23/100-2	Scaffolding Load Test Inspection & Examination Data, Equipment	

CHAPTER 4 INVESTIGATION OF SOUNDNESS OF EXISTING BRIDGES



CHAPTER 4

INVESTIGATION OF SOUNDNESS OF EXISTING BRIDGES

4.1 Method of Investigation for Soundness Test

4.1.1 Field Investigations

The 9 bridges in this project were investigated in the field to determine their present condition, and the items of investigation were as follows:

(1) Selection of the bridge spans to be investigated.

(2) Plans for erection of inspection platforms to perform the investigations.

(3) Routing of road traffic to perform the investigation and safety provisions.

(4) Materials required to make the investigations, and assignment of personnel to make the investigations.

(5) Plans for consigning work in the field

(6) Finalisation of field investigation plans.

4.1.2 A Description of the Investigation and Items to be Performed

In order to determine the soundness of the 9 bridges for this project, the following items of investigation were performed in the field. The investigations were made of the bridge superstructure, substructure and the foundations, and the entire structure of the bridges were investigated to determine their soundness. (see Table 4.1 and Table 4.2)

Table 4.1 Inspection and Examination Contents

Examination Items	Examination Contents	Inspection Method and Test Methods
(1) Present Condition	Cracking, Honeycombs, Reinforcing Corrosion Inspection from Table 4.2	Photograph of Damaged Parts
(2) Construction Condition	Measurement of Section	Convexes, Measurement Tape
	Reinforcement Covering	Measurement and Inspection of Covering by Pacometer
(3) Cracking	Crack Width	Naked Eye (Crack scale)
	Crack Length	Convexes
(4) Quality of Concrete	Compressive Strength Modulus of Elasticity Unit Weight Absorption Ratio	Schmidt Hammer Compressive Test of Concrete Core
	Carbonation Test	Phenol Phthalein Method
(5) Reinforcement	Corrosion Damage	Chipping & Naked Eye
	Tensile Test	Tensile Test
	Reinforcement Arrangement Diameter of Reinforcement	Inspection by Pacometer and Chipping

Table 4.2 Inspection and Examination Items

Members			Inspection Items
Super-structure	Concrete	Main Beam	Cracking, Scaling, Free Lime, Honeycombs, Corrosion Damage, Leakage, Vibration, Deflection, Loss of Member, Discoloration
		Cross Beam Stringer	Cracking, Scaling, Free Lime, Honeycombs, Corrosion Damage, Leakage, Loss of Member, Discoloration
		Slab	Cracking, Scaling, Honeycombs, Come-off, Damage of Joint, Corrosion Damage, Leakage
Sub-structure	Concrete	Abutment Pier	Cracking, Scaling, Corrosion Damage, Free Lime, Honeycombs, Wear, Discoloration, Leakage, Loss of Member
	Foundation		Settlement, Movement, Inclination, Scour
Shoe	Steel Shoe		Corrosion, Cracking, Loosening, Falling, Failure, Discoloration, Leakage, Deformation, Stuffed, Settlement, Movement, Inclination
	Rubber Shoe		Discoloration, Leakage, Deformation, Stuffed, Loss of Member
	Mortar		Cracking, Loss of Member
	Anchor Bolt		Corrosion Damage, Cracking, Loosening, Falling, Failure, Deformation
Hand Rail	Steel		Corrosion, Cracking, Loosening, Falling, Failure, Discoloration, Deformation
	Concrete		Cracking, Scaling, Corrosion Damage, Free Lime, Honeycombs, Discoloration, Loss of Member
Curb	Steel		Corrosion, Cracking, Loosening, Falling, Failure, Discoloration, Deformation
	Concrete		Cracking, Scaling, Corrosion Damage, Free Lime, Honeycombs, Discoloration, Loss of Member
Pavement	Asphalt		Pot Holes, Cracking, Rutting, Leakage
Expansion Joint	Steel		Corrosion, Cracking, Loosening, Falling, Failure, Abnormal Opening, Abnormal Sound, Deformation
	Rubber		Failure, Abnormal Opening, Abnormal Sound, Deformation, Loss of Member
Drainage			Corrosion, Cracking, Loosening, Falling, Failure, Discoloration, Leakage, Deformation, Loss of Member
Lighting			Corrosion, Cracking, Loosening, Falling, Failure, Discoloration, Leakage, Deformation, Loss of Member
Accessory			Corrosion, Cracking, Loosening, Falling, Failure, Deformation, Loss of Member

(1) Method of Inspection and Examination Equipment

1. Inspection Equipment

- Test hammer
- Scope
- Convexes
- Wire Brush
- Crack Gauge
- Calipers
- String
- Folding Measure

2. Record Equipment

- Camera with Strobe, Film
- Chalk
- Black Board
- Pen
- Record Paper
- Stationery

3. Accessory for Inspection

- Ladder
- Traffic Control Equipment
- Rope
- Torch
- Safety Belts
- Bridge Inspection Car

(2) Investigation of Quality of Concrete and Reinforcing Bars

Of the Inspections and Examinations in Table 4.3, Items 1 and 2 were limited to the quality of material, and Items 3, 4 and 5 were confined to taking cross sections of materials and making detailed inspections of the materials and their quality.

Table 4.3 Inspection and Examination of Existing Bridge Condition

Examination Items	Examination Method	Examination Parts
1. Bridge Length, Span	Measurement	All span
2. Cross Section Dimension	Measurement	Middle of Span and 1/4 of Span Total 2 Section
3. Reinforcement Content and Cover	Beam : Chipping Slab : Chipping	1/4 of Span
4. Allowable Stress of Concrete	by Test	
5. Allowable Stress of Reinforcement	ditto	

In the main girders, the concrete was chipped to expose the reinforcing steel at least 3 places, and the concrete strength was examined by taking concrete core samples. After the test examples were taken, the chipped concrete was repaired with quick-curing non-shrinking mortar.

The concrete and reinforcing steel samples tested for the 9 bridges are given in Table 4.4.

The test results were summarized as future material to appraise the soundness of the bridges.

1) Dimensions of the superstructure and substructures.
2) Strength of concrete.
3) Distribution of reinforcing steel and strength.
4) Degree of corrosion of reinforcing steel.
5) Conditions of the cracks in the concrete.
6) Neutralization of the concrete.

Table 4.4 Numbers of Concrete and Reinforcing Bar Test

Bridge No.	Concrete Core Size and Nos.			Concrete Test									Reinforcing Bar Test		
	ø100x200 mm	ø80x160 mm	ø50x100 mm	Compression + Modulus*		Compres-sion	Tension	Unit Weight	Absorp-tion	Mois-ture	Carbona-tion		Tensile Strength	Modulus of Elasticity	Chemical Composi-sion
				ø100x200	ø80x160	ø50x100									
1	-	6	1 Slab 2 Crack		3 (3)		3	6	6	6	8		2	-	1
2	12	-	2 Slab 2 Crack	6 (6)	-	2	6	14	13	13	16		3	2	1
3	6	-	2 Slab 4 Crack	3 (2)	-	2	3	8	8	8	12		2	-	1
4	12	-	2 Slab 4 Crack	4 (4)	-	2	4	10	10	10	18		2	1	1
5	7	-	2 Slab 2 Crack	4 (4)	-	2	3	9	7	7	11		3	2	1
6	6	-	2 Slab -	3 (3)	-	2	3	8	8	8	8		-	-	-
7	8	-	3 Slab -	5 (3)	-	3	3	11	11	11	11		-	-	-
8	6	-	1 Slab 2 Crack	3 (3)	-	1	3	7	6	6	9		2	1	1
9	1	5	2 Slab -	1 (1)	2 (2)	2	3	8	8	8	8		-	-	-
Total	58	11	17 Slab 16 Crack	29 (26)	5 (5)	16	31	81	77	77	101		14	6	6

*: Number of Modulus of Elasticity in ( )

Precautions in Obtaining Concrete Cores and Reinforcing Bar

When obtaining concrete cores, check the concrete for reinforcing bar with a Pacometer and avoid cutting the reinforcing bar. Select locations in the concrete main beam where neutralization is most severe (combine with neutralization test), and in order to use the core sample for compression test select locations in the concrete where there are few cracks. Preferred locations in RC bridges are at the quarter points of the longitudinal spans, at a height in the center of the beams.

In PC bridges due to the prestressing tendons, cores should be taken at a cross section point at a $\frac{1}{2}$ longitudinal point of the beam, at the top side of the beam.

Core samples taken from bridge decks should be from the center of the slab as the purpose is to determine the neutralization and the thickness. The remaining hole should be repaired with quick-curing non-shrink mortar. Testing with a Schmidt Hammer should be close to the location of the core drilling. Fig. 4.1 shows the locations where cores should be drilled, and Fig. 4.2 gives the general methods. Fig. 4.3 gives the method used to find the locations of reinforcing bar.

The locations where to obtain reinforcing bars from PC bridges are from the 1/4 point of the main beam on the lower side. Repair the rebar by welding a reinforcing bar of similar quality and patch with a non-shrink quick-curing mortar.

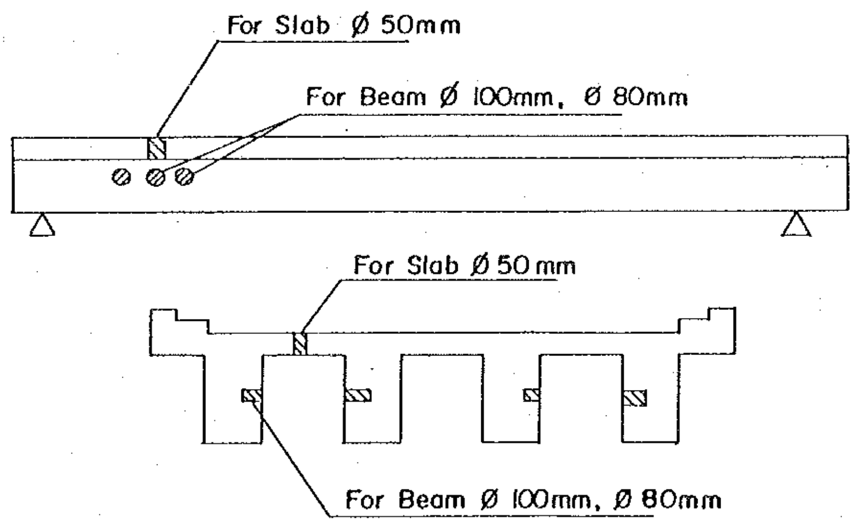


Fig. 4.1 Core Sampling Position (RC)

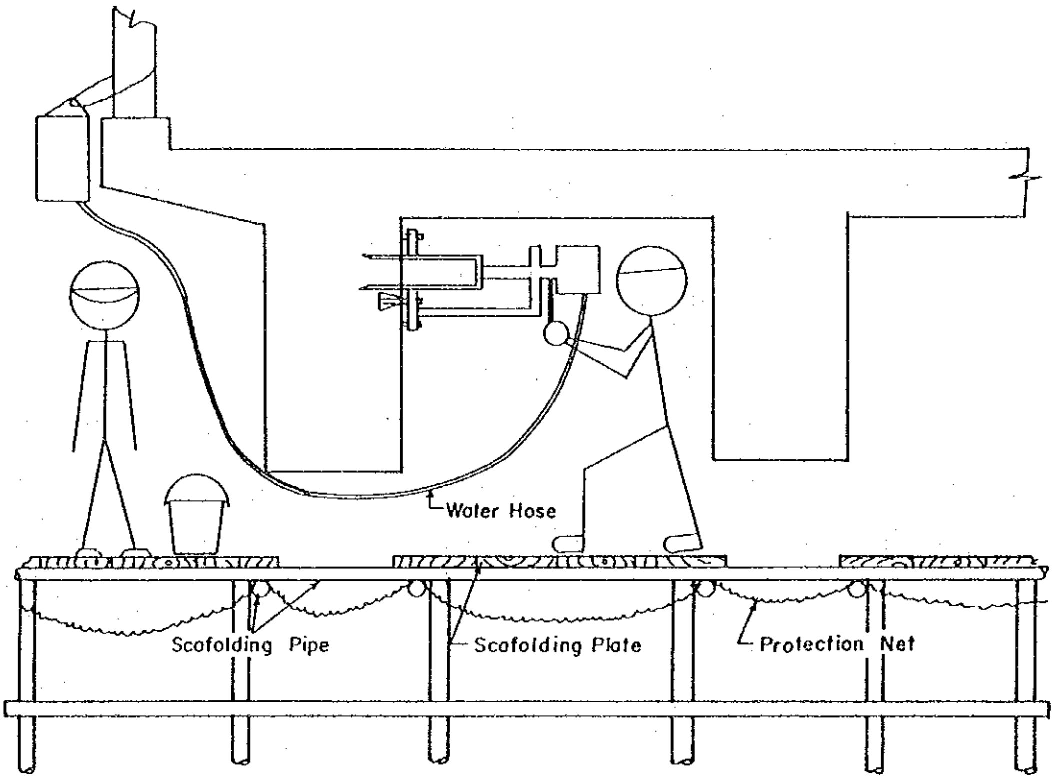


Fig 4.2 Core Sampling

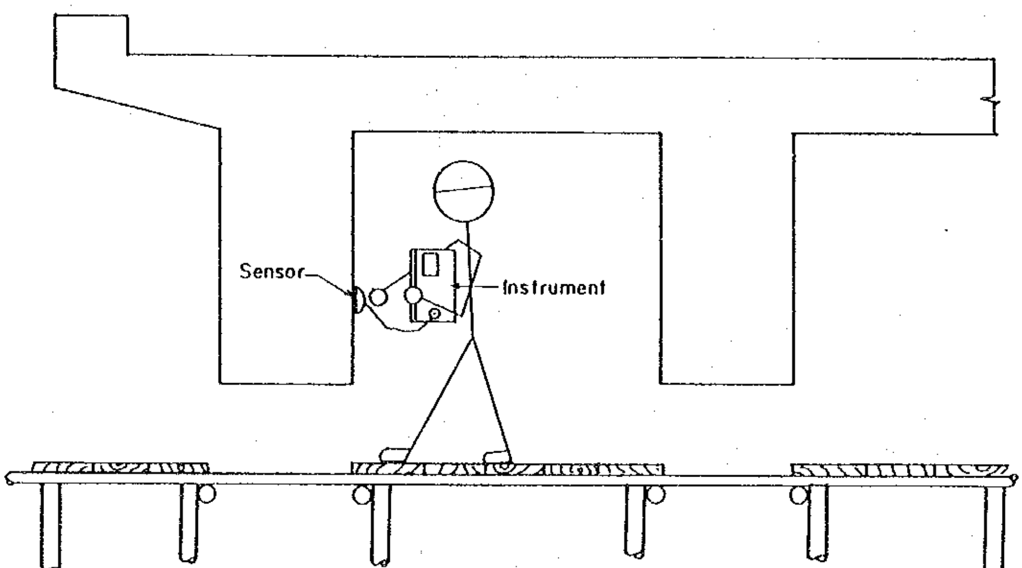


Fig 4.3 Measurement of Re–Bar Position by Sensor

THE STUDY ON ROAD DEVELOPMENT PROJECT	JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. 4.2 Core Sampling** **Fig. 4.3 Measurement of Re-Bar Position by Sensor**

(3) Measurement of Chlorides

The Quantab method was used to measure the amount of chlorides in hardened concrete.

1) Preparation of Test Samples

Concrete cores 100 mm dia., 200 mm high were taken from several locations in the girders, and from these samples, 12 mm dia. holes were drilled, approximately 100 g of concrete dust obtained and further pulverized from which about 70 g of fines passing the 149 μm standard sieve were obtained.

2) Test Method

Weigh at least 30 gram of pulverized concrete into a beaker using a balance with a capacity of 200 gram.

Add 1.5 times of distilled water (battery water, colorless, de-ionized) stirring to bring the powder into suspension for 30 minutes and extract the chlorides. To the solution add 3 Quantabs (low density) and extract solution after confirmed that the liquid portion changes from orange to blue, and take out the solution after confirming that capillary section has changed from brown to white, and read the top of the solution to 0.1, to determine the Cl ion density of the solution. Calculate the chlorine contents in hardened concrete from the following formula:

$$\text{Cl ion density} = \frac{\text{Cl ①} + \text{Cl ②} + \text{Cl ③}}{3} \times \frac{Ww}{Wc} \quad (\text{Cl } \%)$$

where, Wc: weight of original concrete samples (gr)

Ww: weight of water added (gr)

Cl ① + Cl ② + Cl ③: Chlorine ion density from each Quantab conversion table.

Note: When converting to NaCl, multiply a factor of 1.648 to the results

The standard value of chlorine density in hardened concrete is less than 0.04%.

The subject bridges are Bridge No. 4 for RC bridges, and Bridge No. 6 for PC Bridges.

4.2 Results of the Investigation for Soundness

The results of the investigation for the soundness test of the 9 bridges (6 RC bridges, 3 PC bridges) were shown in this section to determine their soundness and conditions as follows:

4.2.1 Present Conditions and Cracks

4.2.2 The Survey Data for Longitudinal Sections and Bridge Cambers

4.2.3 The Results of Concrete Strength

4.2.4 The Results of Reinforcing Bar Strength

4.2.5 Structural Drawing of Existing Bridges

4.2.6 Chloride Contents

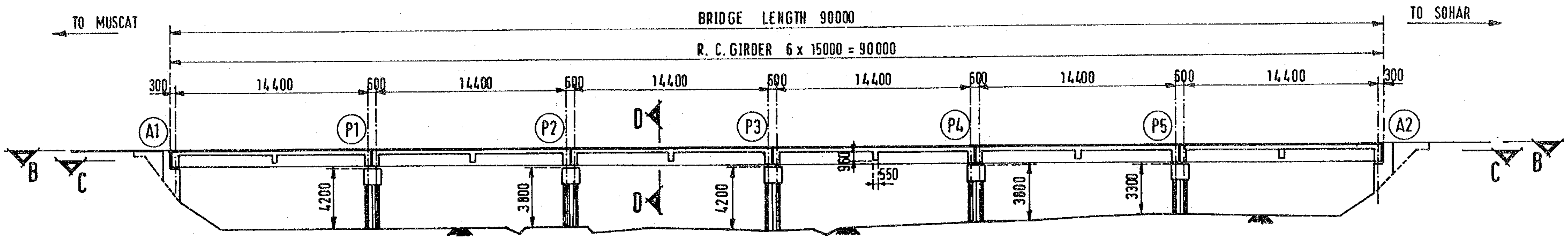
4.2.7 Damage Ranking Lists

BRIDGE NO.	BRIDGE TYPE	SIDE ELEVATION	PLAN ALIGNMENT	TYPICAL CROSS SECTION	SECTION OF PIER
NO. 1	PRECAST R.C GIRDER WITH CAST IN PLACE RC SLAB	90 000 6 @ 15000 = 90 000	R = ∞	10 500 750 9 000 750	10 450
NO. 2	PRECAST R.C GIRDER WITH PRECAST R.C SLAB	76 000 8000 4@15000=60000 8000	R = ∞	10 140 770 8 600 770	9 470
NO. 3	PRECAST R.C GIRDER WITH PRECAST R.C SLAB	211 000 8000 13 @ 15000 = 195 000 8000	R = ∞	10 100 750 8 600 750	9 400
NO. 4	PRECAST R.C GIRDER WITH PRECAST R.C SLAB	76 000 8000 4@15000=60 000 8000	R = 4 000	10 100 750 8 600 750	9 650
NO. 5	PRECAST R.C GIRDER WITH PRECAST R.C SLAB	105 000 7 @ 15000 = 105 000	R = ∞	10 100 1050 8 000 1050	9 400
NO. 6	R.C I GIRDER WITH CASTIN PLACE R.C SLAB	180 000 6 @ 30000 = 180 000	R = 470	10 100 1200 7 700 1200	10 900
NO. 7	R.C RECTANGULAR GIRDER WITH CASTIN PLACE R.C SLAB SUPPORTED ON PRECAST R.C BLOCKS	146 900 20950 5 @ 21000 = 105 000 20950	R = ∞	10 860 1680 7 500 1680	10 000
NO. 8	PRECAST R.C GIRDER WITH PRECAST R.C SLAB	135 000 9 @ 15 000 = 135 000	R = 575	10 100 1025 8 000 1075	9 400
NO. 9	R.C RECTANGULAR GIRDER WITH CASTIN PLACE R.C SLAB SUPPORTED ON PRECAST R.C BLOCKS	146 900 20950 5 @ 21 000 = 105 000 20950	R = ∞	10 860 1680 7 500 1680	10 000

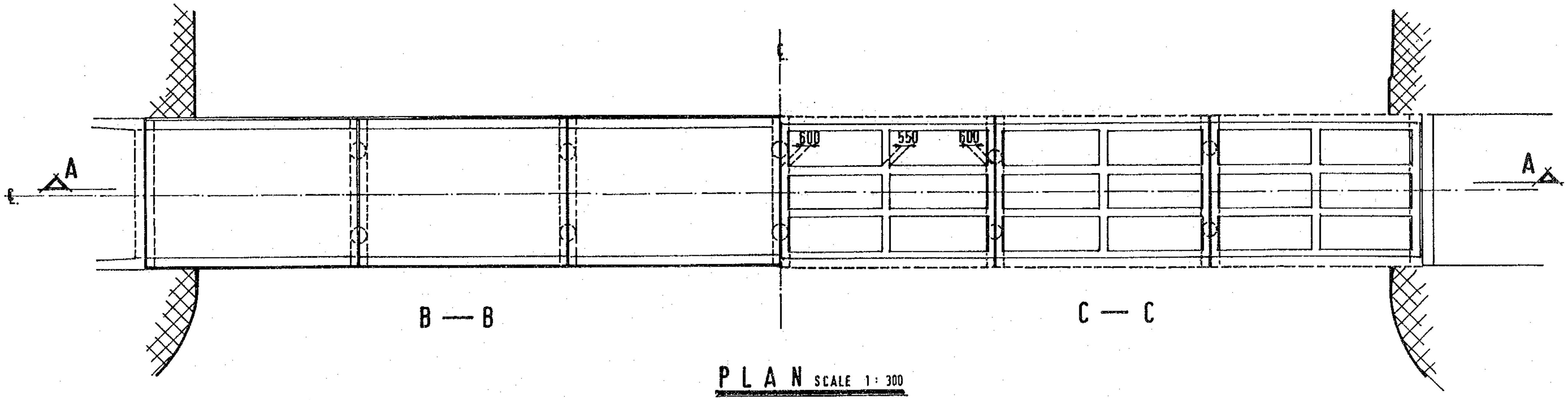
Fig 4.4 List of 9 Existing Bridges

4.2.1 Present Conditions and Cracks

The results of investigation for present conditions including dimensions and cracks for superstructures and substructures are summarized in Fig. 4.5 through Fig. 4.48.



SECTION A - A
SIDE ELEVATION SCALE 1 : 300



PLAN SCALE 1 : 300

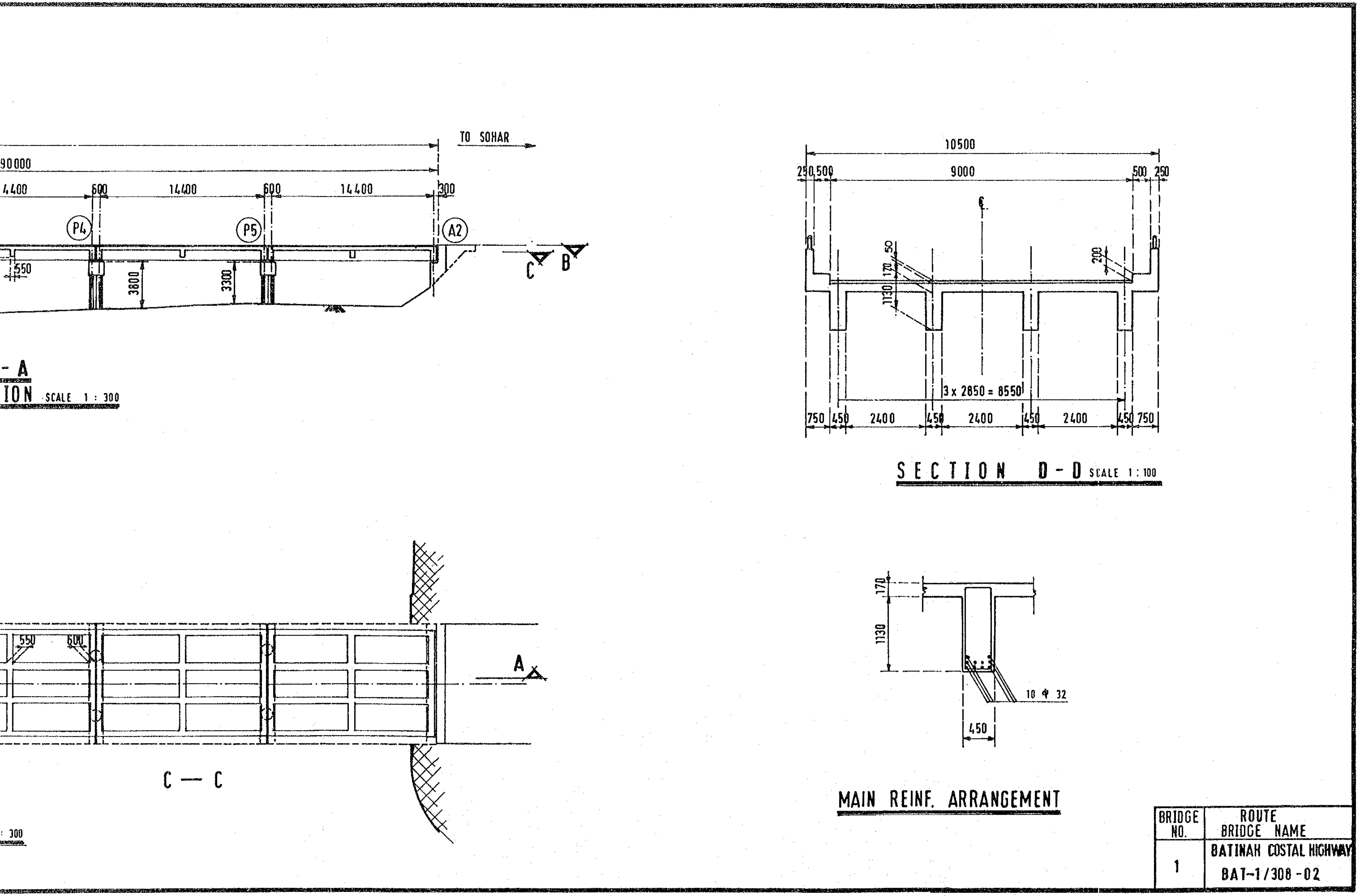


Fig 4.5 General View of Br.No.1

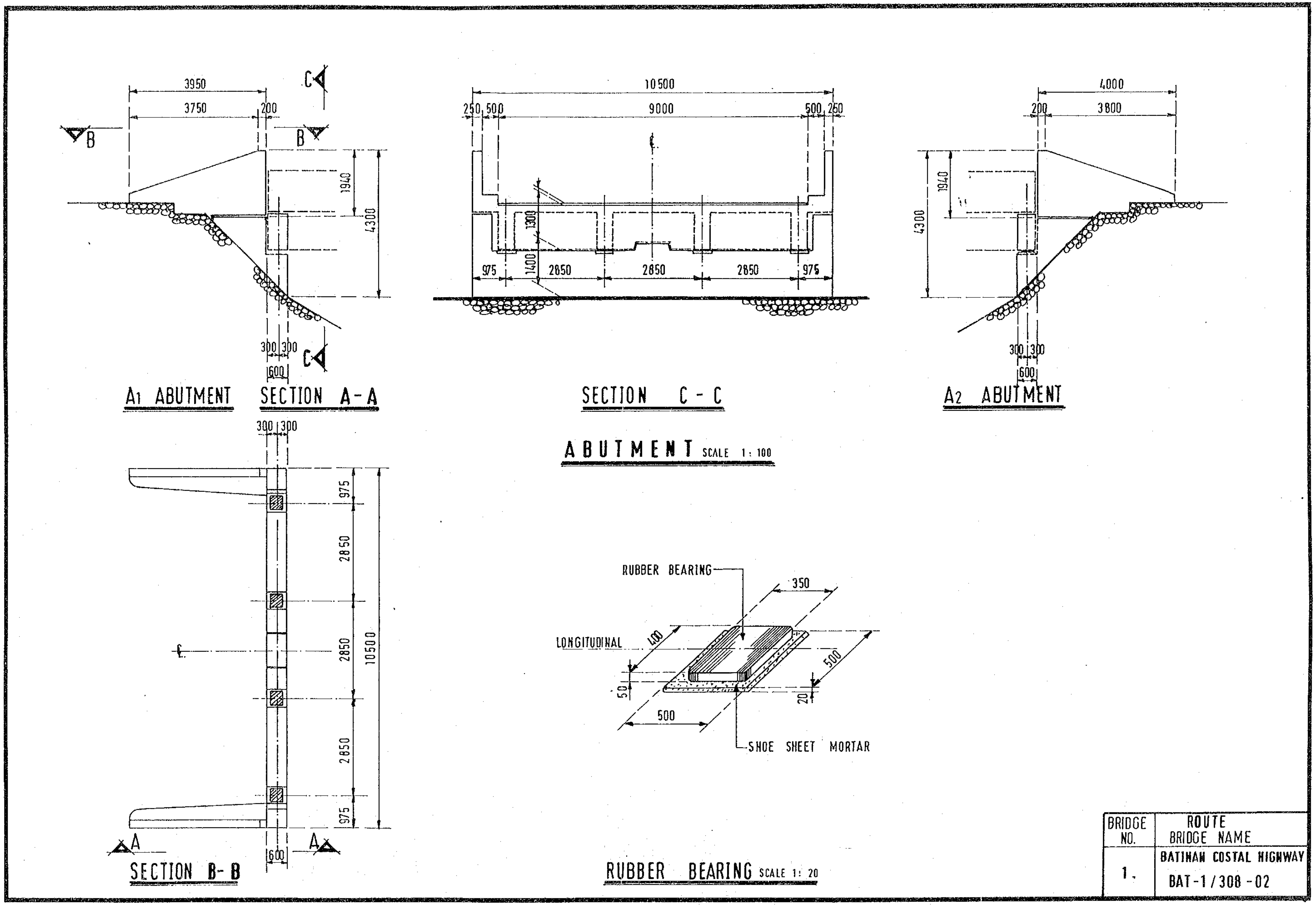
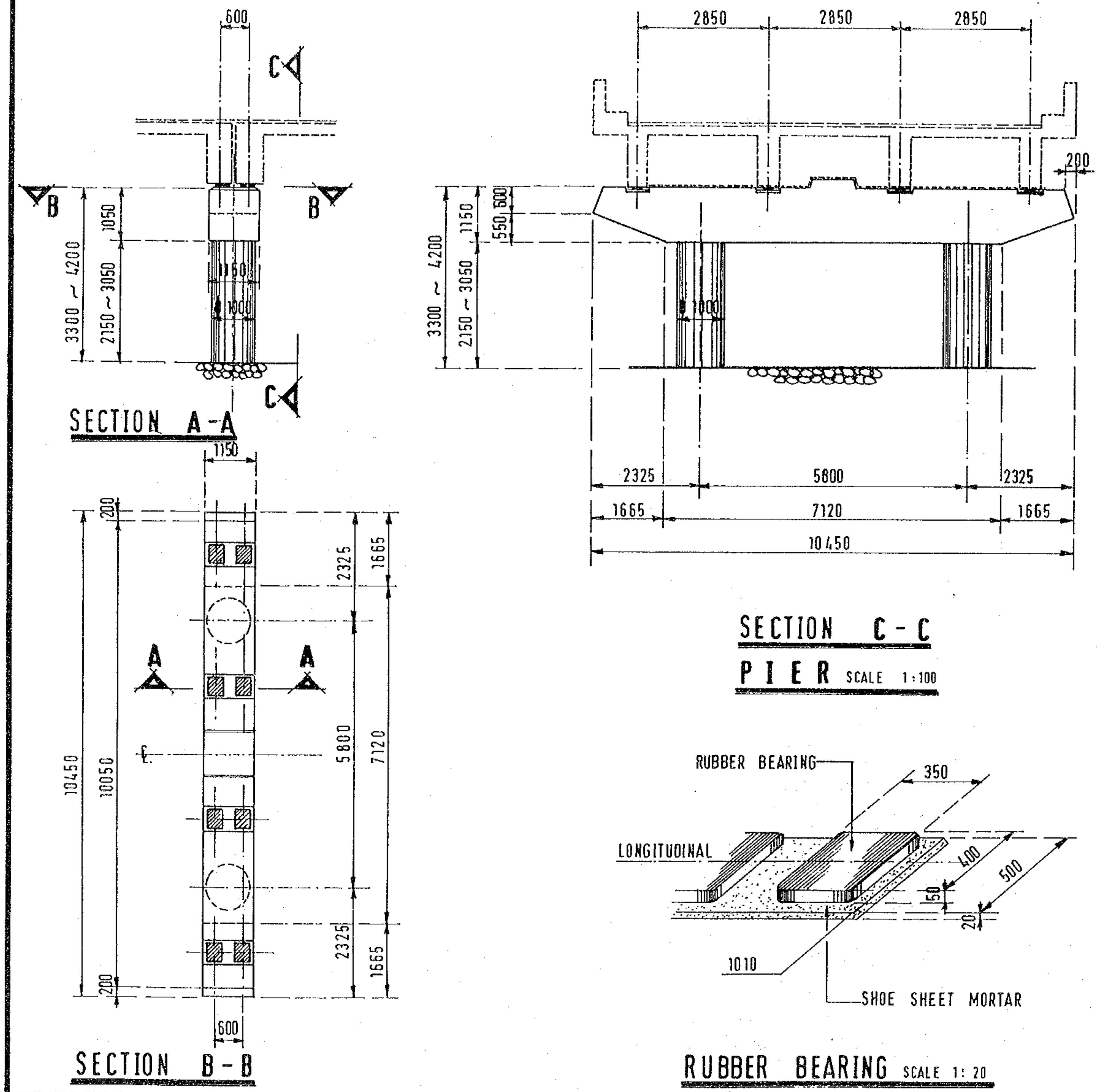
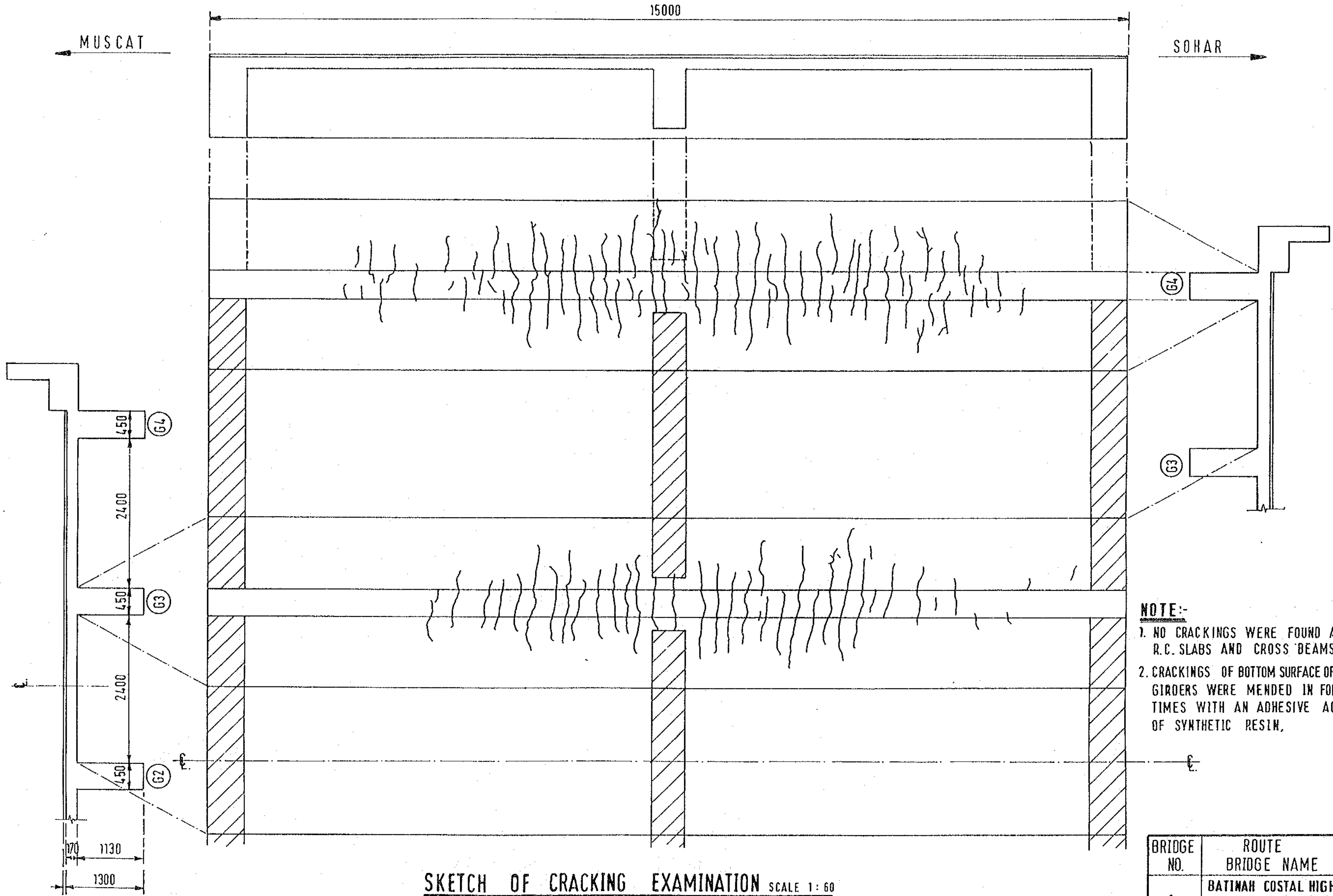


Fig 4.6 General View of Br.No.1



BRIDGE NO.	ROUTE BRIDGE NAME
1	BATINAH COSTAL HIGHWAY BAT- 1/308 - 02

Fig 4.7 General View of Br.No.1



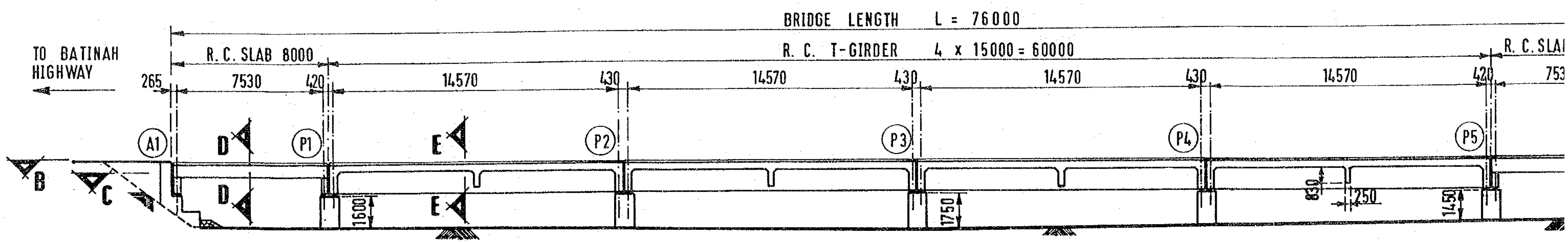
NOTE:-

1. NO CRACKINGS WERE FOUND AT THE R.C. SLABS AND CROSS BEAMS
2. CRACKINGS OF BOTTOM SURFACE OF MAIN GIRDERS WERE MENDED IN FORMER TIMES WITH AN ADHESIVE AGENT OF SYNTHETIC RESIN,

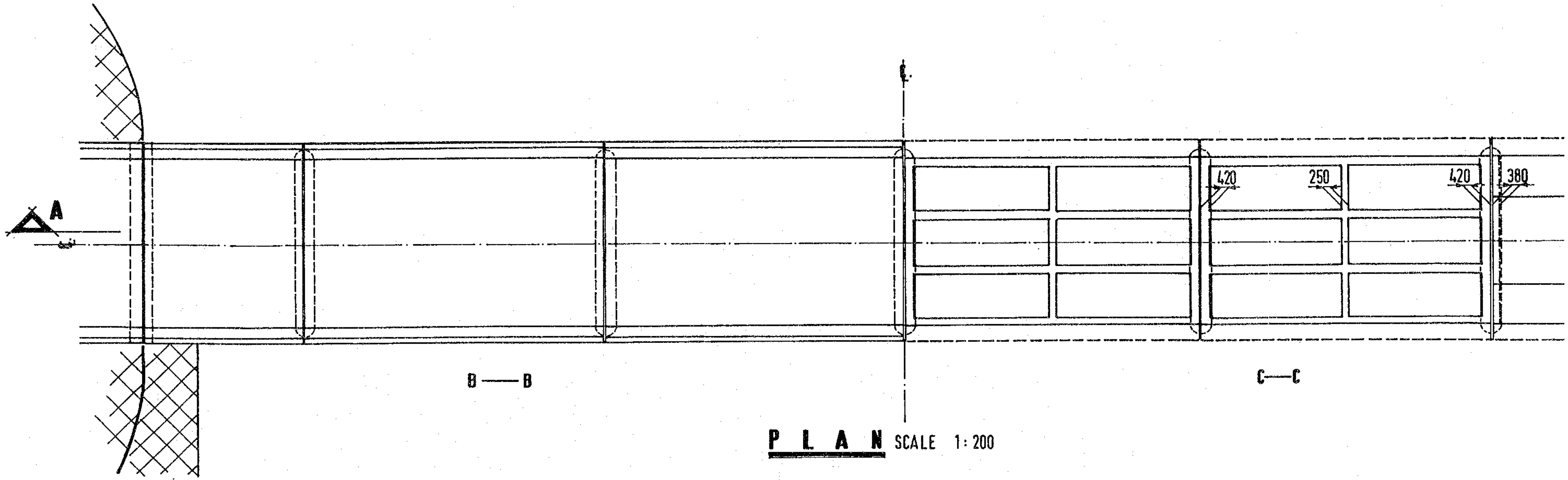
SKETCH OF CRACKING EXAMINATION SCALE 1 : 60

BRIDGE NO.	ROUTE BRIDGE NAME
1	BATINAH COSTAL HIGHWAY BAT-1/308-02

Fig 4.8 Cracking Conditions



SIDE ELEVATION
SECTION A - A SCALE 1: 200



P L A N SCALE 1: 200

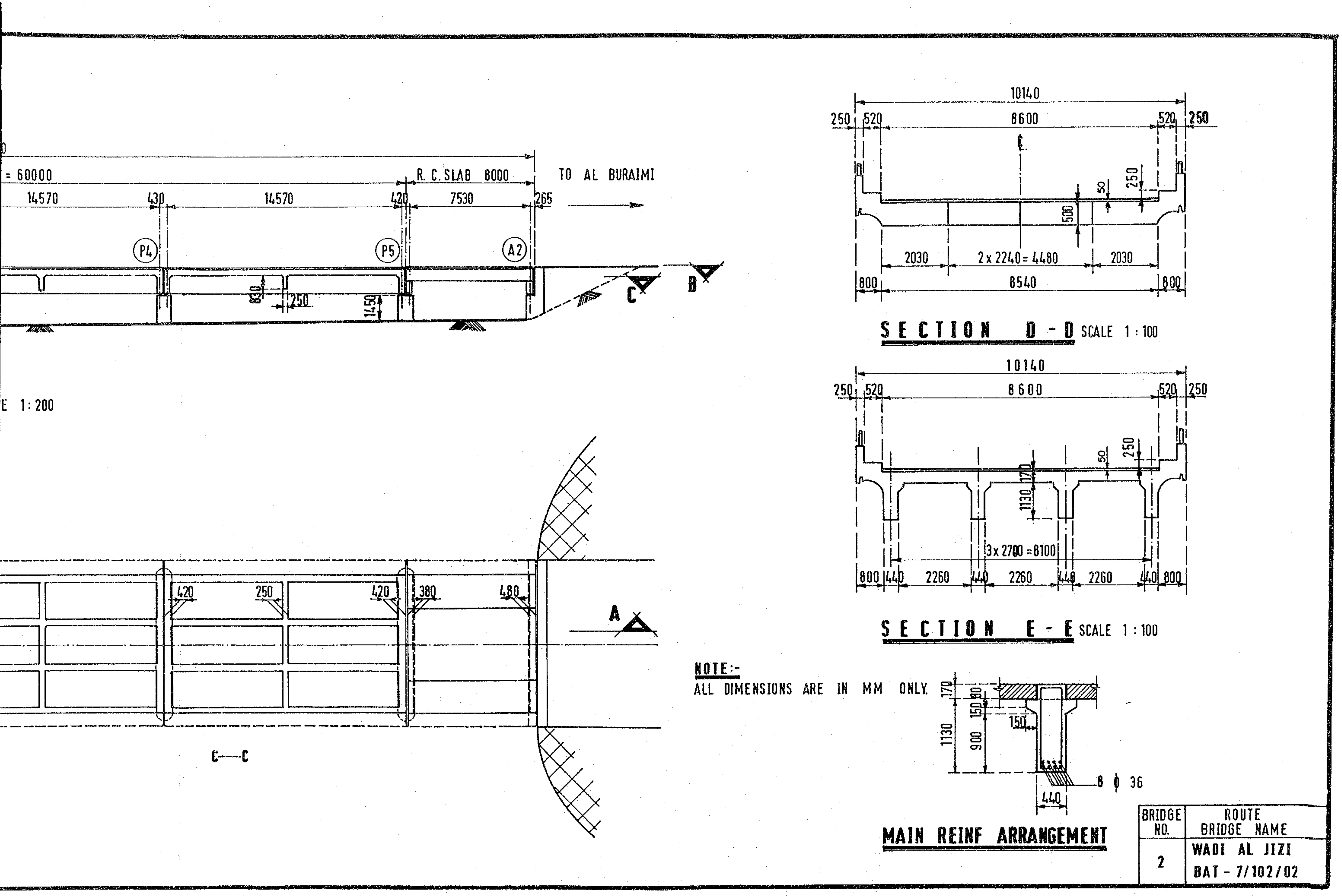


Fig 4.9 General View of Br.No.2

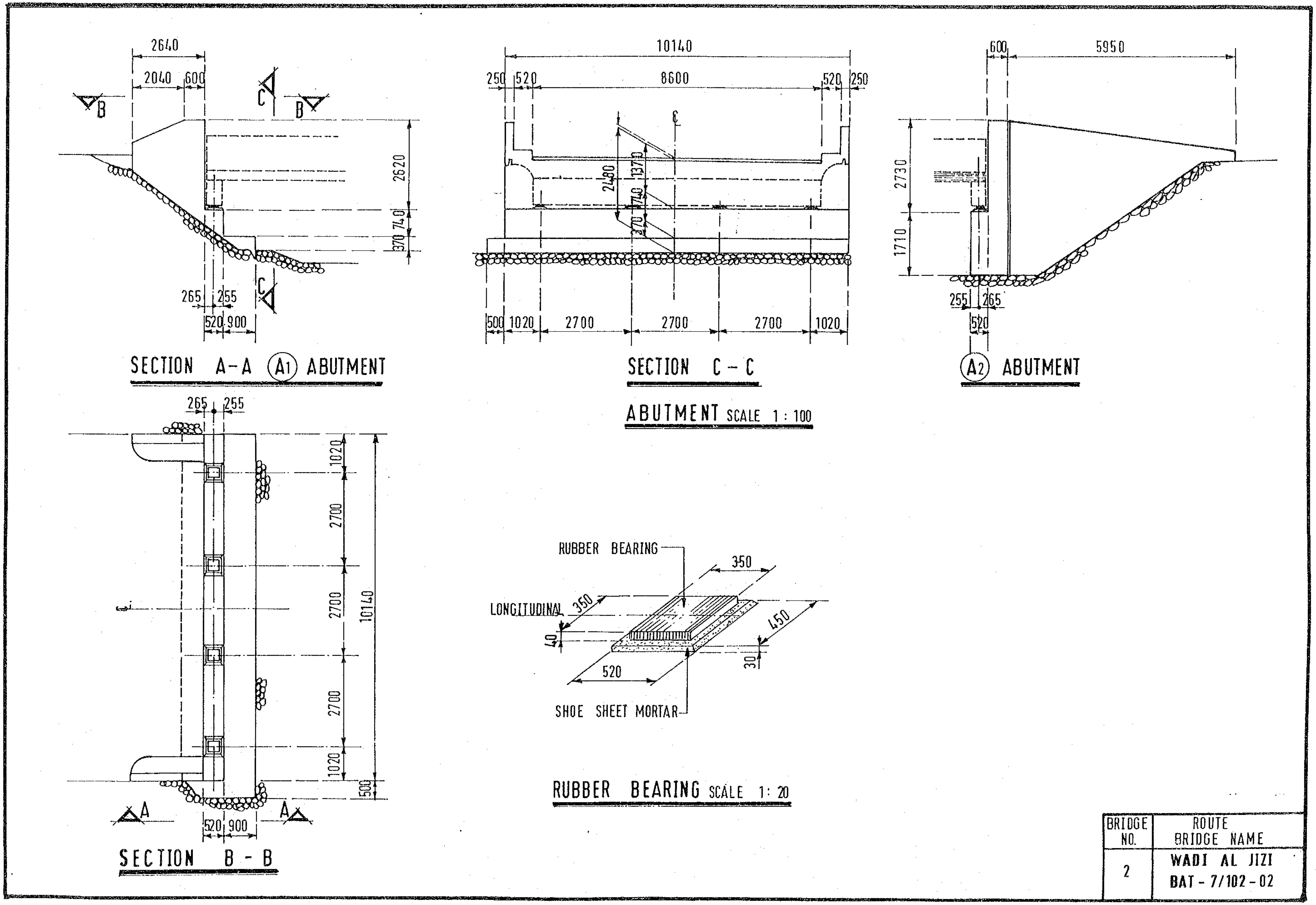


Fig 4.10 General View of Br.No.2

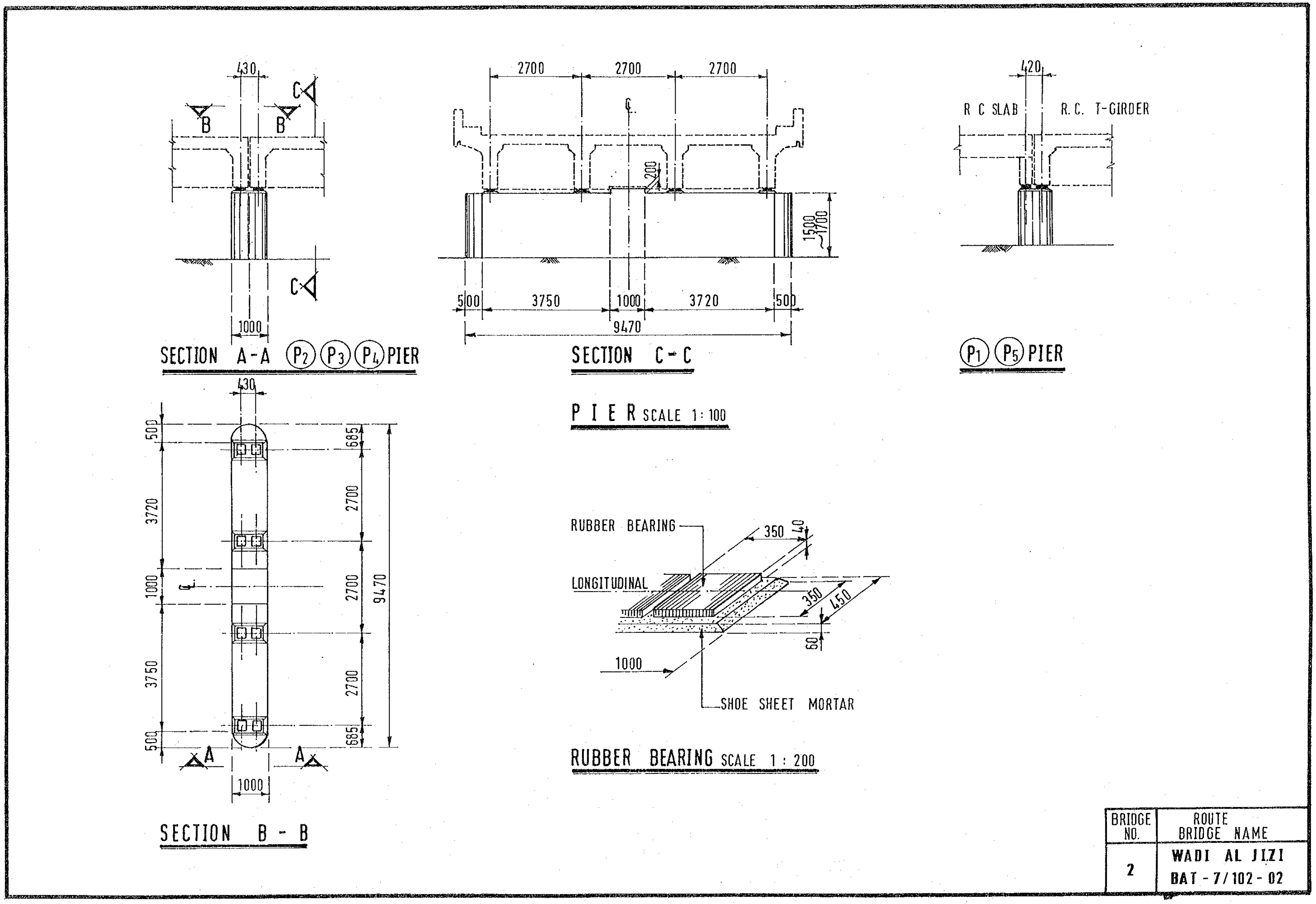


Fig. 4.11 General View of Br.No.2

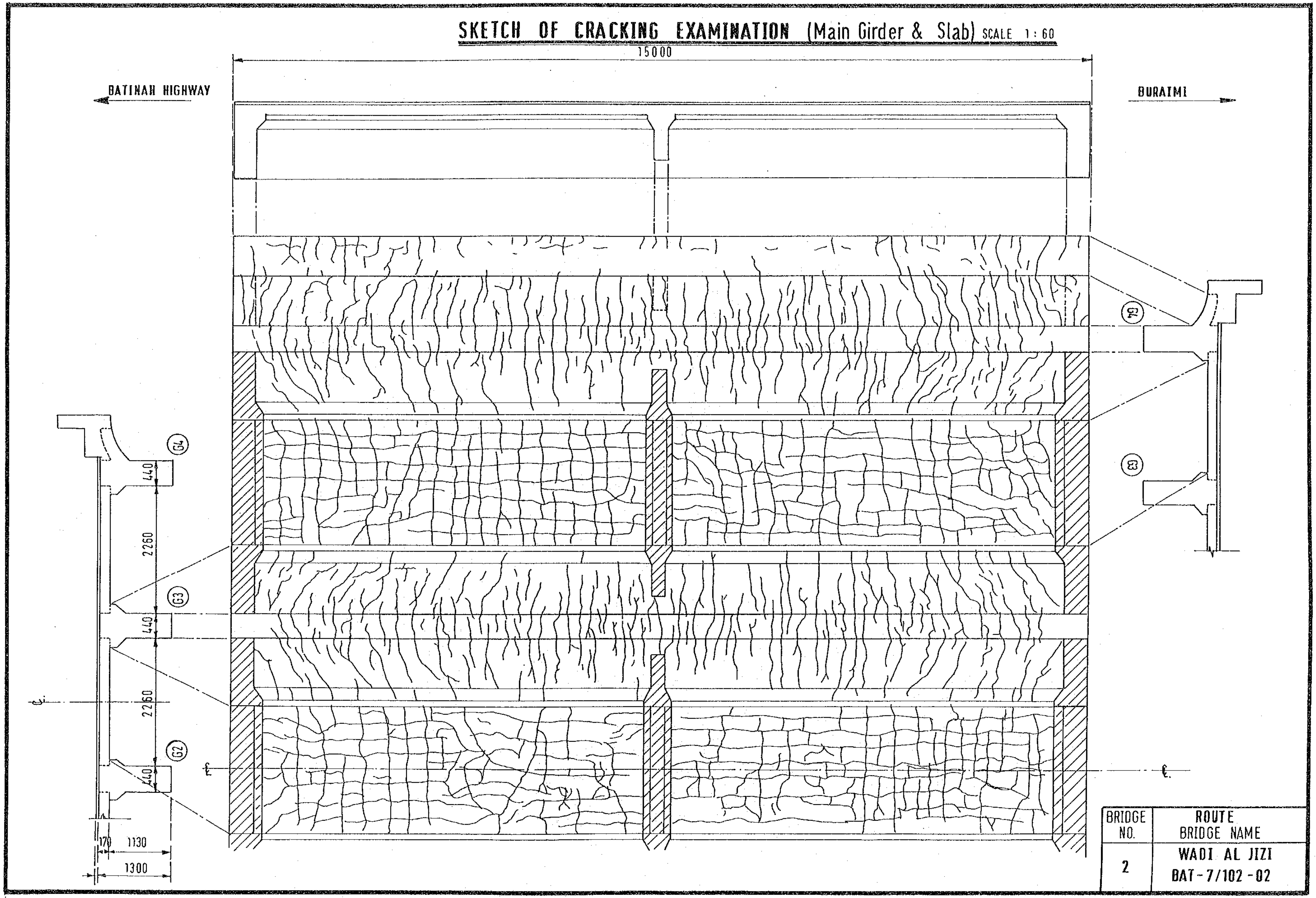
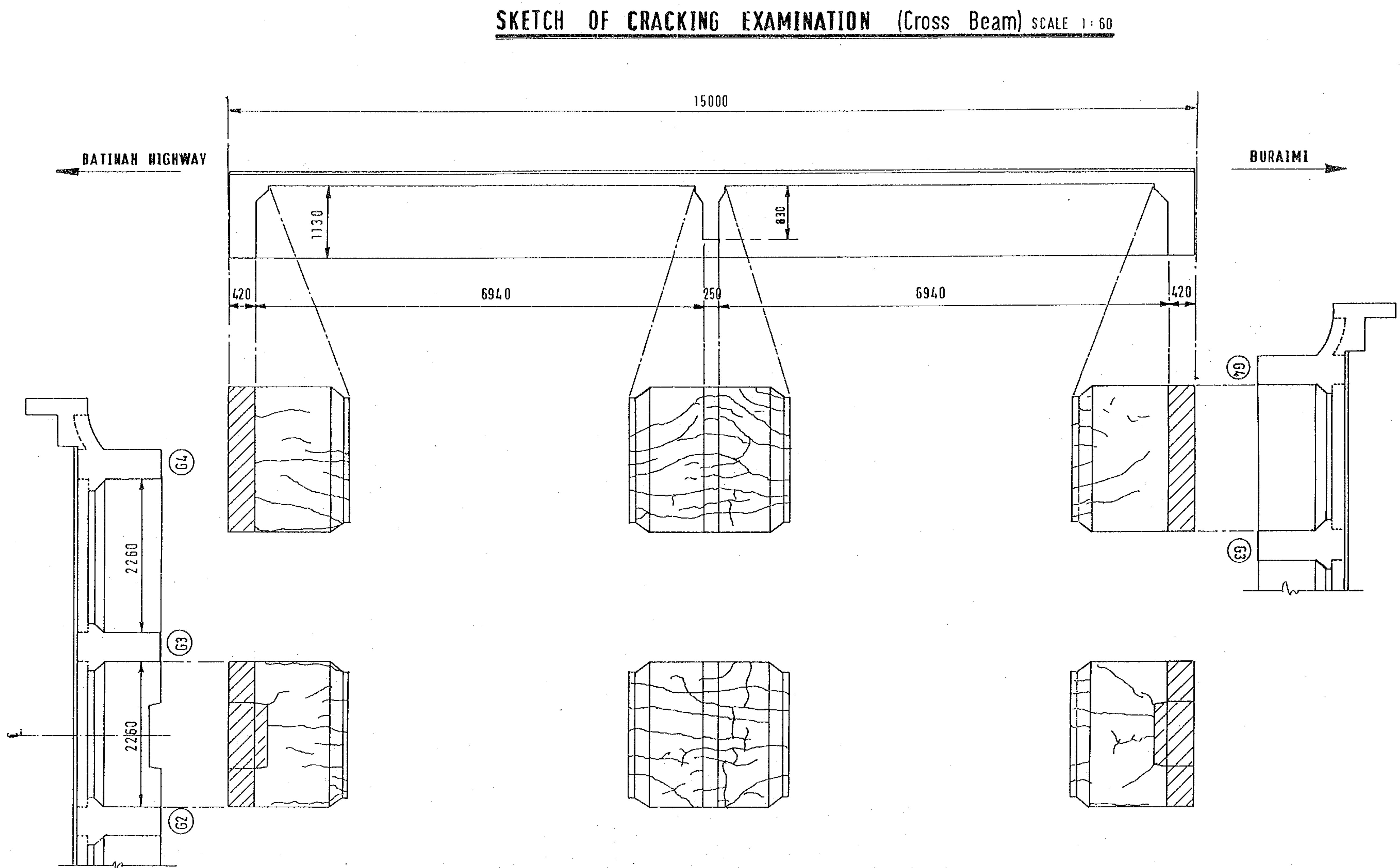


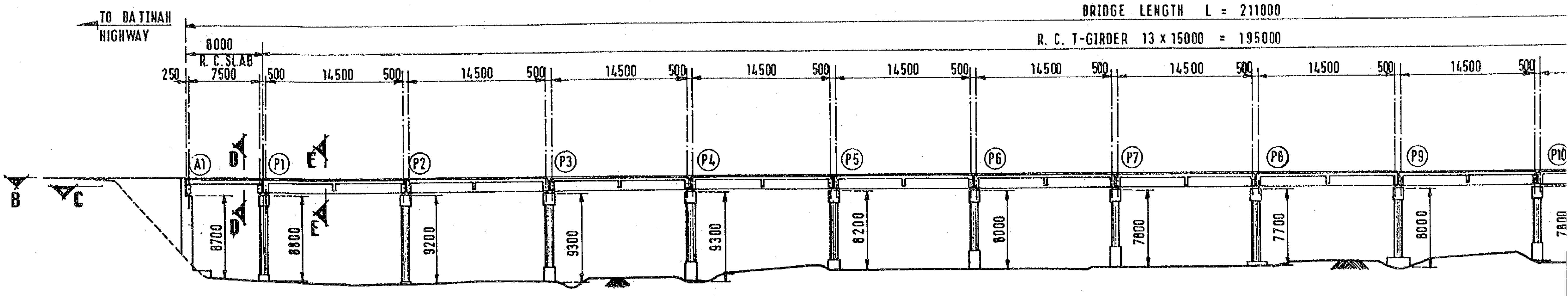
Fig 4.12 Cracking Conditions



NOTE:- ALL CRACKINGS ON THE SURFACE OF THE MAIN BEAMS, R.C. SLABS AND CROSS BEAMS WERE MENDED IN FORMER TIMES WITH AN ADHESIVE AGENT OF SYNTHETIC RESIN.

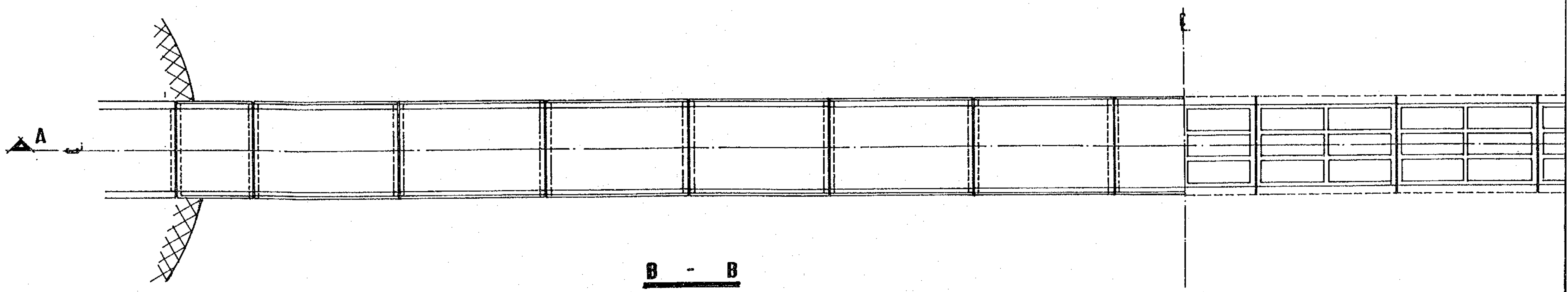
BRIDGE NO.	ROUTE BRIDGE NAME
2	WADI AL JIZI BAT 7/102-02

Fig 4.13 Cracking Conditions

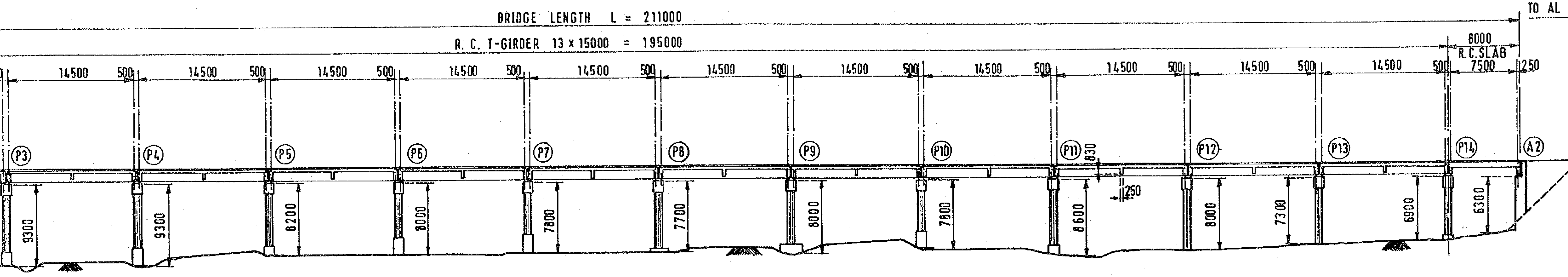


SECTION A - A

SIDE ELEVATION SCALE 1:400

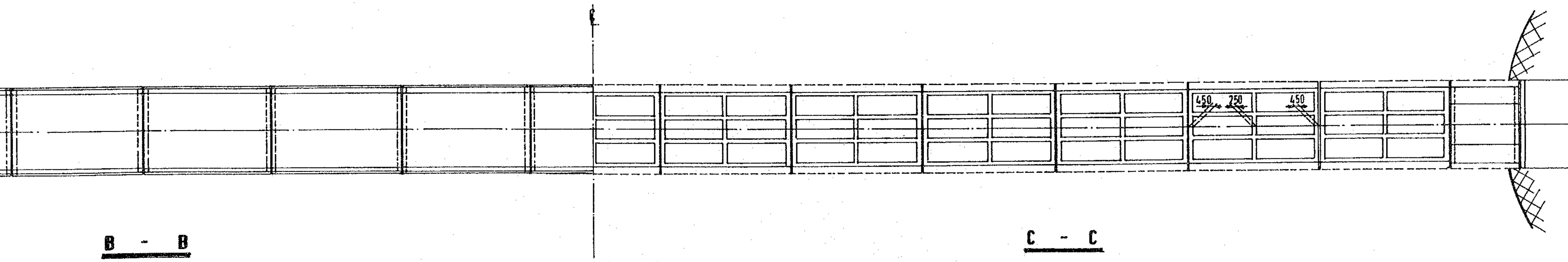


P L A N SCALE 1: 400



SECTION A - A

SIDE ELEVATION SCALE 1:400



B - B

C - C

PLAN SCALE 1: 400

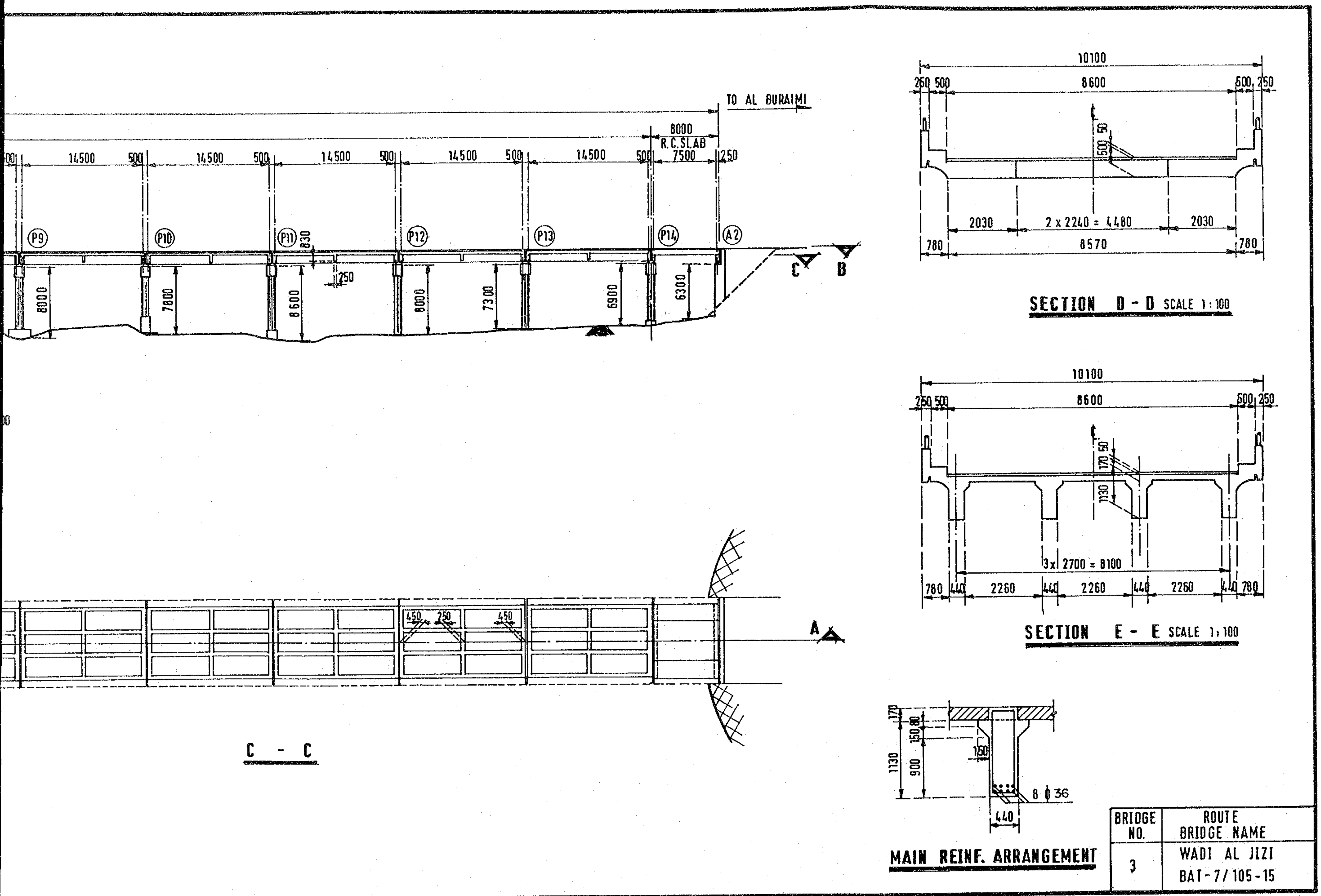
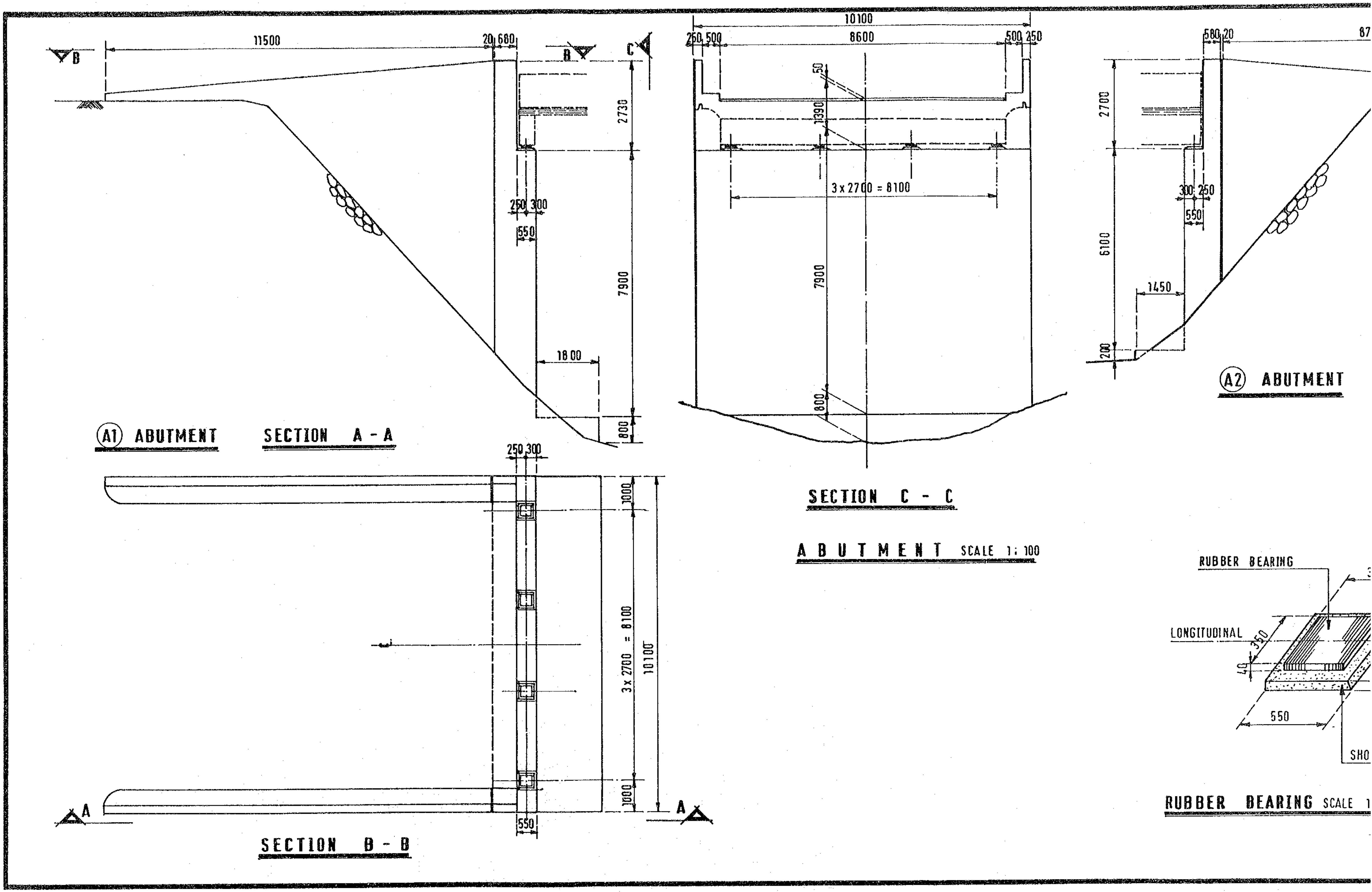


Fig 4.14 General View of Br.No.3



(A1) ABUTMENT
SECTION A - A
SECTION B - B
SECTION C - C
ABUTMENT SCALE 1 : 100
(A2) ABUTMENT
RUBBER BEARING
LONGITUDINAL
RUBBER BEARING SCALE 1
11500
20 680
2730
7900
800
250 300
550
1800
1000
3 x 2700 = 8100
10100
10100
250 500
8600
500 250
50
1390
3 x 2700 = 8100
580 20
2700
6100
300 250
1450
200
350
40
550

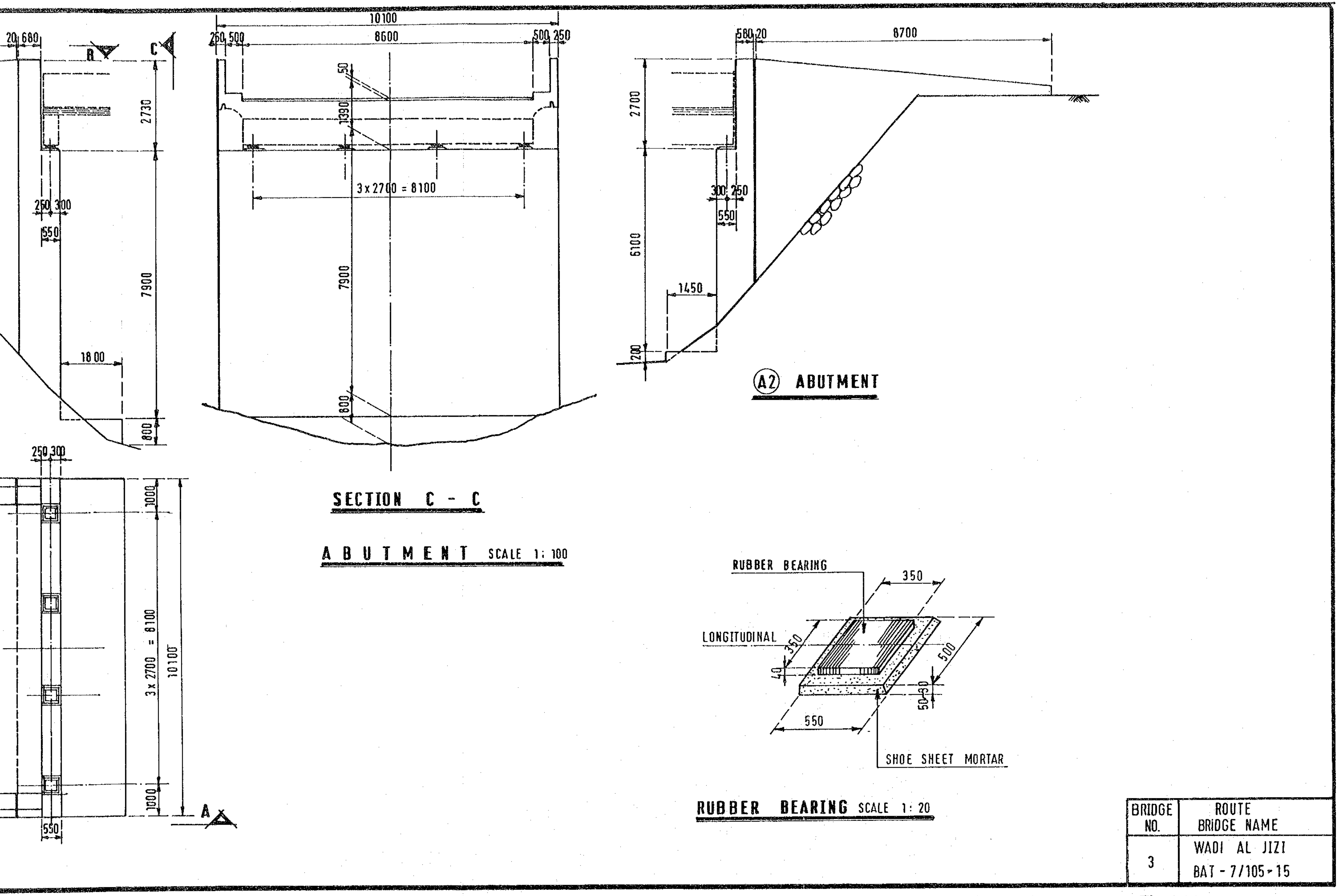


Fig 4.15

General View of Br.No.3

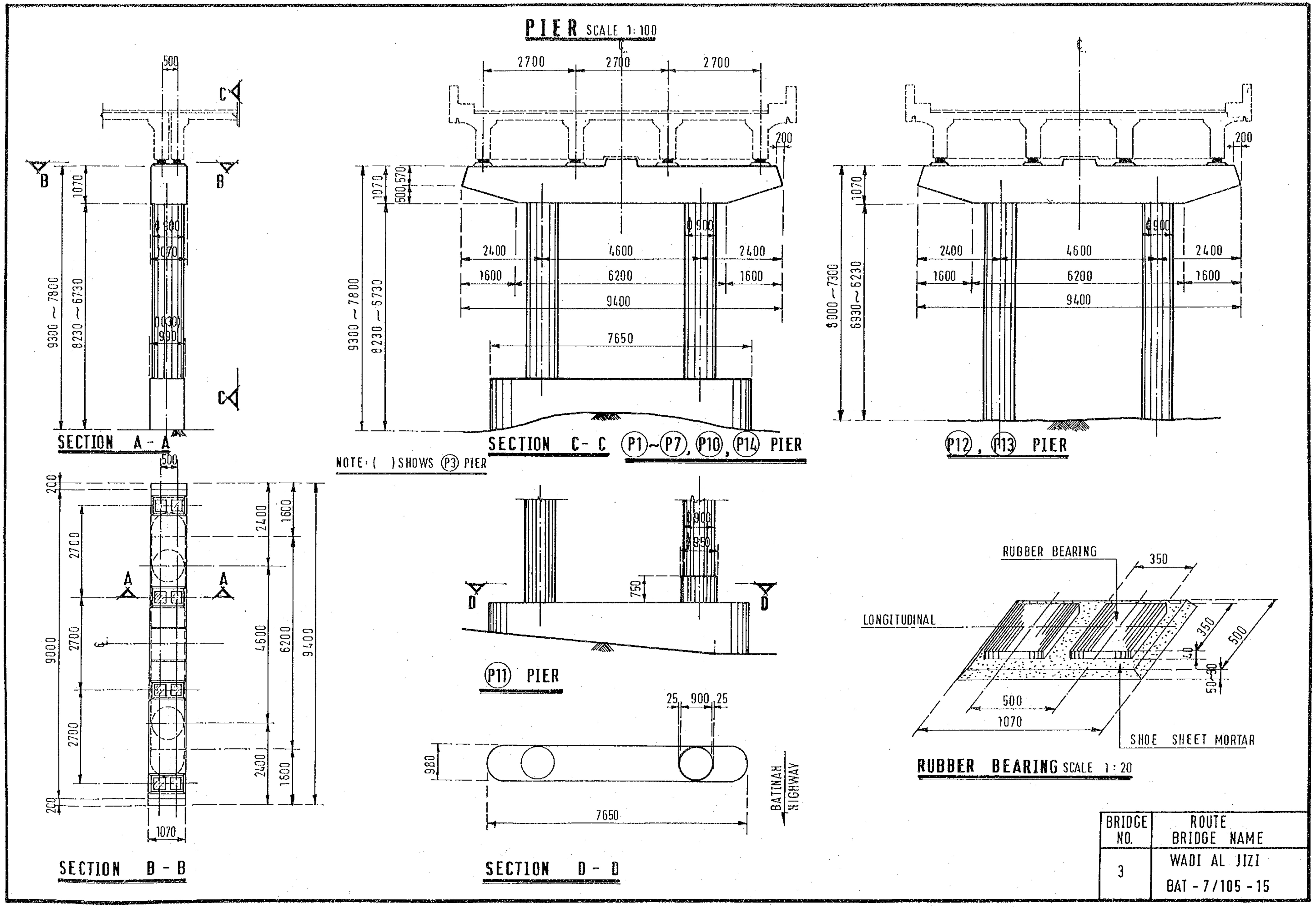
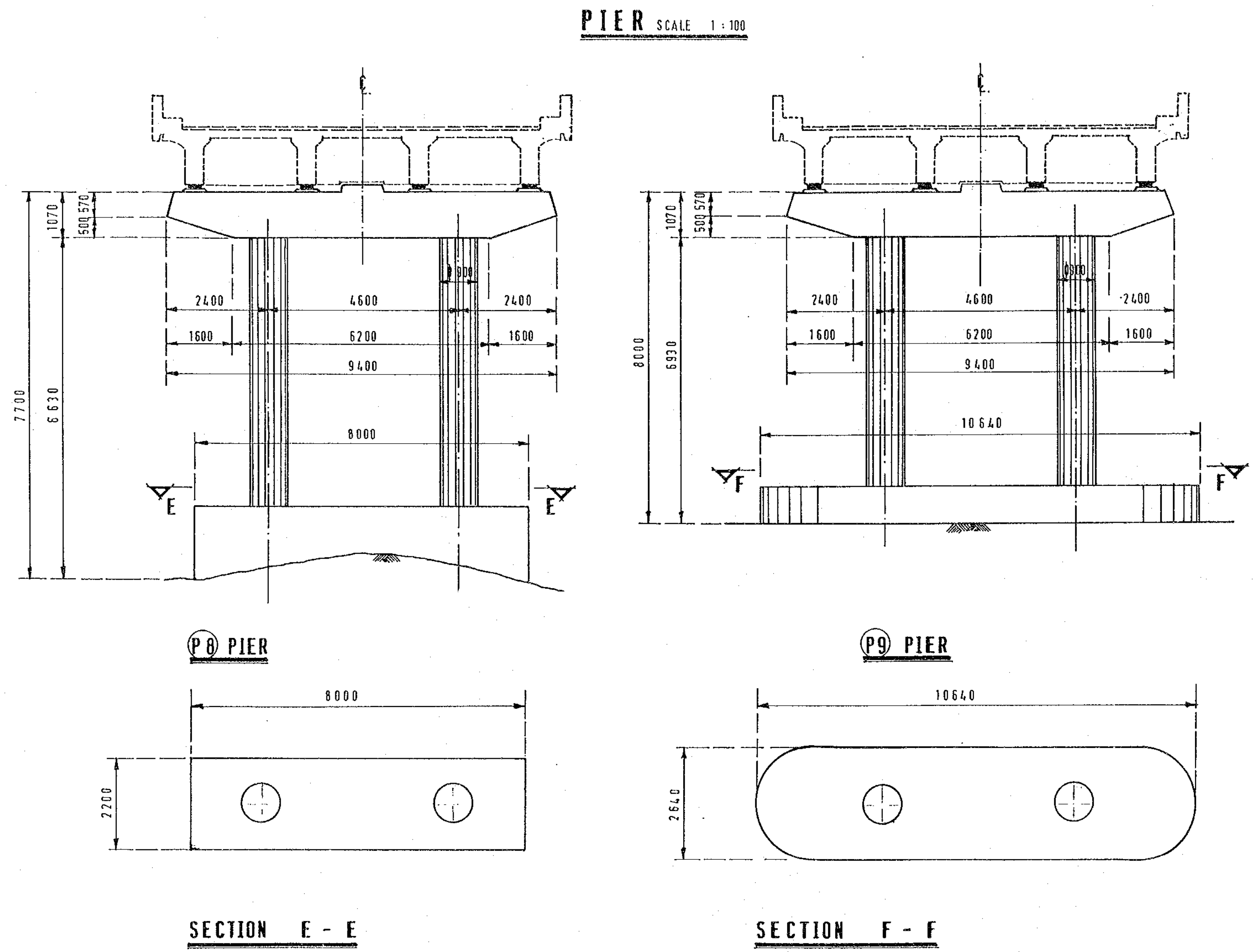


Fig 4.16 General View of Br.No.3



BRIDGE NO.	ROUTE BRIDGE NAME
3	WADI AL JIZI BAT - 7/105 - 15

Fig 4.17 General View of Br.No.3

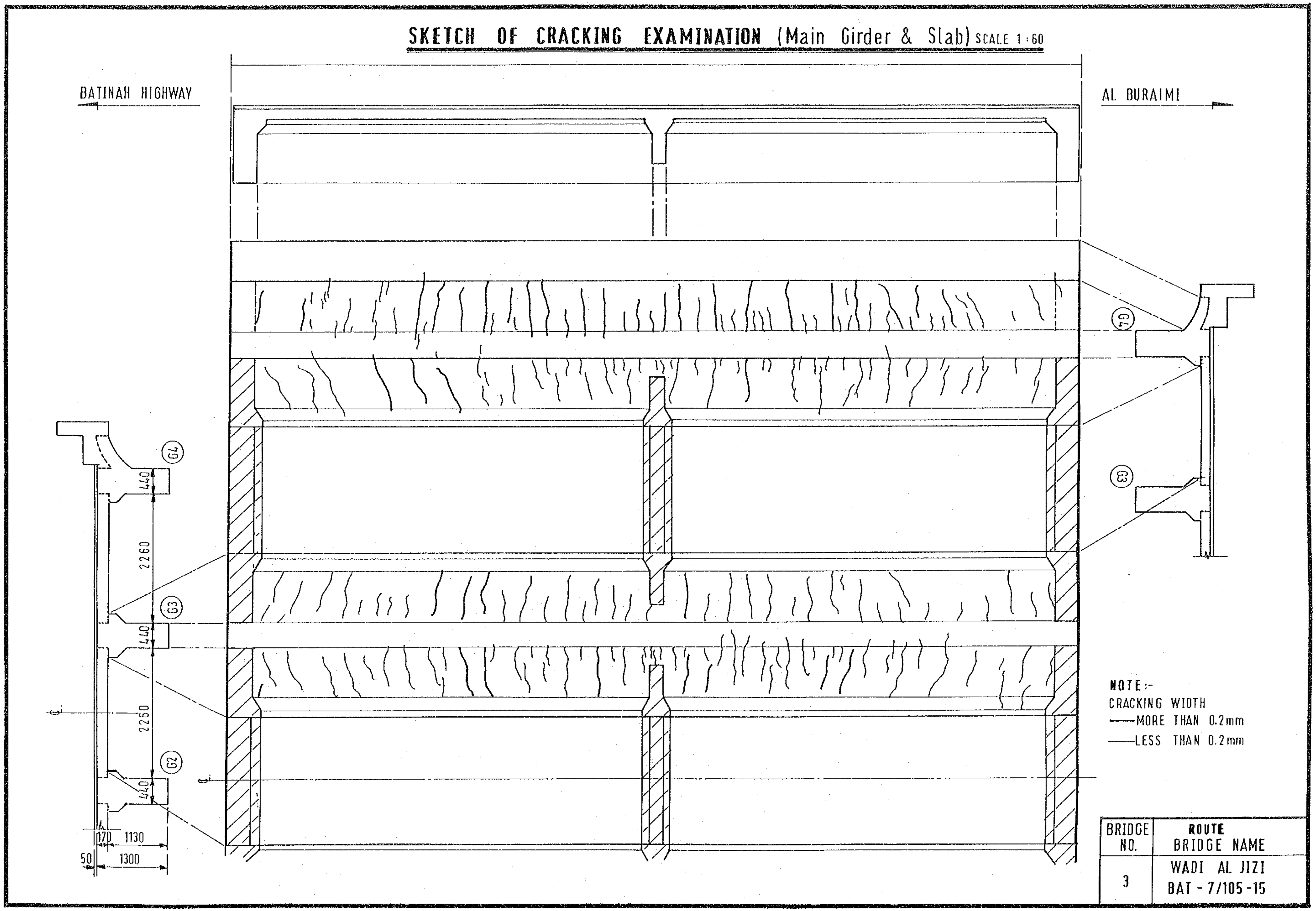


Fig 4.18 Cracking Conditions

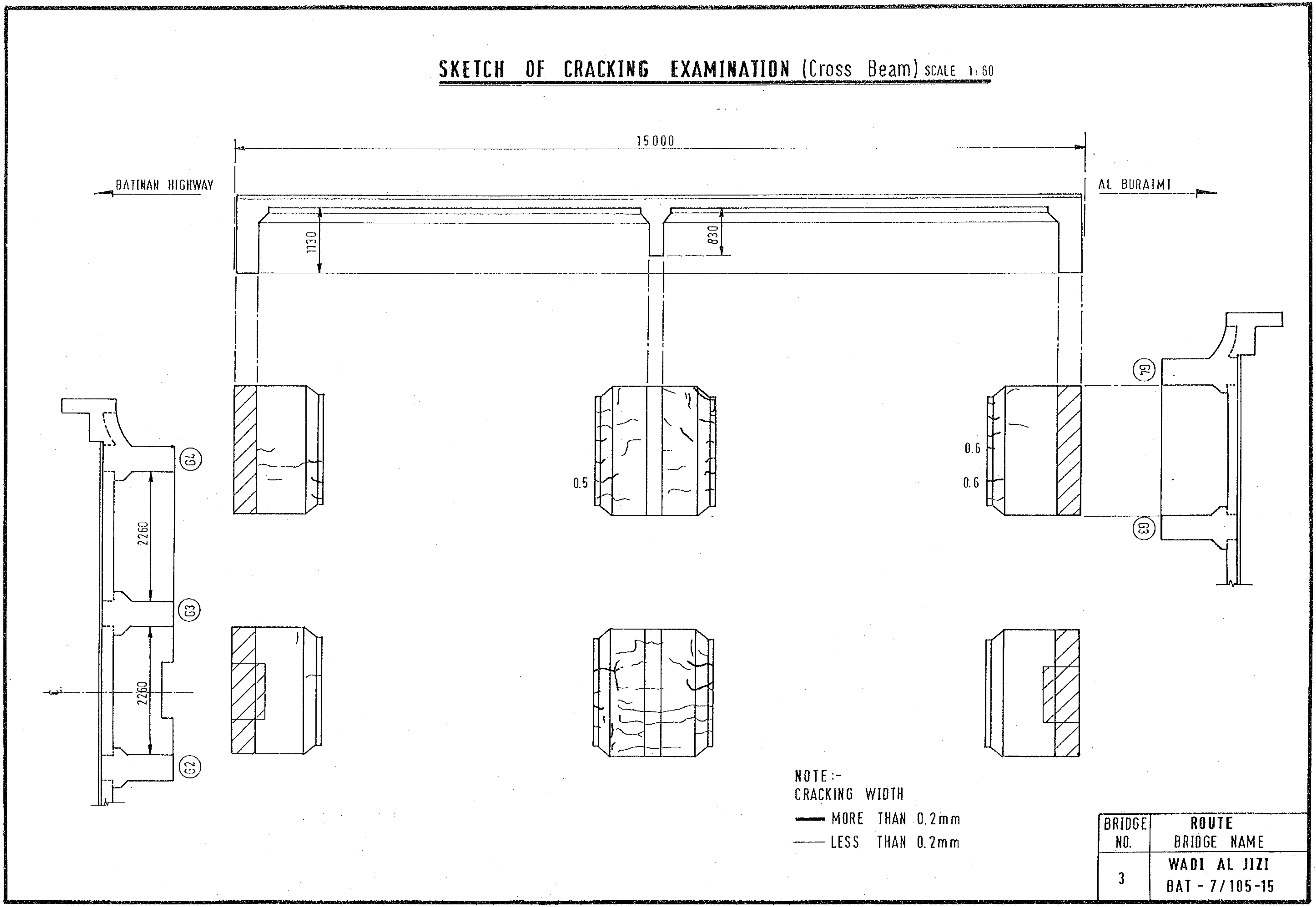
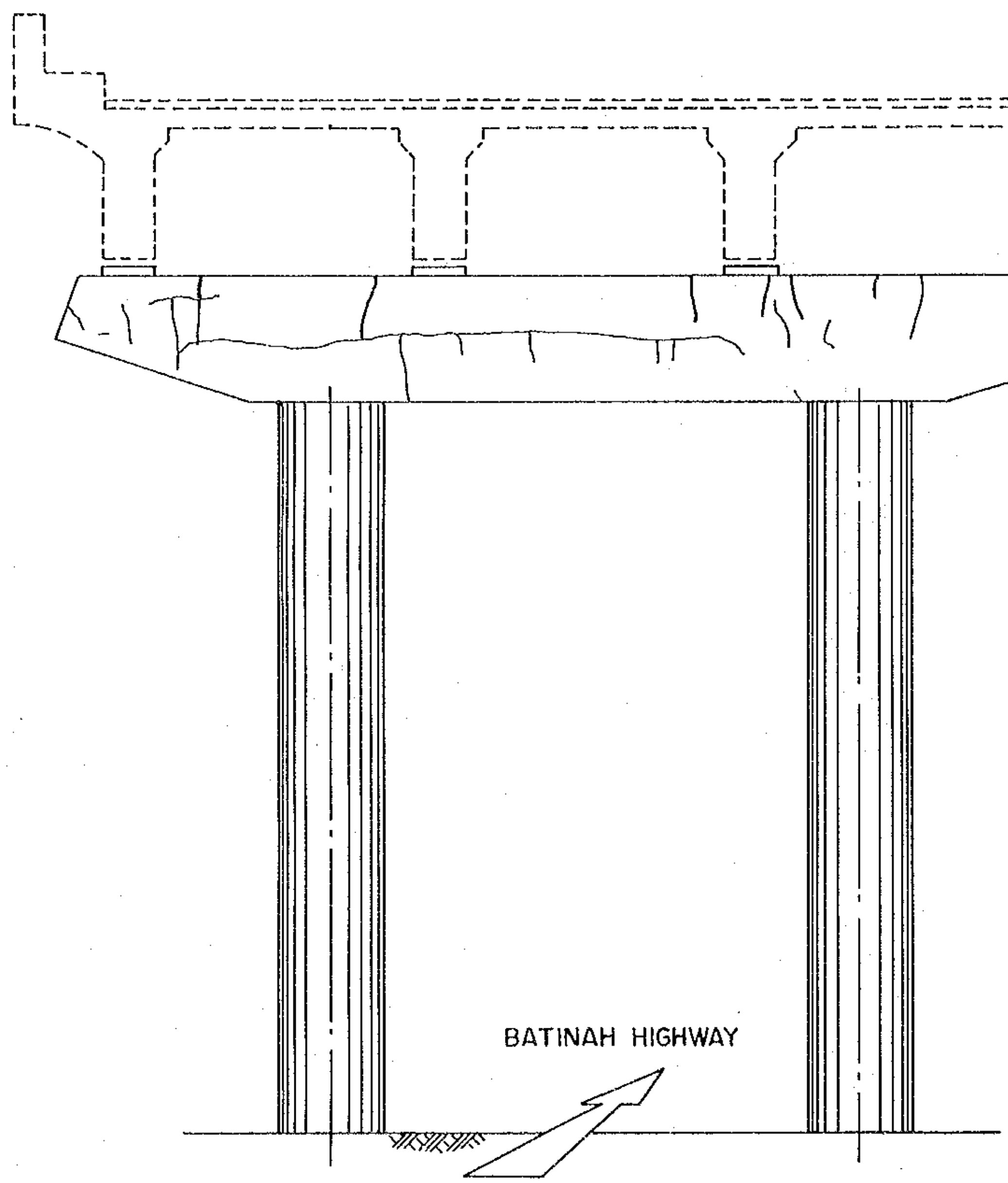
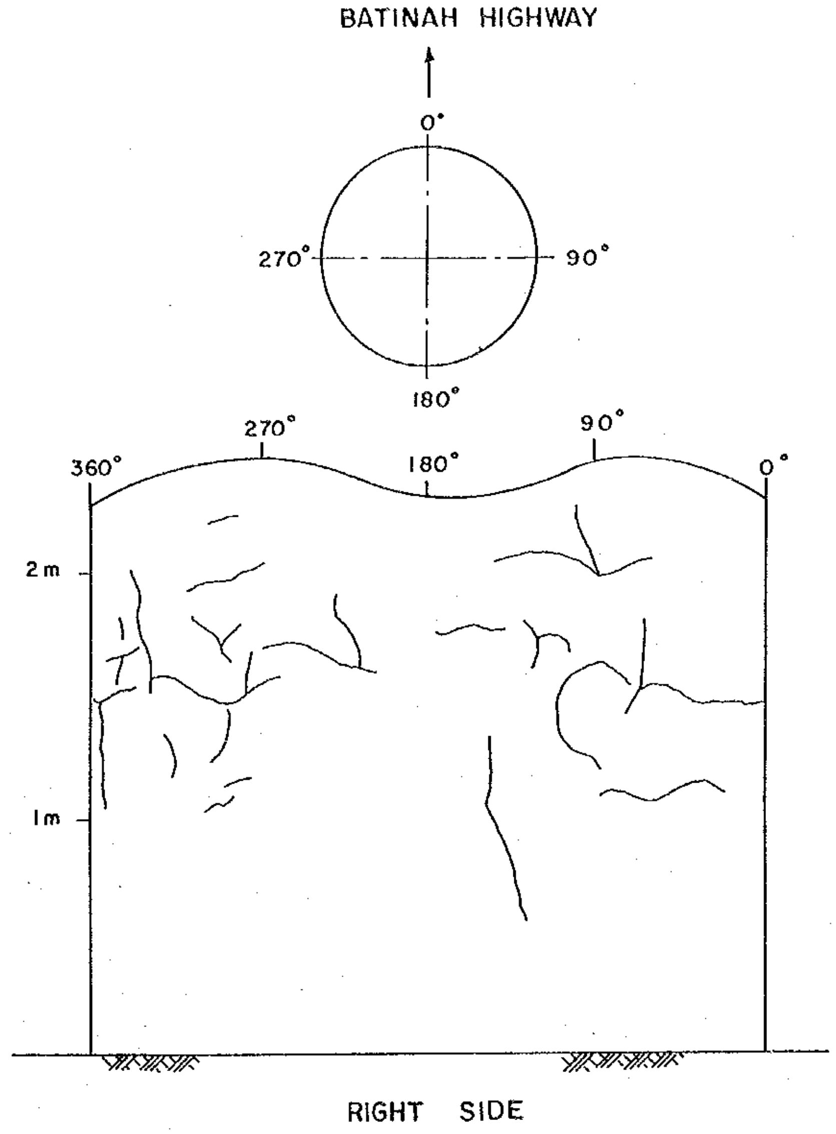


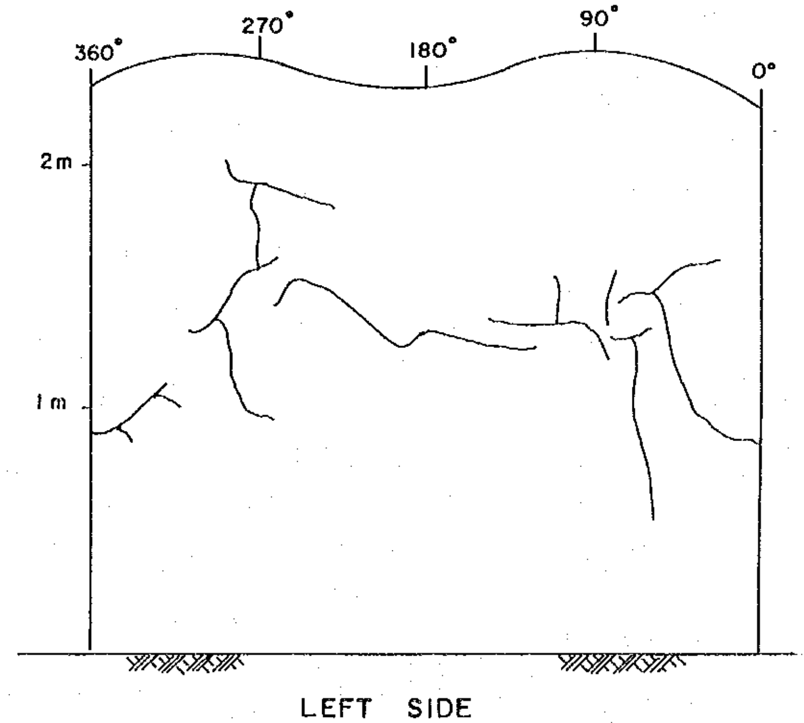
Fig 4.19 Cracking Conditions

SKETCH OF CRACKING EXAMINATION (P 13)

(SCALE. 1 : 60)







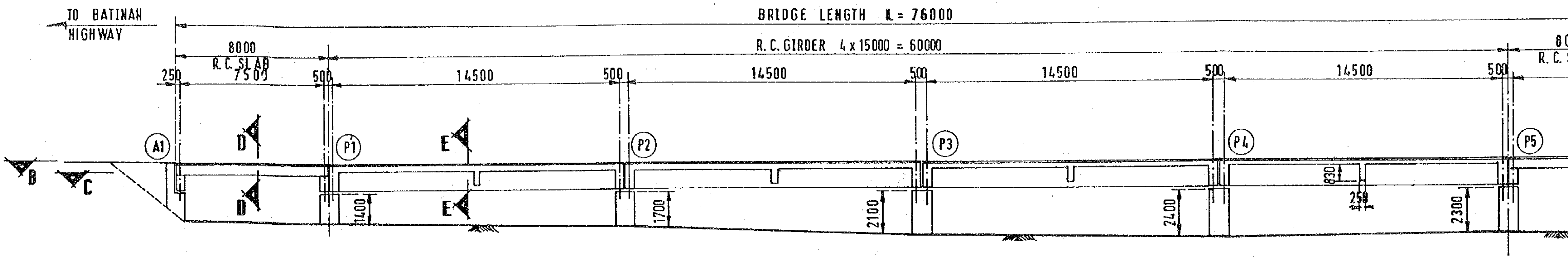
LEGEND

— Cracking Width 0.2mm 0.3mm

— Cracking Width Less Than 0.2 mm

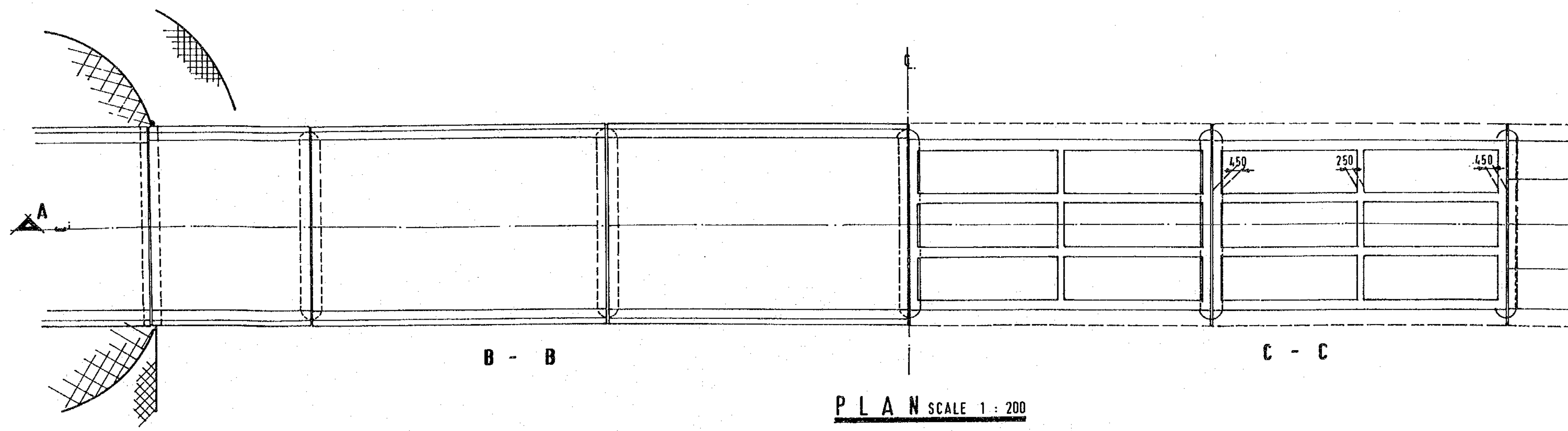
BRIDGE NO.	ROUTE BRIDGE NAME
3	WADI AL JIZI BAT-7/105-15

Fig 4.20 Cracking Conditions



SECTION A - A

SIDE ELEVATION SCALE 1 : 200



PLAN SCALE 1 : 200

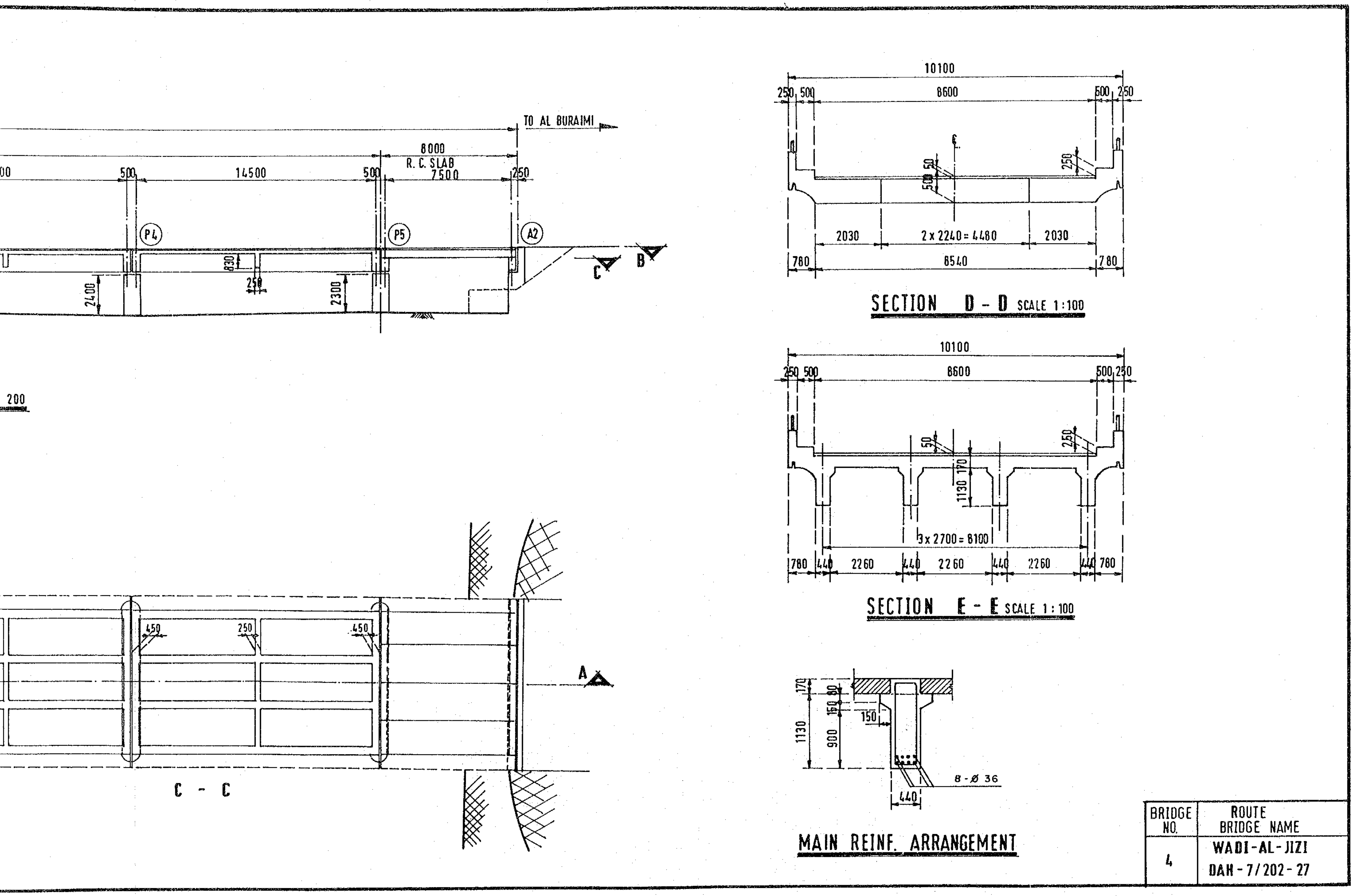


Fig 4.21 General View of Br.No.4

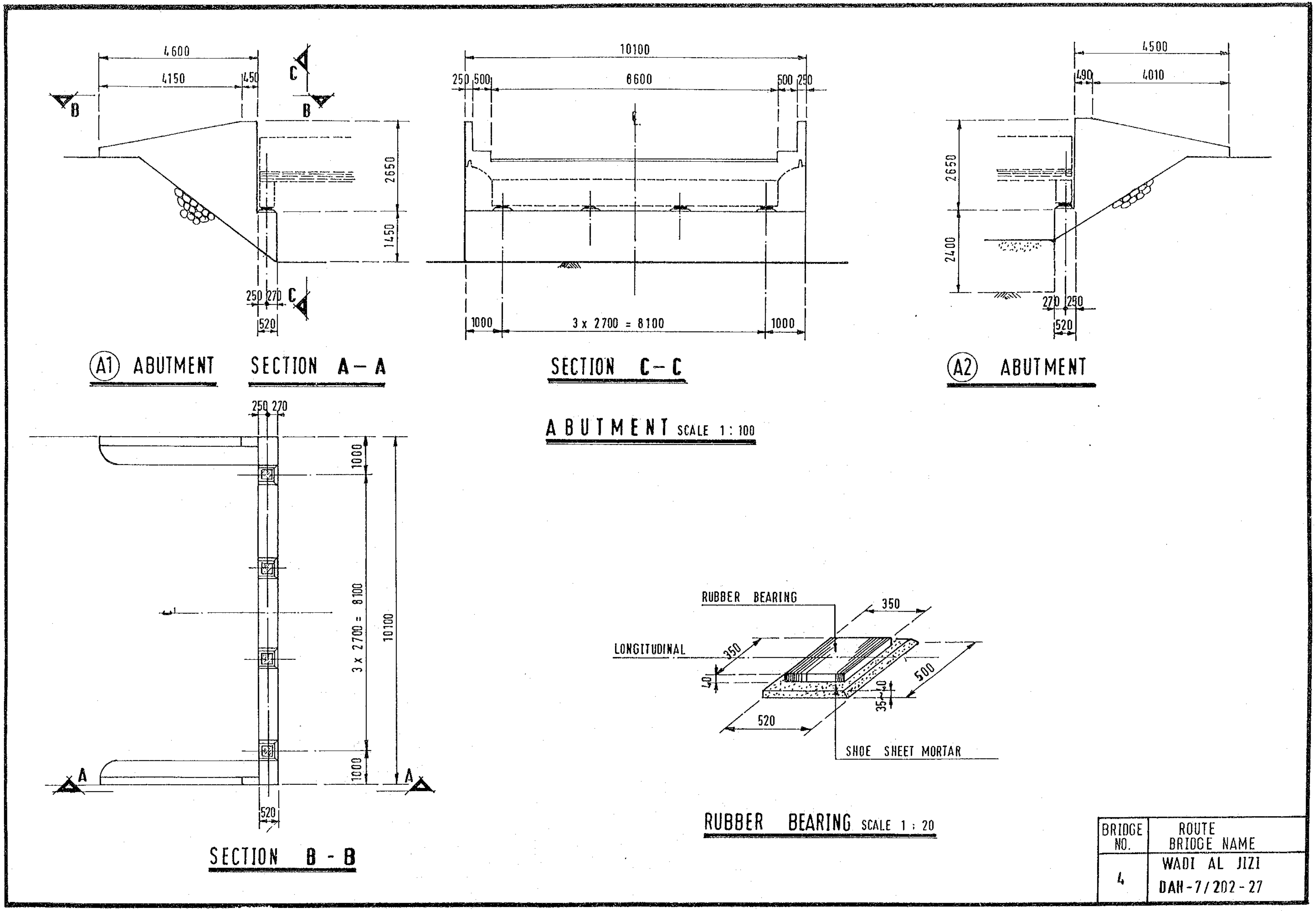
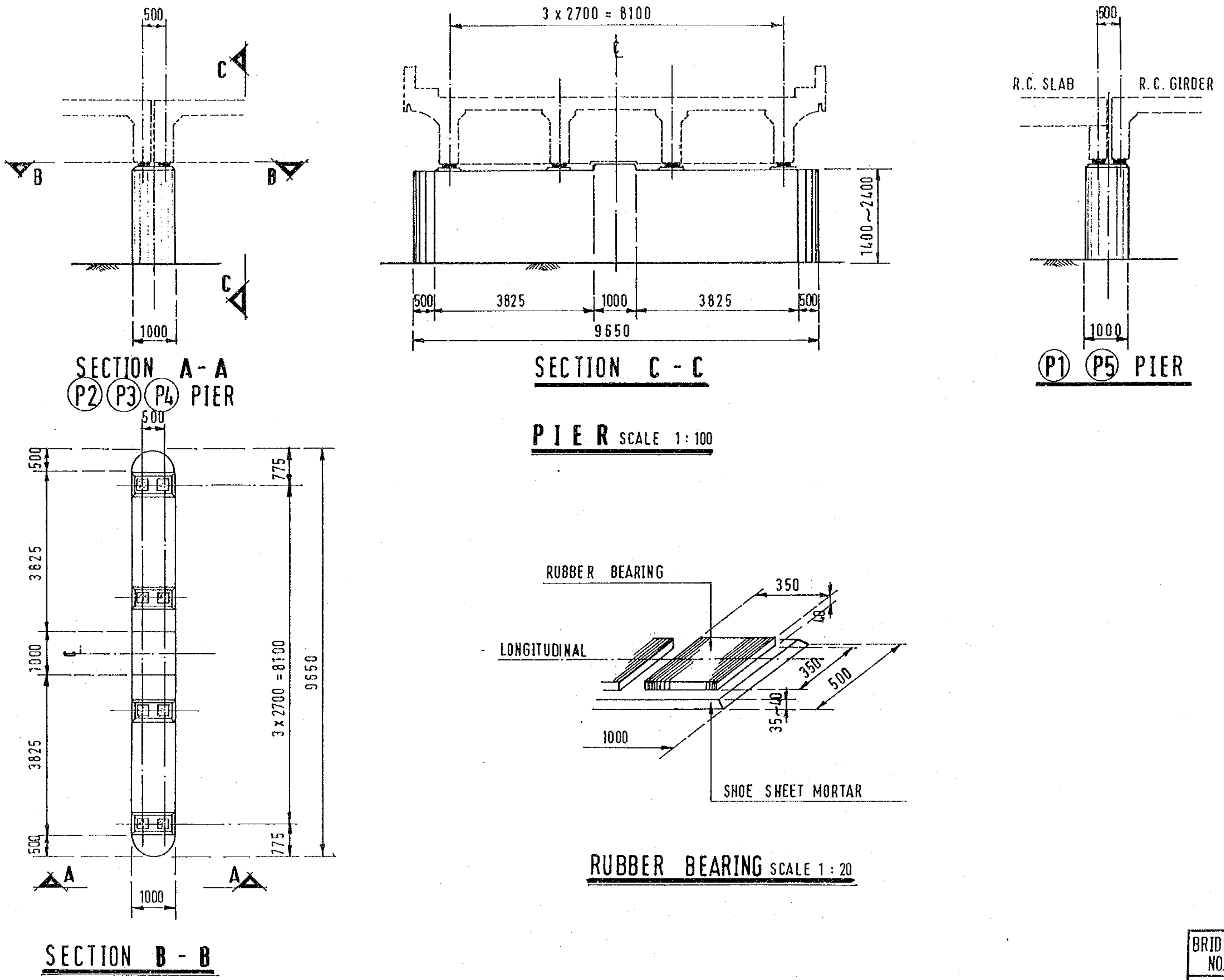


Fig 4.22 General View of Br.No.4



BRIDGE NO.	ROUTE BRIDGE NAME
4	WADI AL JIZI DAH-7/202-27

Fig 4.23 General View of Br.No.4

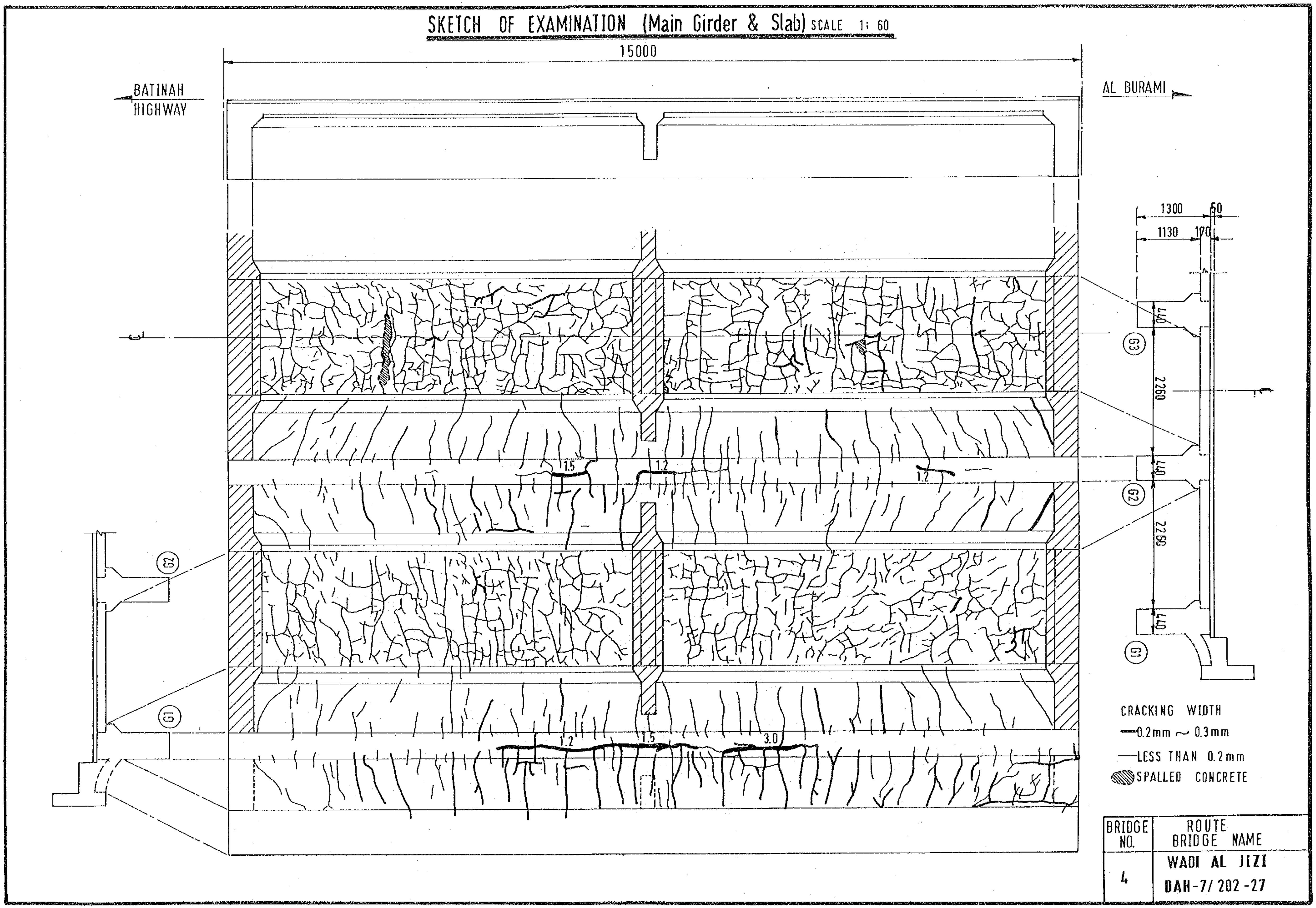


Fig 4.24 Cracking Conditions

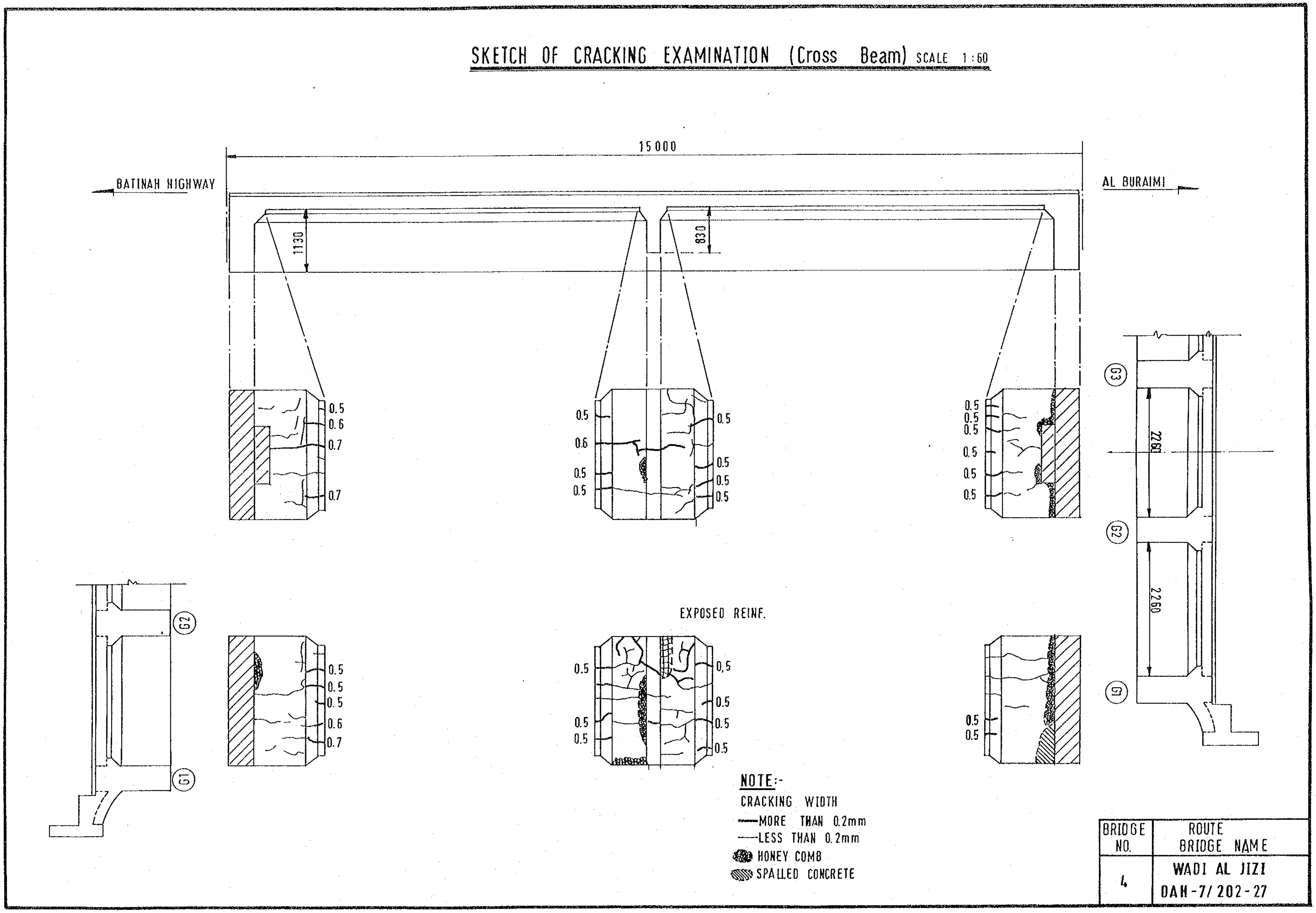
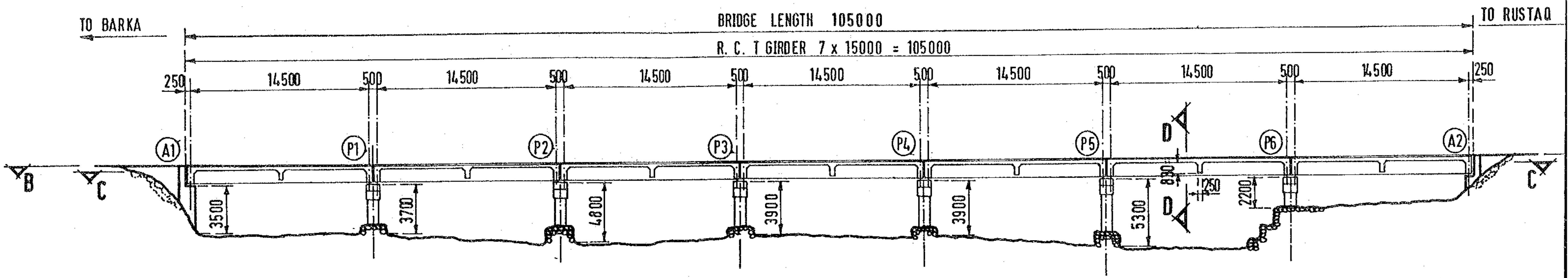
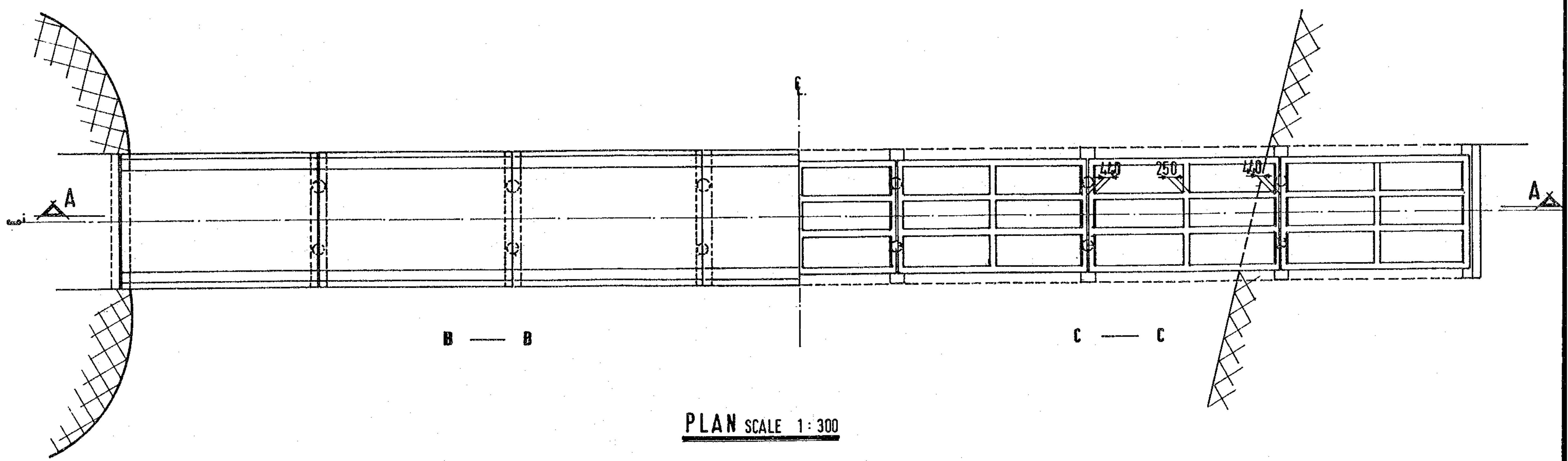


Fig 4.25 Cracking Conditions



SIDE ELEVATION
SECTION A - A SCALE 1:300



PLAN SCALE 1 : 300

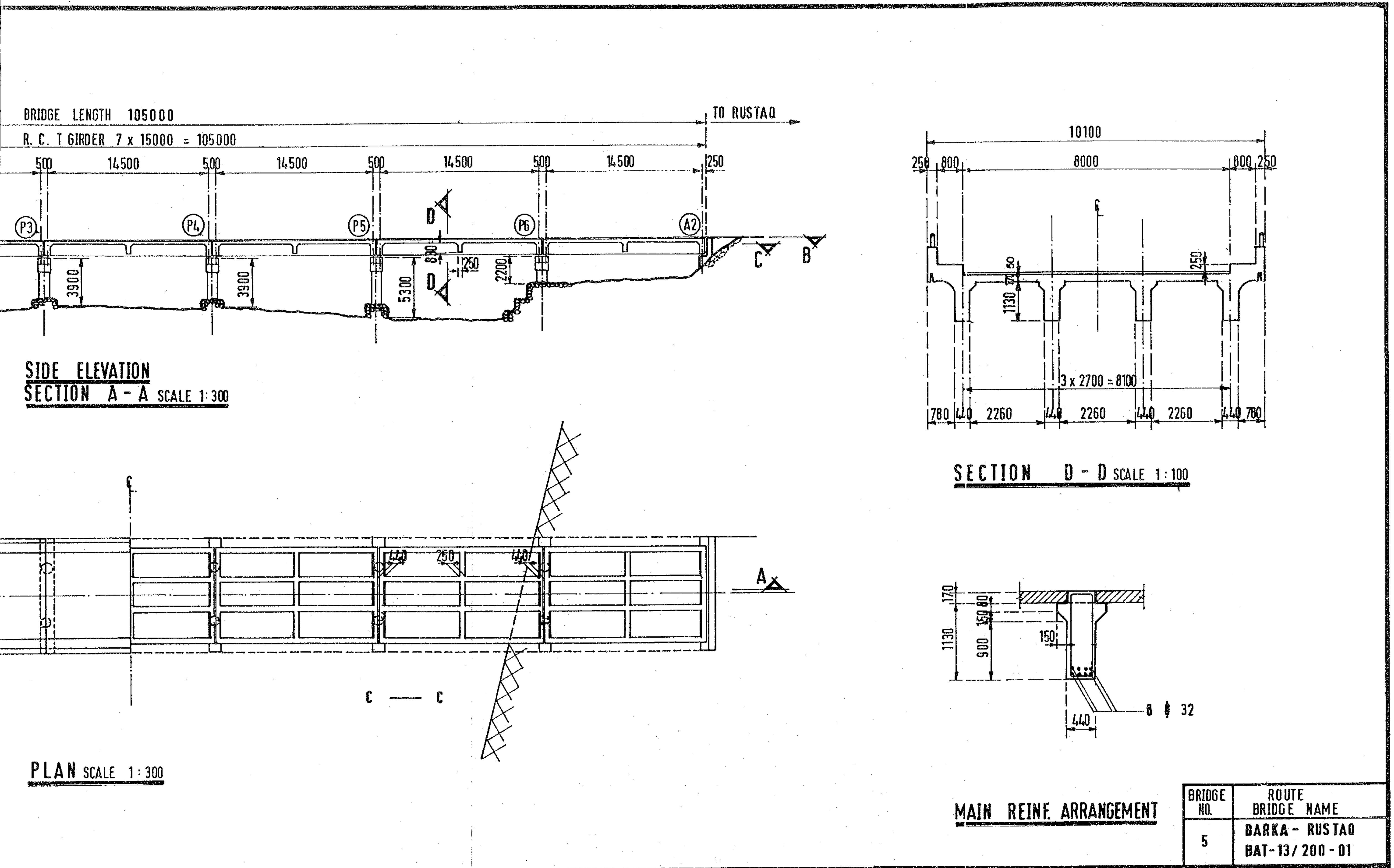


Fig 4.26 General View of Br.NO.5

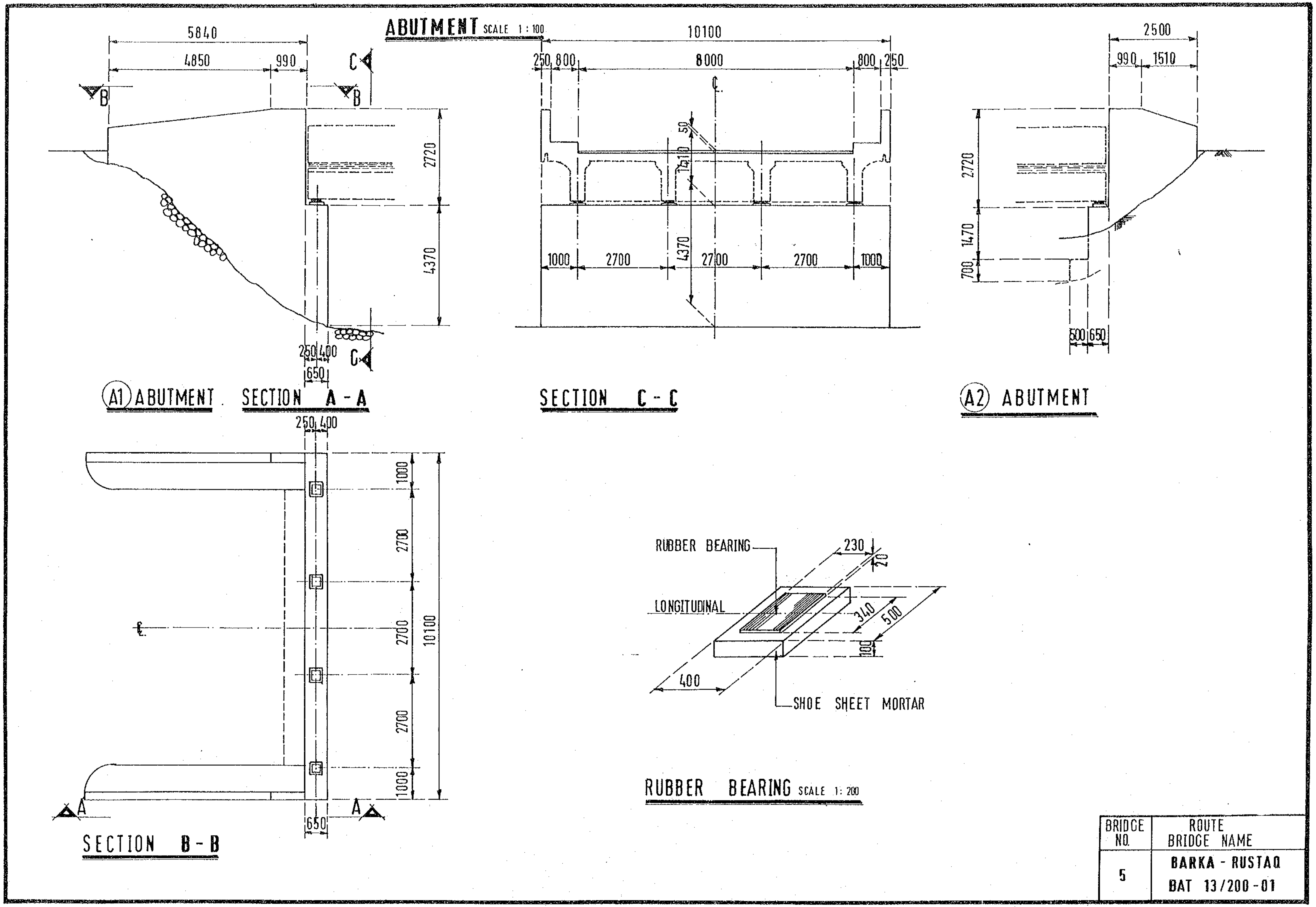


Fig 4.27 General View of Br.No.5

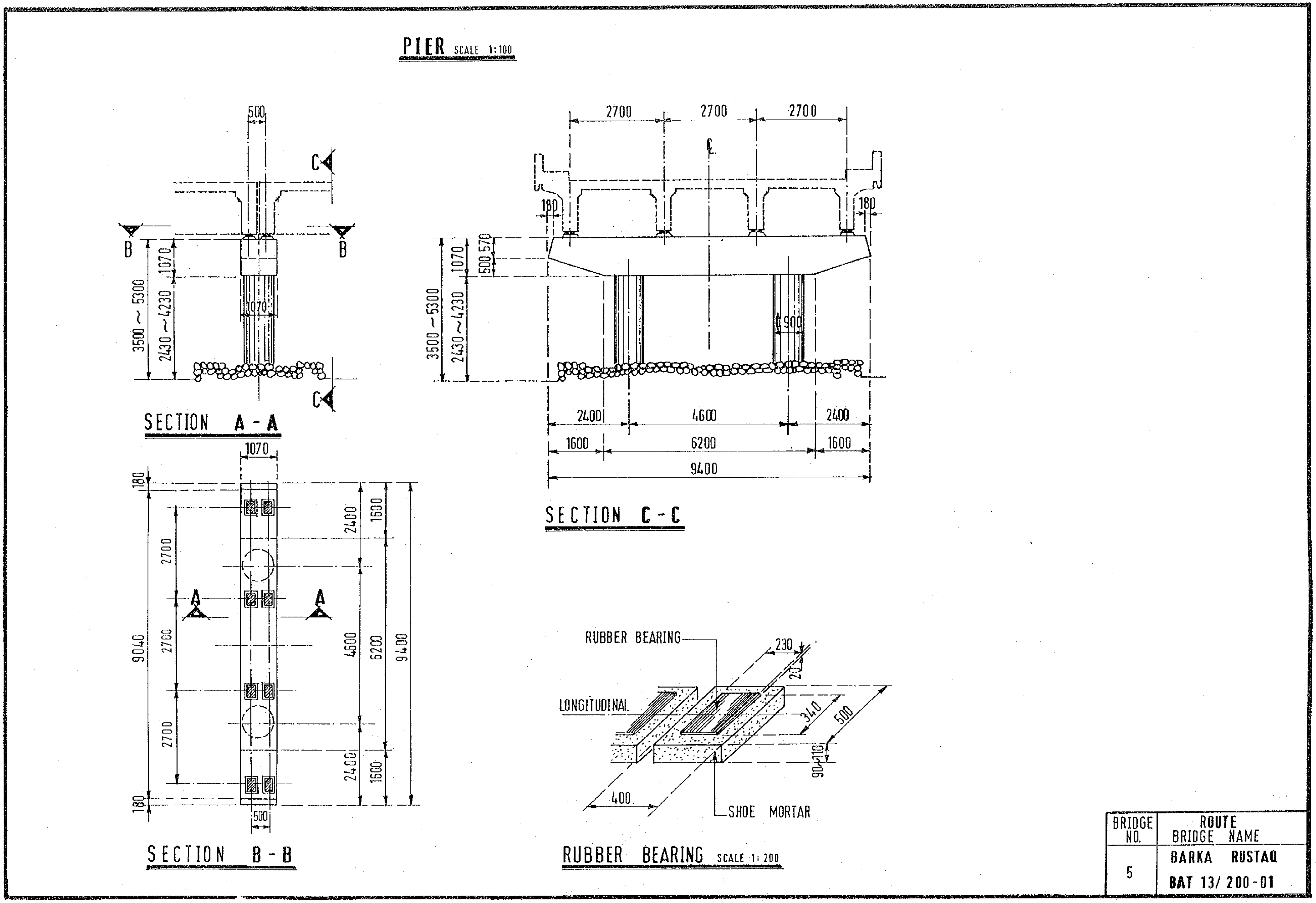


Fig 4.28 General View of Br.NO.5

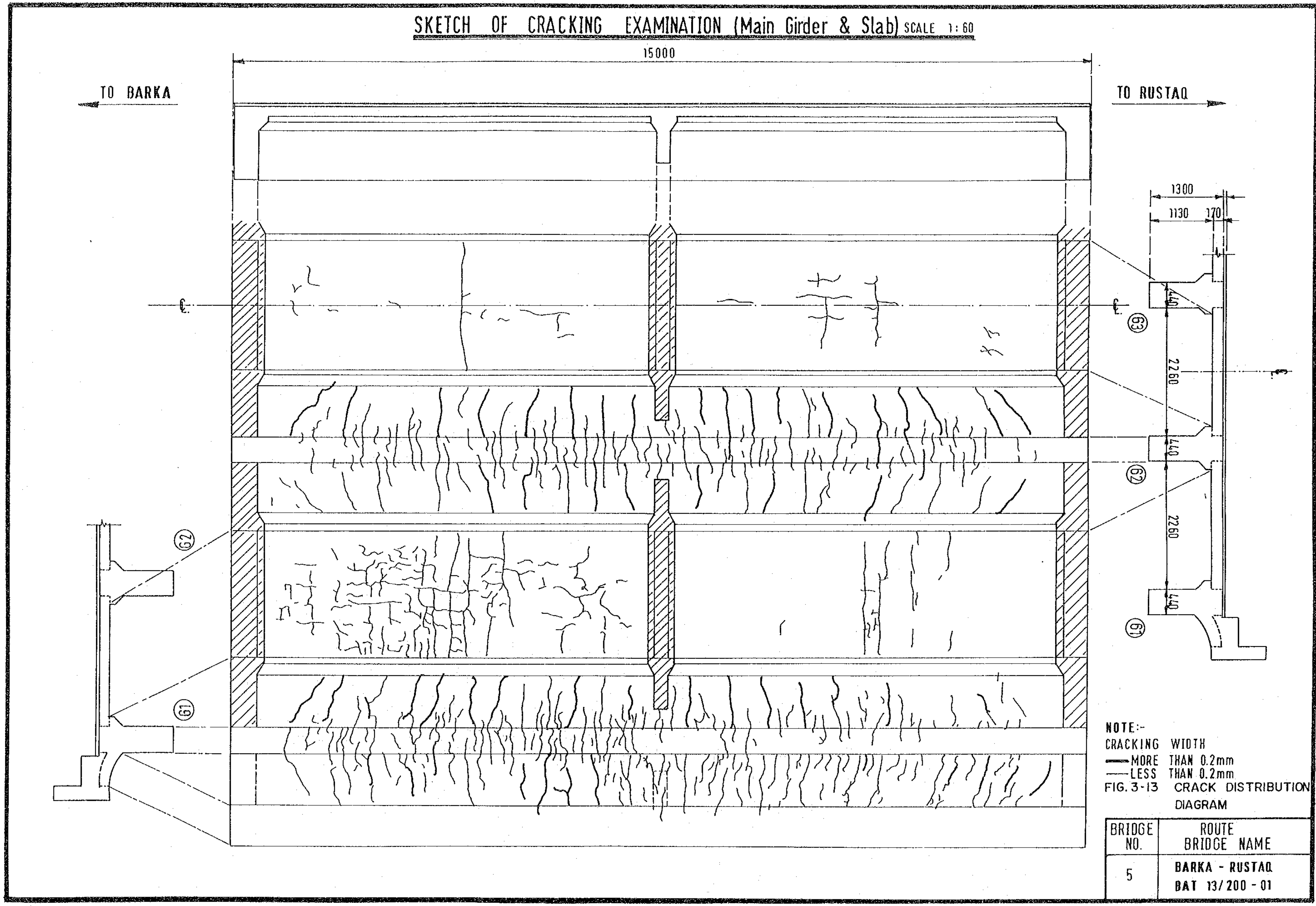
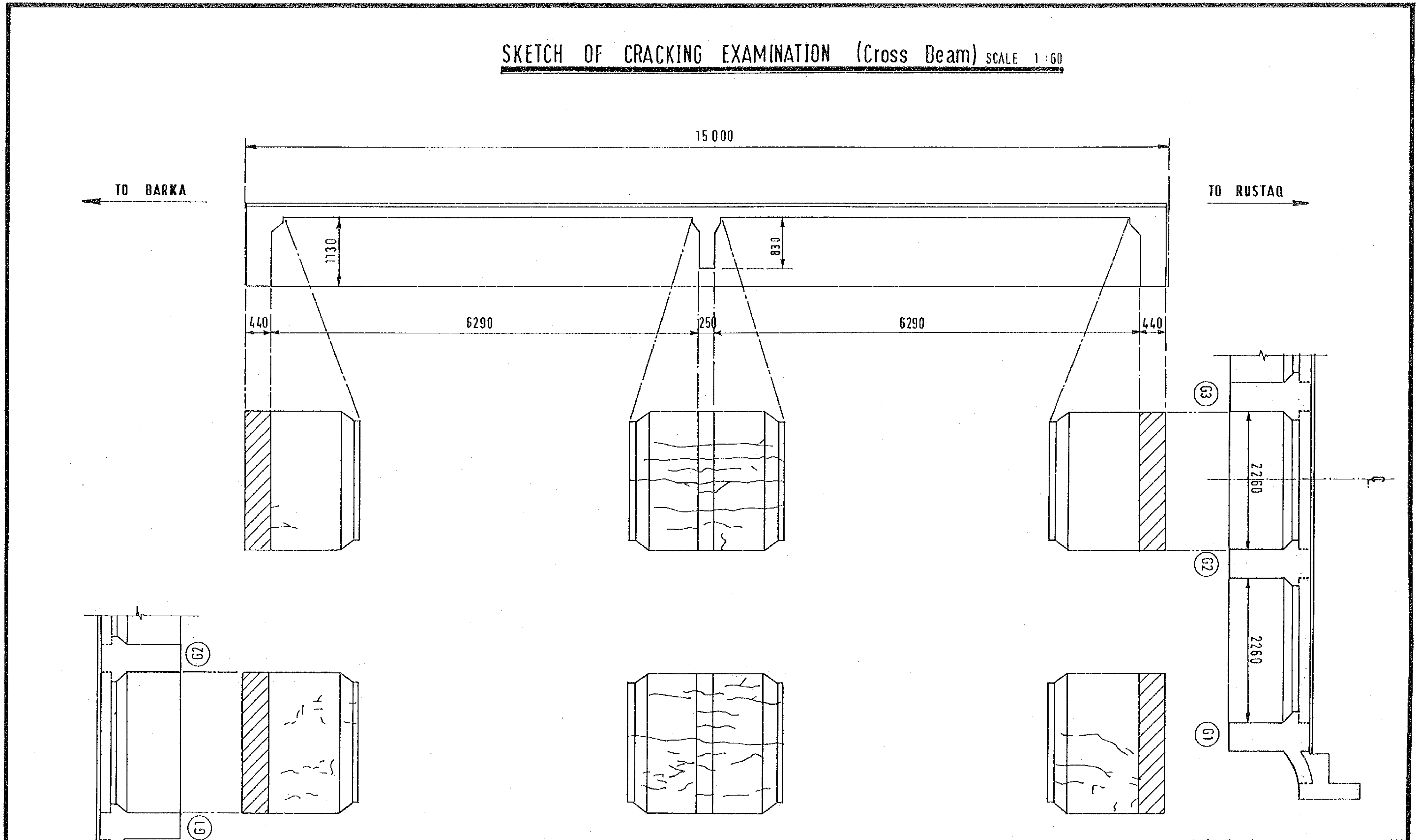


Fig 4.29 Cracking Conditions



BRIDGE NO.	ROUTE BRIDGE NAME
5	BARKA RUSTAQ BAT - 13/200 - 01

Fig 4.30 Cracking Conditions

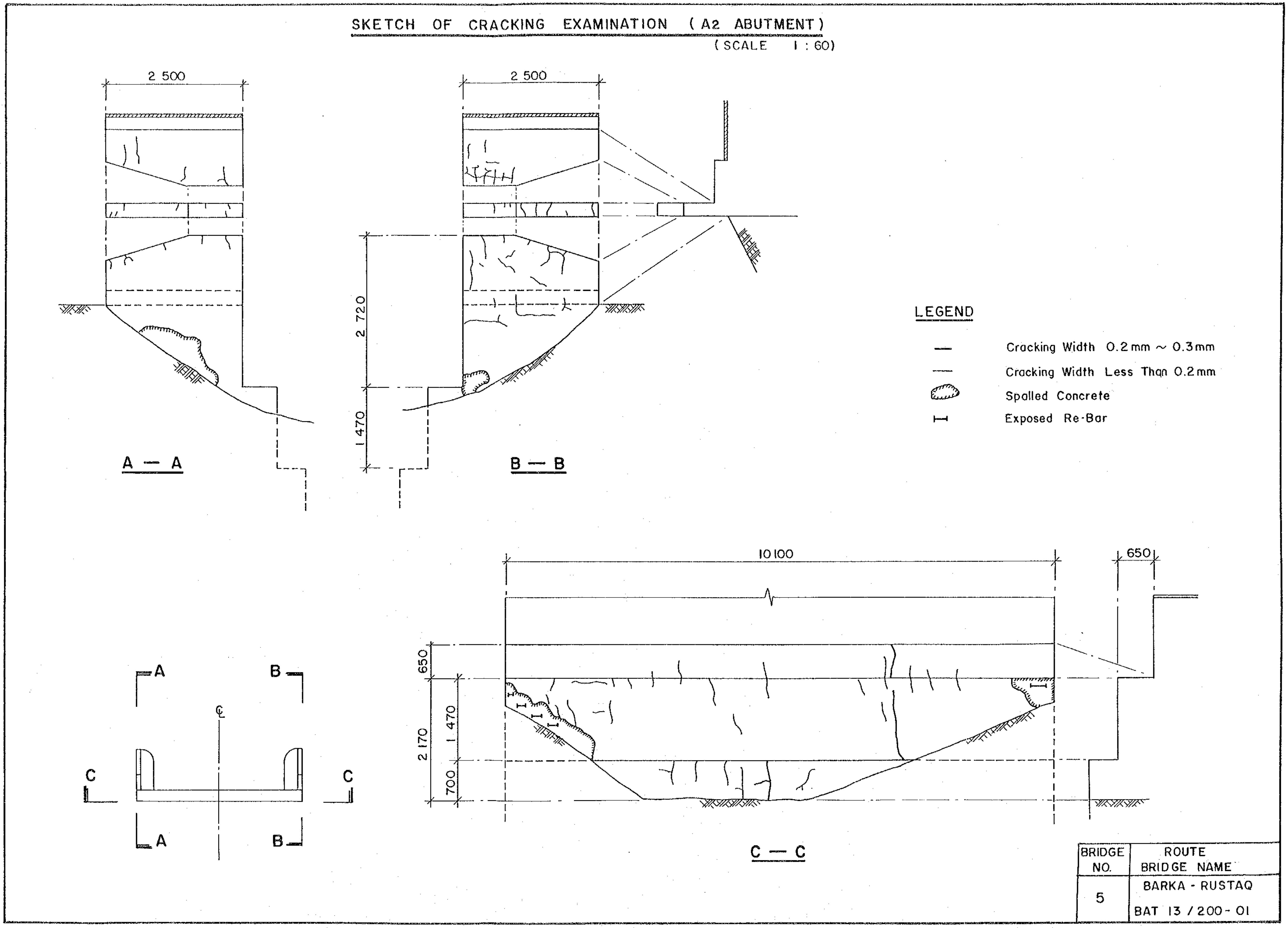


Fig 4.31 Cracking Conditions

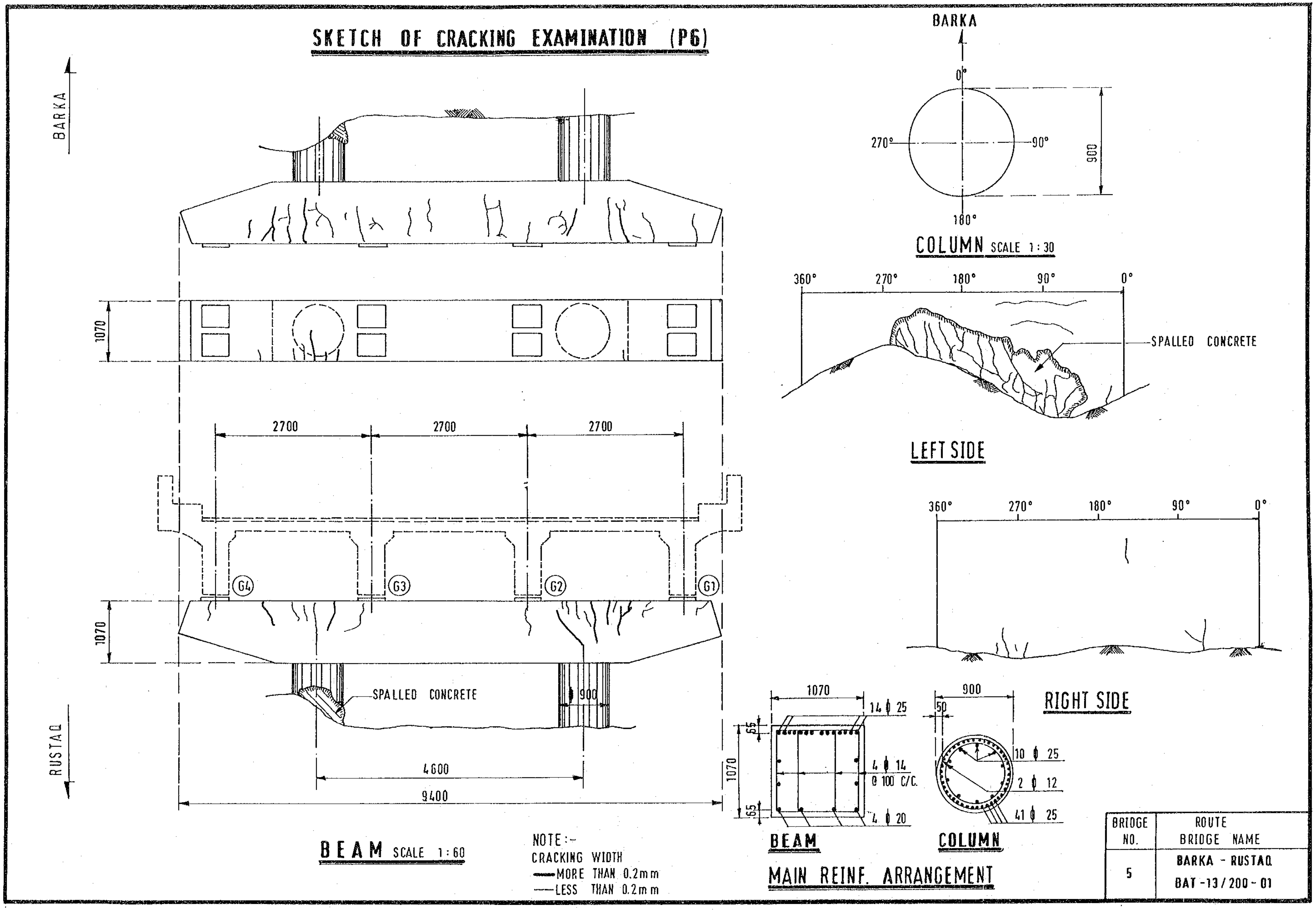
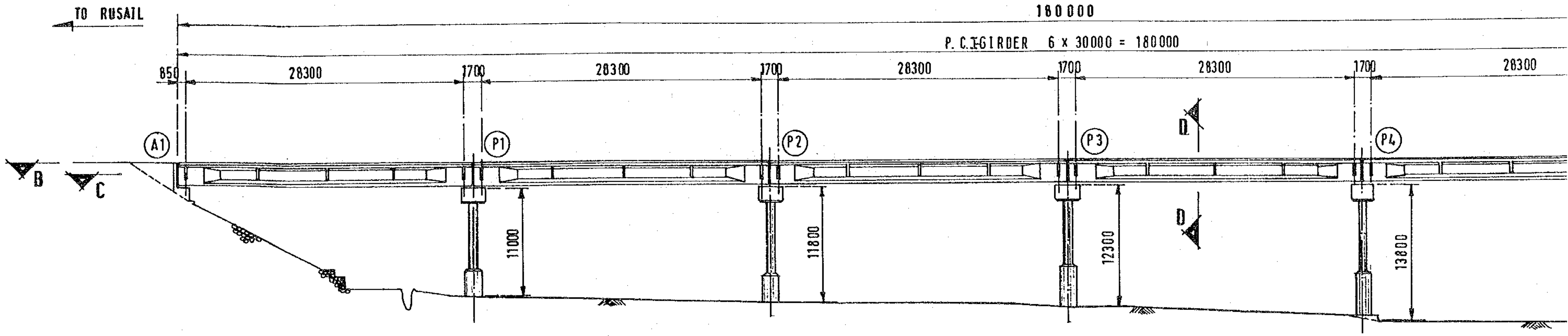
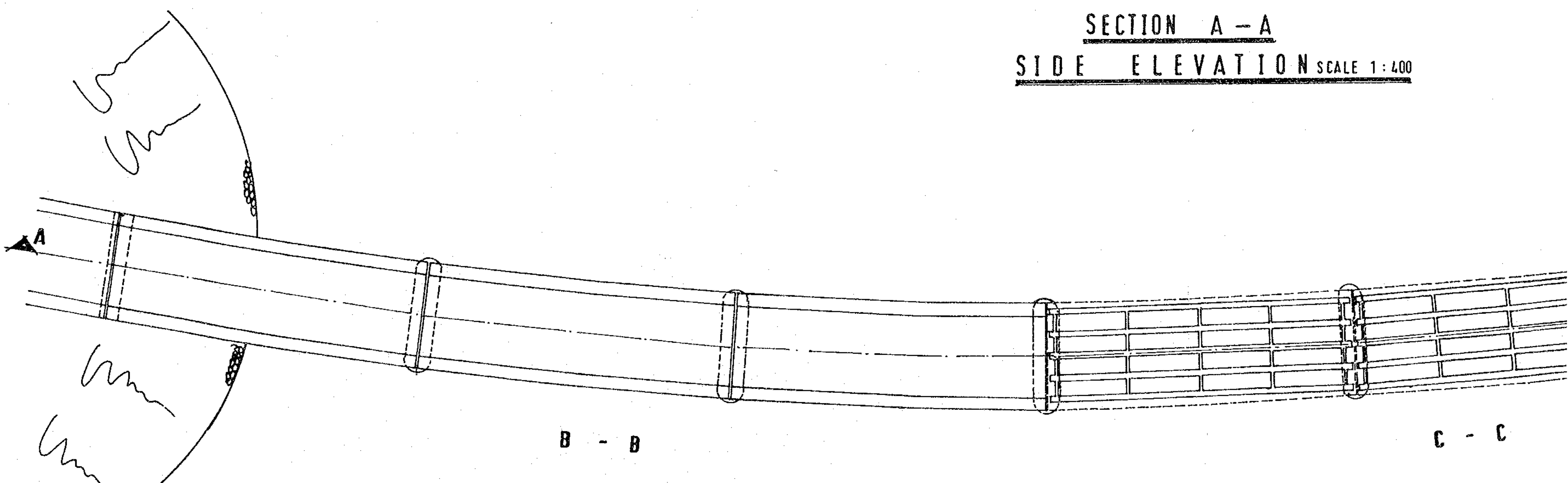


Fig 4.32 Cracking Conditions



SECTION A — A

SIDE ELEVATION SCALE 1 : 400



PLAN SCALE 1 : 400

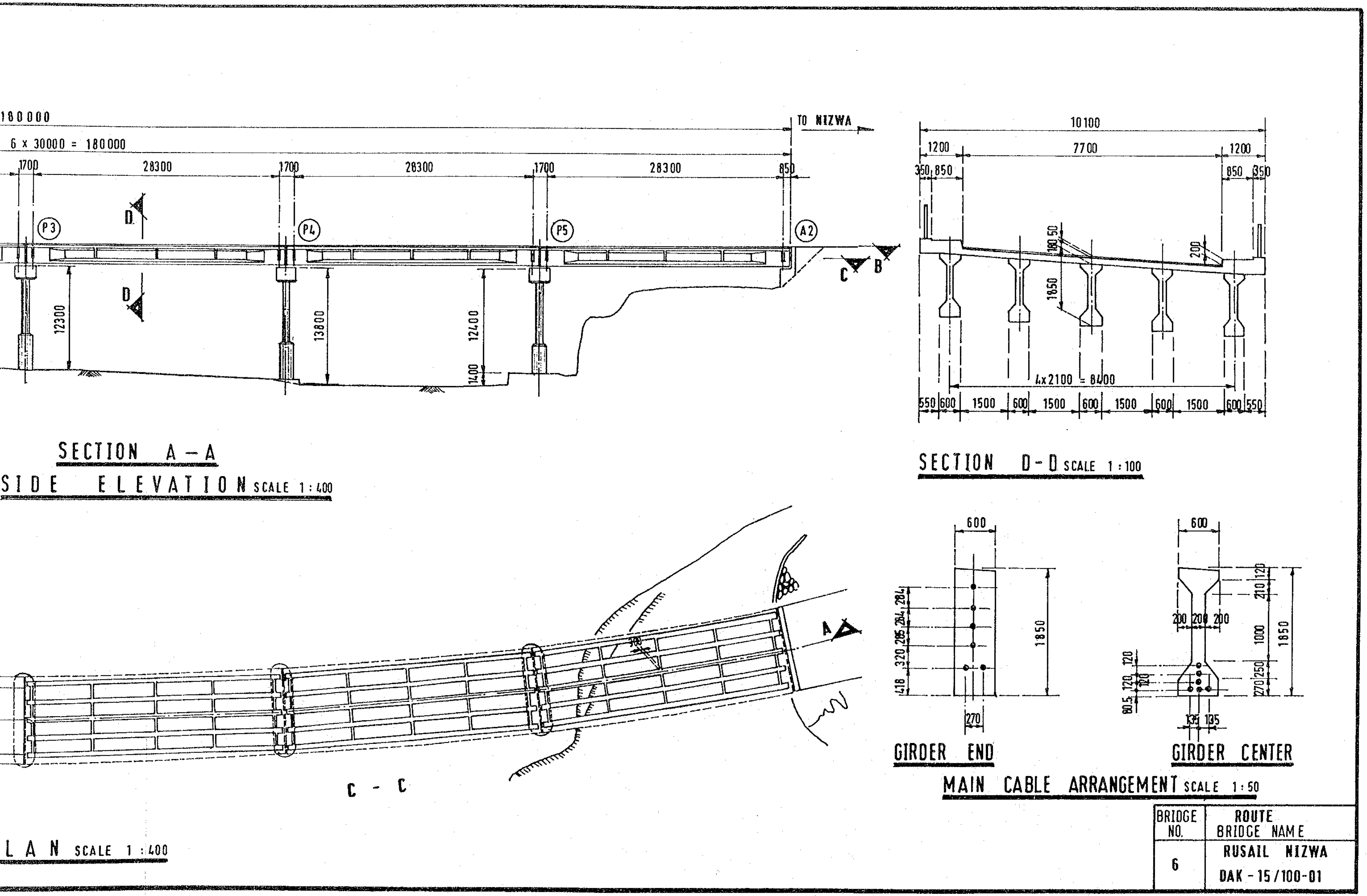
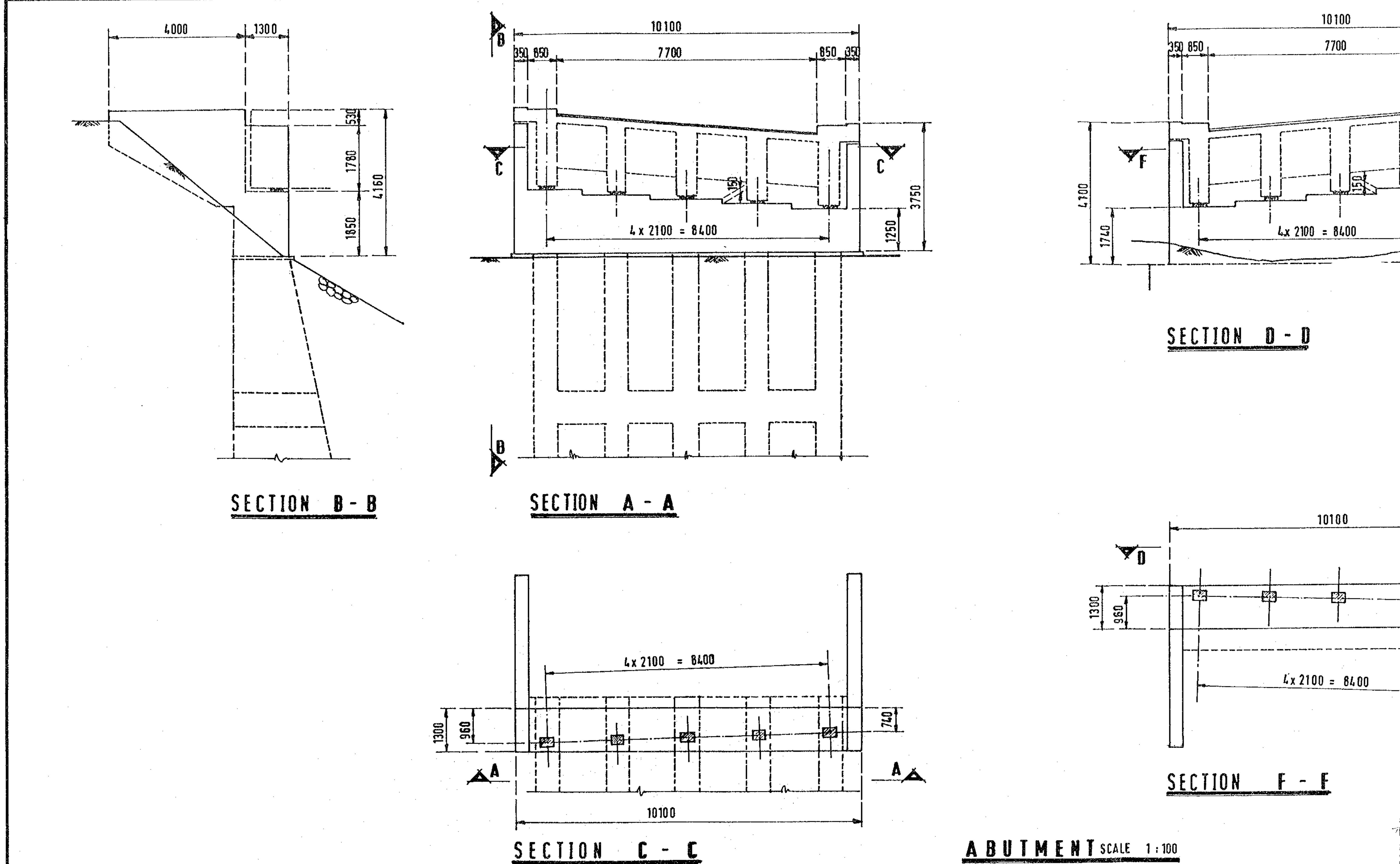


Fig 4.33 General View of Br.No.6



ABUTMENT SCALE 1 : 100