

TABLE OF CONTENTS

Chapter 1	Foundation Investigations	Page
-	1-1 Introduction	1-1
	1-2 Who Performs Foundation Investigations?	1-1
	1-3 Foundation Investigation Overview	1-2
	1-4 Subsurface Drilling Operation	1-3
	1-5 Log of Test Borings	1-4
	1-6 Foundation Report	1-5
	1-7 Applicability of the Log of Test Borings and	1.6
	Foundation Report to the Contract	1-6
	1-8 Basic Soil Properties	1-6
	1-9 Geotechnical Drilling and Sampling Equipment	1-8
Chapter 2	Type Selection	Page
I	2-1 Introduction	2-1
	2-2 Types	2-1
Chapter 3	Contract Administration	Page
1	3-1 Introduction	3-1
	3-2 Utilities	3-5
	3-3 Change Orders	3-6
	3-4 Pile Foundations	3-7
	3-4.1 Driven Piles	3-7
	3-4.2 Cast-In-Drilled-Hole Piles	3-8
	3-5 As-Built Drawings and Pile Records	3-9
	3-6 Differing Site Conditions	3-9
Chapter 4	Footing Foundations	Page
•	4-1 Introduction	4-1
	4-2 Types	4-1
	4-3 Bearing Capacity	4-3
	4-3.1 Failure Modes	4-4
	4-3.2 Factors Affecting Bearing Capacity	4-6
	4-4 Settlement	4-10
	4-5 Ground Improvement/Soil Modification	4-10
	4-6 Construction and Inspection	4-11
	4-7 Excavations	4-12
	4-7.1 Open Excavations	4-13



Chapter 4	Footing Foundations	Page
•	4-7.2 Cofferdams or Shored Excavations	4-15
	4-7.3 Wet Excavations	4-16
	4-7.4 Bottom of Excavation Stability	4-18
	4-7.5 Foundation Inspection & Construction	4-19
	Considerations	
	4-8 Foundation Problems and Solutions	4-21
	4-8.1 Disturbed and/or Contaminated Material	4-21
	4-8.2 Unsuitable Foundation Material	4-22
	4-8.3 Modifications Due to Disturbed, Contaminated or Unsuitable Material	4-22
	4-9 Safety	4-24
Chapter 5	Pile Foundations – General	Page
•	5-1 Introduction	5-1
	5-2 Specifications	5-1
	5-3 Cast-in-Place Piles	5-2
	5-4 Driven Piles	5-3
	5-5 Micropiles and Alternative Piles	5-5
Chapter 6	Cast-in-Place Piles	Page
	6-1 Description	6-1
	6-2 Specifications	6-2
	6-3 Drilling Equipment	6-2
	6-3.1 Continuous Flight Augers	6-2
	6-3.2 Short Flight Augers	6-3
	6-3.3 Single Flight and Double Flight Augers	6-3
	6-3.4 Rock Augers	6-4
	6-3.5 Drilling Buckets	6-4
	6-3.6 Cleanout Buckets	6-5
	6-3.7 Core Barrels	6-5
	6-3.8 Down-Hole Hammers	6-6
	6-3.9 Rotators and Oscillators	6-6
	6-3.10 Reverse Circulation Drilling Equipment	6-8
	6-3.11 Temporary Steel Casings	6-9
	6-3.12 Drilling Rigs	6-10
	6-4 Drilling Methods	6-11
	6-5 Drilling Problems	6-11
	6-5.1 Cave-ins	6-11
	6-5.2 Groundwater	6-11



Chapter 6	Cast-in-Place Piles	Page
•	6-5.3 Utilities	6-12
	6-6 Inspection and Contract Administration	6-13
	6-6.1 Pile Installation Plan	6-13
	6-6.2 CIDH Pile Preconstruction Meeting	6-15
	6-6.3 Construction	6-15
	6-7 Pile Defects	6-16
	6-7.1 Drilling Problems	6-16
	6-7.2 Concrete Placement Problems	6-18
	6-7.3 Casing Removal Problems	6-20
	6-8 Safety	6-22
Chapter 7	Driven Piles	Page
•	7-1 Introduction	7-1
	7-2 General Specifications	7-2
	7-3 Pile Driving Definitions	7-3
	7-4 Hammer Types	7-11
	7-4.1 The Drop Hammer	7-12
	7-4.2 Single Acting Steam/Air Hammer	7-13
	7-4.3 Double Acting Steam/Air Hammer	7-14
	7-4.4 Differential Acting Steam/Air Hammer (External Combustion Hammer	7-16
	7-4.5 Diesel Pile Hammers	7-17
	7-4.5.1 Single Acting Diesel Hammers	7-17
	7-4.5.2 Double Acting Diesel Hammer	7-20
	7-4.6 Vibratory Driver/Extractor	7-21
	7-4.7 Hydraulic Hammer	7-23
	7-4.8 General Hammer Information	7-24
	7-5 Nominal Resistance/Bearing Capacity	7-25
	7-5.1 Pile Load Testing	7-26
	7-5.2 Dynamic Analysis by Wave Equation	7-26
	7-5.2.1 Driveability Study	7-27
	7-5.2.2 Hammer Acceptance Study	7-27
	7-5.2.3 Acceptance Curve Study	7-27
	7-5.3 Manufacturer's Energy Ratings	7-29
	7-5.4 Battered Piles	7-30
	7-6 Preparing to Drive Piles	7-30
	7-6.1 Verification of Hammer Energy	7-32
	7-6.2 Materials Checklist	7-33
	7-6.2.1 Precast Concrete Piles	7-33
	7-6.2.2 Steel Piles	7-33



Chapter 7	Driven Piles	Page
•	7-6.2.3 Timber Piles	7-34
	7-6.3 Logging of Piles	7-34
	7-7 Driving Challenges	7-36
	7-7.1 Difficult or Hard Driving	7-36
	7-7.2 Soft Piles and Re-Drive	7-39
	7-7.3 Alignment of Piles	7-40
	7-7.4 Overdriving	7-41
	7-8 Safety	7-41
Chantar 8	Static Pile Load Testing & Dynamic	Dogo
Chapter 8	Monitoring	Page
	8-1 Introduction	8-1
	8-2 Reasons For Static Load Testing and Pile Dynamic Analysis	8-1
	8-2.1 Static Pile Load Tests	8-2
	8-2.2 Pile Dynamic Analysis (PDA)	8-4
	8-3 Contract Administration of Static Pile Load Testing &	8-6
	Pile Dynamic Analysis	0 0
	8-4 Inspection Requirements During Static Load Testing and PDA	8-7
Chapter 9	Slurry Displacement Piles	Page
•	9-1 Introduction	9-1
	9-1.1 History	9-1
	9-2 Slurry Displacement Method	9-2
	9-3 Principles of Slurry Usage	9-4
	9-4 Sampling and Testing Drilling Slurry	9-8
	9-4.1 Density	9-10
	9-4.2 Sand Content	9-11
	9-4.3 pH Value	9-12
	9-4.4 Viscosity	9-12
	9-5 Types of Slurry	9-13
	9-5.1 Water	9-14
	9-5.2 Mineral	9-15
	9-5.3 Synthetic	9-20
	9-6 Equipment	9-25
	9-7 Specifications	9-29
	9-7.1 Minimum Pile Diameter Requirements	9-29



Chapter 9	Slurry Displacement Piles	Page
_	9-7.2 Concrete Compressive Strength & Consistency	9-30
	Requirements	
	9-7.3 Slurry Testing and Cleaning Requirements	9-30
	9-7.3.1 Mineral	9-30
	9-7.3.2 Synthetic	9-32
	9-7.4 Pile Acceptance Testing Access Requirements	9-33
	9-7.5 Pile Concrete Placement Requirements	9-33
	9-8 Inspection and Contract Administration	9-34
	9-9 Pile Acceptance Testing	9-38
	9-10 Defective Piles	9-41
	9-11 Pile Mitigation and Acceptance	9-45
	9-11.1 What Happens When a Pile is Rejected	9-45
	9-11.2 Pile Mitigation Methodologies	9-45
	9-11.3 Repairs	9-46
	9-11.3.1 Basic Repair	9-46
	9-11.3.2 Grouting Repair	9-46
	9-11.4 Structural Bridging	9-48
	9-11.5 Supplemental and Replacement Piles	9-48
	9-11.6 Pile Mitigation Plan Development and	9-49
	Authorization Procedures	9-49
	9-11.7 Responsibilities of the Engineer	9-49
	9-11.8 Responsibilities of the Contractor	9-50
	9-11.9 Responsibilities of the DES Pile Mitigation	9-52
	Plan Review Committee	
	9-11.10 What to Expect in the Field During Pile Mitigation	9-52
	9-11.11 Procedures For Authorizing the Pile	9-53
	Mitigation Work Performed in the Field and	,
	Pile Acceptance	
	9-12 Safety	9-53
Chapter 10	Pier Columns	Page
	10-1 Description	10-1
	10-2 Specifications	10-2
	10-3 Construction Methods	10-2
	10-4 Excavation	10-2
	10-5 Problem Areas	10-3
	10-6 Safety	10-4



Chapter 11	Ground Anchors & Soil Nails	Page
•	11-1 Introduction	11-1
	11-2 Sub Horizontal Ground Anchors	11-1
	11-2.1 Components	11-1
	11-2.2 Sequence of Construction	11-3
	11-2.3 Safety	11-4
	11-3 Vertical Ground Anchors	11-4
	11-3.1 Sequence of Construction	11-6
	11-4 Testing of Ground Anchors	11-6
	11-4.1 Performance Tests	11-6
	11-4.2 General Acceptance Criteria – Performance & Proof Tests	11-7
	11-4.3 General Construction Control	11-7
	11-5 Soil Nails	11-8
	11-5.1 Sequence of Construction	11-11
	11-5.2 Engineer's Responsibility	11-11
	11-5.3 Contractor's Responsibility	11-11
	11-5.4 Testing of Soil Nail Walls – Verification, Proof & Supplemental	11-11
	11-5.4.1 Verification Nails	11-12
	11-5.4.2 Proof Testing	11-14
	11-5.4.3 Supplemental Testing	11-14
	11-5.5 Safety	11-14
Chapter 12	Cofferdams and Seal Courses	Page
	12-1 General	12-1
	12-2 Sheet Piles and Bracing	12-1
	12-3 Excavation	12-4
	12-4 Seal Course	12-5
	12-4.1 Concrete Deposited Underwater (Tremie Placement Method)	12-6
	12-4.2 Seal Course Inspections	12-6
	12-4.3 Thickness of Seal Course	12-7
	12-5 Contractor's Responsibility	12-7
	12-6 Engineer's Responsibility	12-8
	12-7 Dewatering	12-8
	12-8 Safety	12-9
Chapter 13	Micropiles	Page
•	13-1 Introduction	13-1



Chapter 13	Micropiles	Page
•	13-2 Micropiles	13-1
	13-2.1 Micropile Definition and Description	13-1
	13-2.2 Applications	13-2
	13-2.3 Caltrans Applications	13-3
	13-2.4 Seismic Retrofit	13-3
	13-2.5 Earth Retention	13-3
	13-2.6 Foundation for New Structures (Retaining Walls)	13-4
	13-2.7 Construction and Contract Administration	13-4
	13-2.8 Measurement and Payment	13-4
	13-2.9 Safety	13-5
	Specialty Piles and Special	n
Chapter 14	Considerations for Pile Foundations	Page
	14-1 Introduction	14-1
	14-2 Specialty Piles	14-1
	14-2.1 Alternative Piling	14-1
	14-2.2 Continuous Flight Auger Piling	14-2
	14-2.3 Other Specialty Piling	14-2
	14-3 Special Considerations	14-2
	14-3.1 Overhead Sign Structure Pile Foundations	14-2
	14-3.2 Tip Grouting	14-4
	14-3.3 Type II Shafts	14-5
	14-3.4 Soldier Piling	14-5 14-6
	14-3.5 Other Special Considerations	14-0
Appendices		
	Appendix A – Foundation Investigations	A-1 - A-2
	Appendix B – Contract Administration	B-1 - B-4
	Appendix C – Footing Foundations	C-1 - C-7
	Appendix D – Pier Column & Type I Pile Shaft	D-1 - D-21
	Appendix E – Driven Piles	E-1 - E-22
	Appendix F – Pile Dynamic Analysis, Static Pile Load Testing and Field Acceptance Criteria	F-1 - F-73
	Appendix G – Slurry Displacement Piles	G-1 – G-36
	Appendix H – Ground Anchors & Soil Nails	H-1 – H-7
	Appendix I – Cofferdams and Seal Courses	I-1 – I-4
	Appendix J – Micropiles	J-1 – J-38



Appendices

Appendix K – Foundation Construction Checklists

K-0 - K-62