



American Railway Engineering and Maintenance-of-Way Association

# CHAPTER 1

## ROADWAY AND BALLAST<sup>1</sup>

### TABLE OF CONTENTS

Part/Section	Description	Page
<b>1</b>	<b>Roadbed</b> .....	<b>1-1-1</b>
1.1	Exploration and Testing.....	1-1-4
1.2	Design.....	1-1-13
1.3	Construction.....	1-1-39
1.4	Maintenance.....	1-1-54
1.5	Recommended Practices for Foundations Under Road Crossings and Special Trackwork.....	1-1-70
1.6	Alternative Ground Improvement Methods.....	1-1-79
<b>2</b>	<b>Ballast</b> .....	<b>1-2-1</b>
2.0	Substructure Introduction.....	1-2-3
2.1	Design.....	1-2-4
2.2	Material Introduction (1991) R(2015).....	1-2-8
2.3	Materials.....	1-2-9
2.4	Property Requirements.....	1-2-9
2.5	Production and Handling (1988) R(2015).....	1-2-12
2.6	Loading (1988) R(2015).....	1-2-12
2.7	Inspection (1988) R(2015).....	1-2-13
2.8	Sampling and Testing (1988) R(2015).....	1-2-13
2.9	Measurement and Payment (1988) R(2015).....	1-2-13
2.10	Maintenance Practices.....	1-2-14
2.11	Sub-ballast Recommended Practices.....	1-2-21
2.12	Hot Mix Asphalt (HMS) Underlayment.....	1-2-27
<b>3</b>	<b>Natural Waterways</b> .....	<b>1-3-1</b>
3.1	General.....	1-3-5
3.2	Hydrologic Capacity of Waterway Openings <sup>1</sup> .....	1-3-5
3.3	Determination of Hydraulic Capacity of Structures.....	1-3-28
3.4	Basic Concepts and Definitions of Scour.....	1-3-50
3.5	Calculating Scour.....	1-3-54

<sup>1</sup> The material in this and other chapters in the *AREMA Manual for Railway Engineering* is published as recommended practice to railroads and others concerned with the engineering, design and construction of railroad fixed properties (except signals and communications), and allied services and facilities. For the purpose of this Manual, RECOMMENDED PRACTICE is defined as a material, device, plan, specification, principle or practice recommended to the railways for use as required, either exactly as presented or with such modifications as may be necessary or desirable to meet the needs of individual railways, but in either event, with a view to promoting efficiency and economy in the location, construction, operation or maintenance of railways. It is not intended to imply that other practices may not be equally acceptable.

## TABLE OF CONTENTS (CONT)

Part/Section	Description	Page
3.6	Protecting Roadway and Bridges From Scour .....	1-3-94
3.7	Means of Protecting Roadbed and Bridges from Washouts and Floods.....	1-3-179
3.8	Construction and Protection of Roadbed Across Reservoir Areas .....	1-3-181
3.9	Glossary .....	1-3-190
<b>4</b>	<b>Culverts .....</b>	<b>1-4-1</b>
4.1	Location and Type.....	1-4-7
4.2	Specifications for Placement of Reinforced Concrete Culvert Pipe.....	1-4-10
4.3	Specifications for Prefabricated Corrugated Steel Pipe and Pipe-arches for Culverts, Storm Drains, and Underdrains .....	1-4-10
4.4	Specifications for Coated Corrugated Steel Pipe and Arches.....	1-4-17
4.5	Standard Specification for Corrugated Aluminum Alloy Pipe .....	1-4-17
4.6	Material Requirements for Corrugated Structural Steel Plate Structures.....	1-4-24
4.7	Specifications for Corrugated Structural Aluminum Alloy Plate Pipe, Pipe-arches, and Arches.....	1-4-26
4.8	Specifications for Corrugated High Density Polyethylene Pipe.....	1-4-28
4.9	Specifications for Corrugated Polypropylene Pipe.....	1-4-29
4.10	Specifications for Fiberglass Reinforced Polymer Mortar (FRPM) Pipe.....	1-4-30
4.11	Hydraulics of Culverts .....	1-4-31
4.12	Design Criteria for Corrugated Metal Pipes.....	1-4-59
4.13	Design Criteria for Structural Plate Structures .....	1-4-76
4.14	Structural Design Considerations of Corrugated High Density Polyethylene and Polypropylene Pipes.....	1-4-81
4.15	Structural Design Considerations for Fiberglass Reinforced Polymer Mortar (FRPM) Pipes.....	1-4-83
4.16	Culvert End Treatments .....	1-4-84
4.17	Assembly and Installation of Pipe Culverts .....	1-4-88
4.18	Earth Boring and Jacking Culvert Pipe through Fills.....	1-4-93
4.19	Culvert Rehabilitation.....	1-4-95
4.20	Specification for Steel Tunnel Liner Plates .....	1-4-100
4.21	Construction of Tunnel Using Steel Tunnel Liner Plates .....	1-4-108
4.22	Culvert Inspection.....	1-4-109
4.23	Perforated Pipe Drains .....	1-4-117
4.24	Commentary .....	1-4-121
<b>5</b>	<b>Utilities .....</b>	<b>1-5-1</b>
5.1	Guidelines for Pipelines Conveying Flammable Substances .....	1-5-4
5.2	Specifications for Uncased Gas Pipelines within the Railway Right-of-Way .....	1-5-11
5.3	Guidelines for Pipelines Conveying Non-Flammable Substances.....	1-5-23
5.4	Guidelines for Overhead Pipelines Crossings .....	1-5-29
5.5	Specifications for Fiber Optic “Route” Construction on Railroad Right of Way.....	1-5-31
5.7	Guidelines for Horizontal Directional Drilling (HDD) Construction on Railroad Right-of-Way .....	1-5-51
<b>6</b>	<b>Fences.....</b>	<b>1-6-1</b>
6.0	Fencing (2015) .....	1-6-3
6.1	Fence Types and Usage General Considerations .....	1-6-4
6.2	Design Considerations (2015) .....	1-6-25
6.3	Material Selections Considerations (2015).....	1-6-25
6.4	Other Fence Components and Specialty Applications (2015) .....	1-6-25
6.5	Methods of Controlling Drifting Snow R(2015) .....	1-6-32
6.6	Recommendations for Snow Fences R(2015) .....	1-6-36
6.7	Methods of Controlling Drifting Sand (2015) .....	1-6-53

## TABLE OF CONTENTS (CONT)

Part/Section	Description	Page
<b>7</b>	<b>Roadway Signs</b> .....	<b>1-7-1</b>
7.1	Classification .....	1-7-2
7.2	Design .....	1-7-4
7.3	Materials .....	1-7-4
<b>8</b>	<b>Tunnels</b> .....	<b>1-8-1</b>
8.1	Scope and Purpose .....	1-8-2
8.2	Related Sections .....	1-8-2
8.3	Notable North American Railroad Tunnels .....	1-8-3
8.4	Design .....	1-8-4
8.5	Maintenance and Construction .....	1-8-30
8.6	Measurement and Payment .....	1-8-35
8.7	Ventilation .....	1-8-36
8.8	References .....	1-8-41
8.9	Glossary of Common Tunneling Terms .....	1-8-42
<b>9</b>	<b>Vegetation Control</b> .....	<b>1-9-1</b>
9.1	Rationale and Scope of Work .....	1-9-2
9.2	Preparing a Vegetation Control Program (2015) .....	1-9-3
9.3	Executing a Vegetation Control Program .....	1-9-11
9.4	Evaluating Results of a Vegetation Control Program .....	1-9-14
9.5	Glossary (2015) .....	1-9-16
9.6	Lead Agencies in the United States (2015) .....	1-9-17
9.7	Commentary (2015) .....	1-9-19
<b>10</b>	<b>Geosynthetics</b> .....	<b>1-10-1</b>
10.1	Geotextile Specifications for Railroad Track Separation/Stabilization Applications .....	1-10-3
10.2	Geotextile Specifications for Railroad Drainage Applications .....	1-10-14
10.3	Geotextile Specifications for Railroad Erosion Control Applications .....	1-10-19
10.4	Geocomposite Drainage System Specifications for Railroad Applications .....	1-10-25
10.5	Cellular Confinement System Specification for Railroad Use .....	1-10-29
10.6	Geogrid Specifications for Ballast and Sub-Ballast Reinforcement .....	1-10-33
<b>Chapter 1 Glossary</b> .....		<b>1-G-1</b>
<b>References</b> .....		<b>1-R-1</b>