PROVEN: RESILIENCE

American Concrete Pipe Association

Reinforced Concrete Pipe is Resilient

ACPA

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Director - Florida Concrete Pipe Association

27 yrs. Civil Engineering Experience

- Consultant (7 yrs)
- Concrete Pipe Producer (12 yrs)
- Florida Power & Light Contractor (1 yr)
- Concrete Pipe Association (7 yrs)

Texas A&M University (M.S.)

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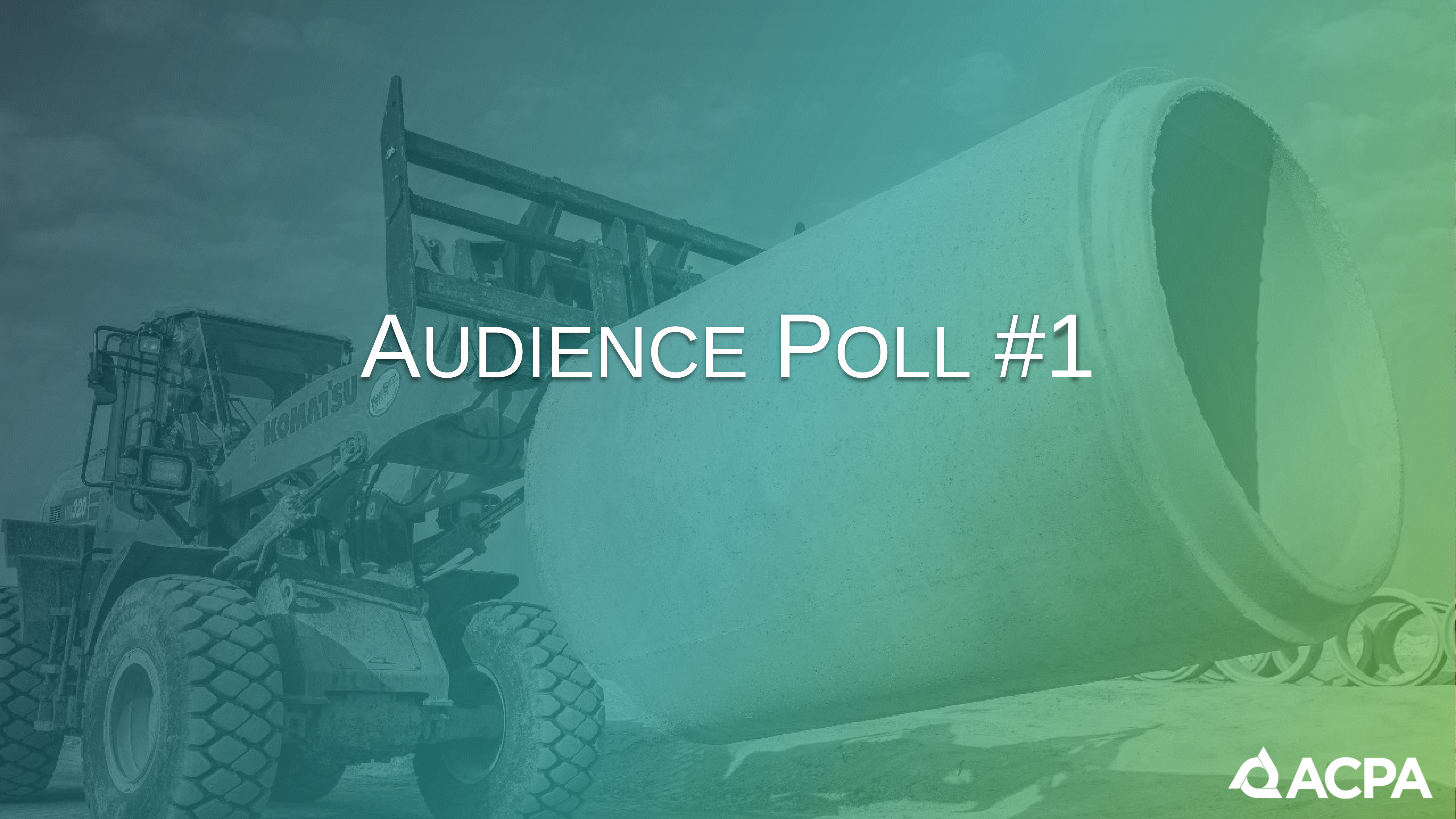
AUDIENCE POLL #1



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Resilience Defined

"THE ABILITY TO PREPARE AND PLAN FOR, ABSORB, RECOVER FROM, OR MORE SUCCESSFULLY ADAPT TO ADVERSE EVENTS" - AASHTO Special Committee on Transportation Security and Emergency Management (SCOTSEM)

Resilience Defined

"Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents." - Presidential Policy Directive 21 – Critical Infrastructure Security and Resilience

Risks to Storm Pipes and Culverts

Accidents

- Specification Oversights
- Installation Imperfections
- Fuel Spills

Natural Incidents

- Groundwater
- Flooding / Overtopping
- Wildfires

What Makes RCP Resilient …

- Quality Control & Accumulative Experience
- Structural Redundancy
- Design Code Parameters
- Inherent Rigid & Physical Characteristics

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4R Framework
Identifying Resiliency

Robustness STRENGTH OF AN ASSET OR SYSTEM TO WITHSTAND RELEVANT THREATS

Redundancy PRESENCE OF A BACKUP SYSTEM OR PLAN

Resourcefulness ABILITY TO IDENTIFY, DIAGNOSE, AND TREAT PROBLEMS WITH AVAILABLE RESOURCES

Rapidity ABILITY TO RESTORE FUNCTIONALITY IN A TIMELY WAY

Source: 4R Framework for Identifying and Evaluating Resiliency in Transportation System Assets and Organizations, Colorado Department of Transportation.

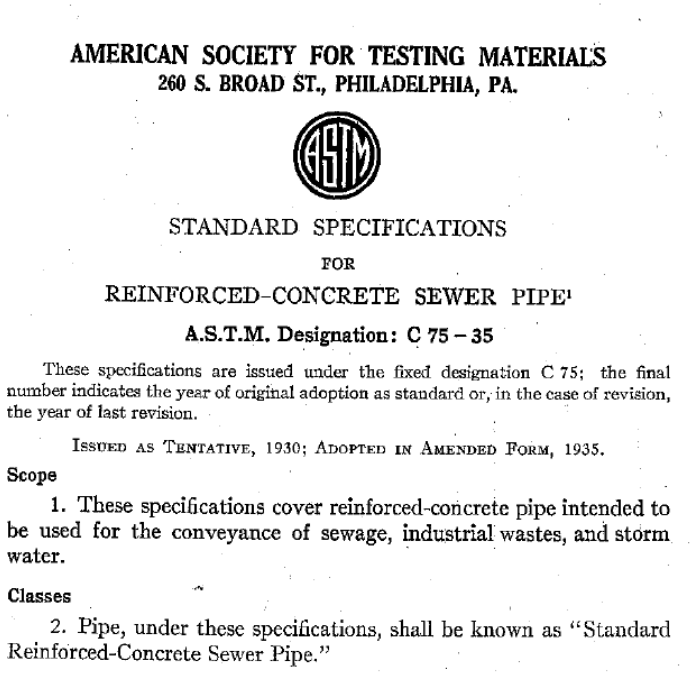
Quality Control & Accumulative Experience

Institutional Knowledge

1905 – Precast RCP introduced in U.S.

1910 – Research rigid pipe installations

1912 – Specification development



AMERICAN SOCIETY FOR TESTING MATERIALS
260 S. BROAD ST., PHILADELPHIA, PA.

STANDARD SPECIFICATIONS
FOR
REINFORCED-CONCRETE SEWER PIPE[1]

A.S.T.M. Designation: C 75 – 35

These specifications are issued under the fixed designation C 75; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

Issued as Tentative, 1930; Adopted in Amended Form, 1935.

Scope

1. These specifications cover reinforced-concrete pipe intended to be used for the conveyance of sewage, industrial wastes, and storm water.

Classes

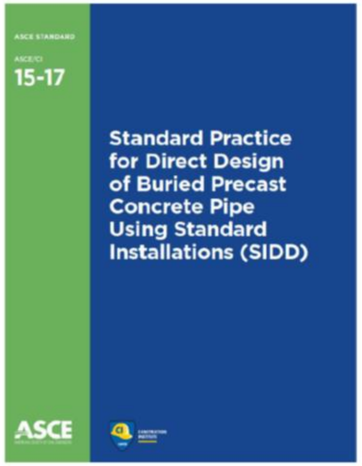
2. Pipe, under these specifications, shall be known as "Standard Reinforced-Concrete Sewer Pipe."

1913 – Formal practice of calculating loads on buried pipe

1920s – Indirect Design & Bedding Factor

1960s – Rein. Conc. beam theory adapted

1993 – ASCE Standard 15 & Standard Installations Types



Accumulative Experience

ACPA CERTIFIED PLANT™

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AASHTO

AREMA®

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION

ASCE

AMERICAN SOCIETY OF CIVIL ENGINEERS

ASTM

ACPA

Structural Redundancy

Safety Factor in RCP Structural Design

- Fill Height Table Allows Use of RCP Within a Range of Depths/Loads (Service Load or D-Load)
- At Maximum D-Load / Max. Fill Ht., RCP Has a Structural Safety Factor of 1.5
- At More Shallow Depths, Safety Factor May Range 2 to 4

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Fill Height Tables are based on:
1. γ_s = 120 pcfs
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition - this gives conservative results in comparison to trench conditions
4. A Type 1 installation requires greater soil stiffness from the surrounding soils than the Type 2, 3, and 4 installations, and is thus harder to achieve. Therefore, field verification of soil properties and compaction levels should be performed.

D-Load (lb/ft/ft) for Type 1 Bedding

Class I · Class II · Class III · Class IV · Class V · Special Design

Pipe Size (in)	Fill Height in Feet													
	15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	898	957	1016	1075	1134	1194	1253	1312	1371	1430	1489	1548	1607	1666
15	876	933	990	1048	1105	1163	1220	1277	1335	1392	1449	1507	1564	1621
18	865	921	978	1034	1091	1147	1203	1260	1316	1373	1429	1485	1542	1598
21	861	917	973	1029	1084	1140	1196	1252	1308	1364	1420	1476	1532	1588
24	861	917	972	1028	1084	1139	1195	1251	1306	1362	1418	1474	1529	1585
27	864	920	975	1031	1087	1142	1198	1254	1309	1365	1421	1476	1532	1588
30	870	925	981	1037	1093	1148	1204	1260	1316	1372	1427	1483	1539	1595
33	877	933	989	1045	1101	1157	1213	1269	1325	1381	1437	1493	1549	1605
36	885	941	998	1054	1110	1167	1223	1279	1335	1392	1448	1504	1561	1617
42	890	946	1002	1058	1115	1171	1227	1283	1339	1395	1451	1508	1564	1620
48	897	953	1010	1066	1122	1178	1234	1290	1346	1403	1459	1515	1571	1627
54	906	963	1019	1075	1131	1188	1244	1300	1356	1413	1469	1525	1581	1638
60	917	973	1029	1086	1142	1199	1255	1312	1368	1425	1481	1538	1594	1650
66	928	985	1041	1098	1155	1211	1268	1325	1381	1438	1495	1552	1608	1665
72	940	997	1054	1111	1168	1225	1282	1339	1396	1453	1510	1567	1624	1681
78	949	1006	1063	1120	1177	1234	1291	1348	1405	1462	1519	1576	1633	1690
84	958	1015	1072	1129	1186	1244	1301	1358	1415	1472	1529	1587	1644	1701
90	967	1024	1082	1139	1196	1254	1311	1368	1425	1483	1540	1597	1655	1712
96	977	1034	1092	1149	1207	1264	1322	1379	1436	1494	1551	1609	1666	1723
102	987	1045	1102	1160	1217	1275	1333	1390	1448	1505	1563	1620	1678	1736
108	997	1055	1113	1171	1228	1286	1344	1402	1459	1517	1575	1633	1690	1748
114	1008	1066	1124	1182	1240	1298	1356	1413	1471	1529	1587	1645	1703	1761
120	1019	1077	1135	1193	1251	1309	1367	1426	1484	1542	1600	1658	1716	1774
126	1030	1088	1146	1205	1263	1321	1380	1438	1496	1555	1613	1671	1730	1788
132	1041	1100	1158	1217	1275	1334	1392	1451	1509	1568	1626	1685	1743	1802
138	1052	1111	1170	1229	1287	1346	1405	1464	1522	1581	1640	1698	1757	1816
144	1064	1123	1182	1241	1300	1359	1418	1477	1536	1595	1654	1712	1771	1830

TYPE 1 EMBEDMENT:

95% STD. PROCTOR DENSITY

A-1, A-3, SW, SP, GW, GP SOILS

15" – 72" DIAMETER RCP (CLASS III)

MAX. SERVICE DEPTH = ~ 22 – 23'

SAFETY FACTOR = 1.5 @ MAX. DEPTH

24" CLASS III RCP EXAMPLE:

@23', S.F. = 1.5

@16', S.F. = 2.2

@9', S.F. = 3.8

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Fill Height Tables are based on:

1. γ_s = 120 pcfs
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -this gives conservative results in comparison to trench conditions

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D-Load (lb/ft/ft) for Type 4 Bedding

Class I	Class IV
Class II	Class V
Class III	Special Design

Type 4 Embedment:

No Compaction of

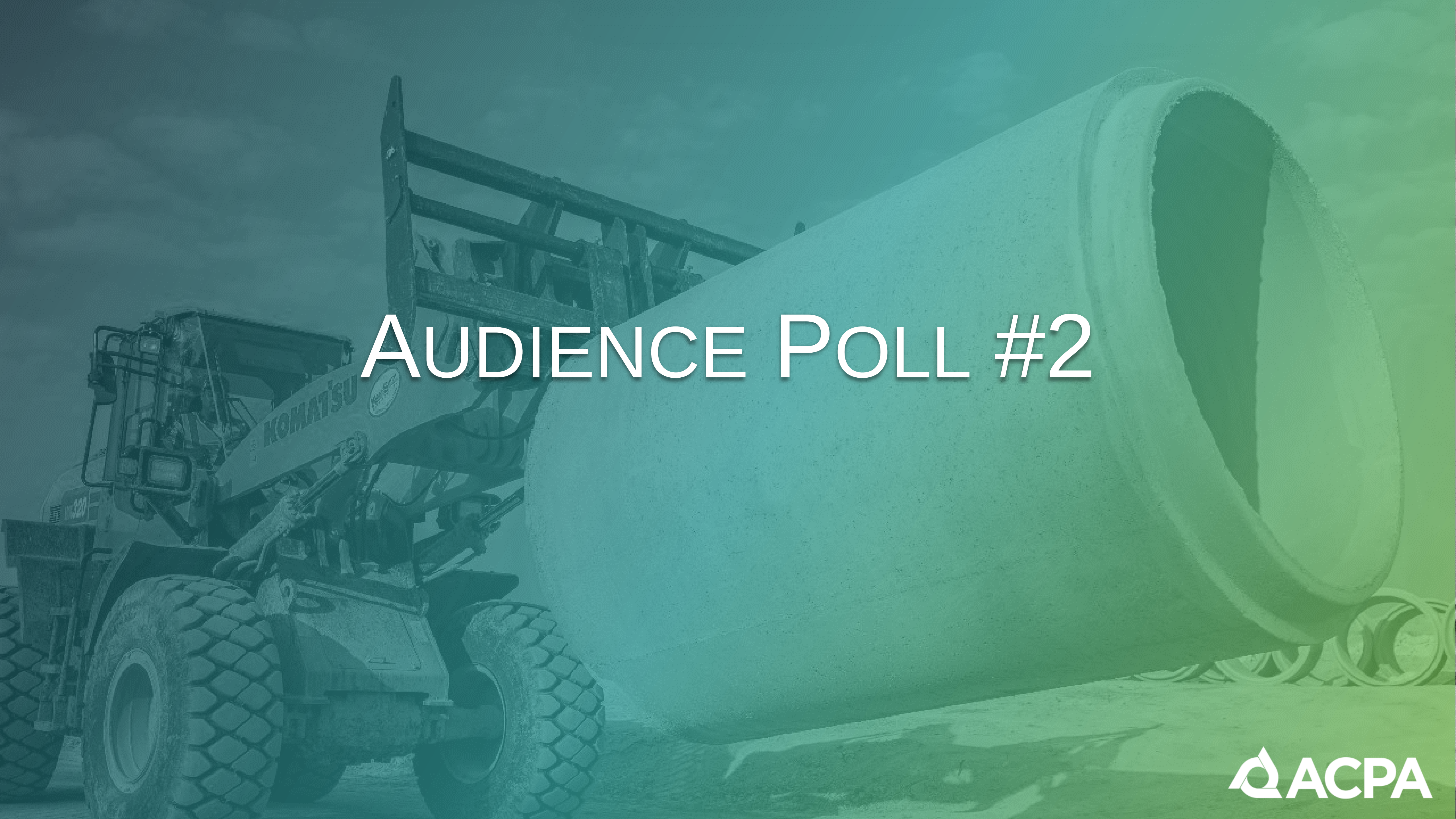
A-1 – A-4 / SW, SP, GW, GP, GM, SM, ML, GC soils

	Fill Height in Feet													
Pipe Size (in)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
12	1579	1481	1111	1032	1071	1154	1264	1383	1372	1521	1671	1820	1969	2119
15	1519	1426	1073	998	1036	1116	1221	1335	1326	1616	1612	1756	1899	2042
18	1443	1391	1050	978	1015	1093	1195	1307	1297	1580	1576	1715	1854	1994
21	1306	1366	1035	966	1002	1079	1179	1283	1279	1557	1552	1688	1825	1961
24	1288	1349	1025	959	994	1070	1168	1276	1267	1541	1535	1670	1804	1938
27	1431	1352	1025	960	993	1068	1165	1271	1259	1531	1524	1657	1790	1922
30	1560	1360	1029	965	995	1070	1166	1270	1254	1524	1517	1648	1780	1911
33	1437	1316	1010	955	988	1064	1160	1264	1252	1520	1512	1642	1773	1903
36	1336	1285	993	947	982	1060	1157	1260	1251	1518	1509	1639	1768	1898
42	1181	1211	966	935	976	1057	1153	1256	1252	1518	1508	1636	1764	1892
48	1068	1090	941	927	973	1056	1152	1255	1257	1522	1511	1638	1765	1892
54	1029	1058	925	921	973	1058	1154	1257	1264	1529	1516	1642	1768	1894
60	1059	1038	912	918	975	1062	1158	1261	1273	1538	1523	1649	1774	1899
66	1021	1022	906	917	978	1066	1163	1266	1282	1548	1532	1657	1781	1906
72	969	1008	902	917	984	1072	1169	1272	1292	1559	1541	1666	1790	1914
78	927	996	899	920	990	1079	1176	1280	1303	1570	1551	1675	1799	1923
84	893	986	898	925	997	1086	1184	1283	1315	1582	1562	1686	1810	1933
90	866	978	898	931	1004	1094	1192	1296	1408	1595	1574	1697	1820	1944
96	844	948	899	936	1012	1102	1201	1305	1417	1608	1585	1708	1831	1955
102	826	932	911	949	1024	1115	1214	1318	1429	1685	1597	1720	1843	1966
108	812	927	923	962	1037	1128	1226	1330	1441	1698	1609	1732	1855	1978
114	801	938	935	975	1050	1141	1239	1343	1454	1712	1682	1745	1867	1990
120	793	949	947	986	1063	1154	1252	1356	1467	1726	1694	1757	1879	2002
126	786	960	959	999	1076	1167	1265	1369	1480	1740	1707	1823	1892	2014
132	782	971	967	1013	1090	1180	1278	1382	1493	1754	1720	1836	1952	2027
138	779	982	968	1026	1103	1194	1292	1395	1506	1769	1733	1848	1965	2040
144	778	994	980	1039	1116	1207	1305	1409	1519	1783	1746	1861	1978	2095

RCP Structural Safety Factor

- Excess Capacity (Redundancy)
- Measurable Capacity
- Certified via Plant Testing (3-Edge Bearing)
- Resilience to:
  - Deep Fills, Excessive Loads, Construction Loads
  - Sub-standard Soil Densification
  - Disturbed Embedment when Resetting Trench Box

AUDIENCE POLL #2



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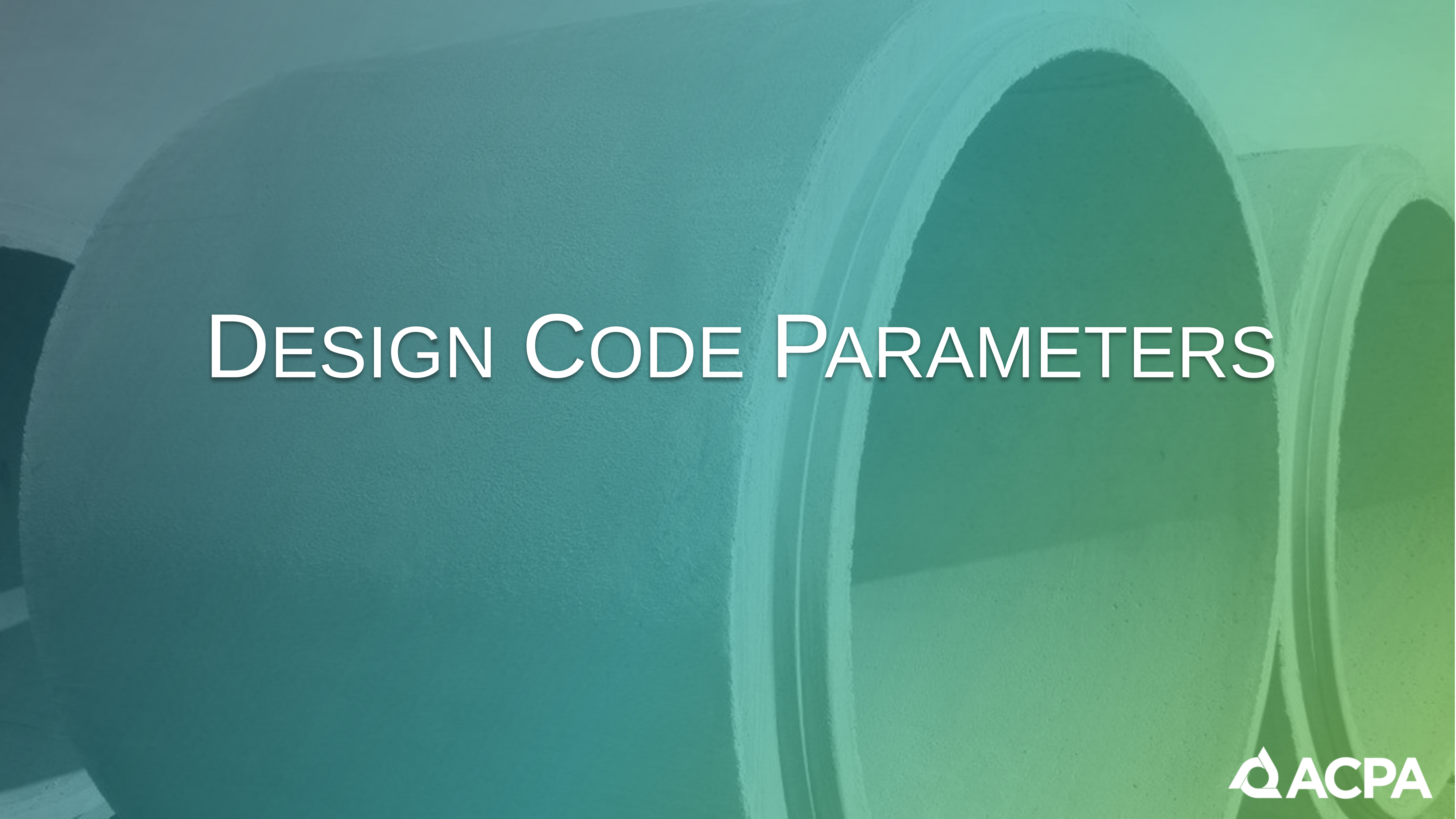
Installation Imperfections

- Trench box movement / disturbed embedment
- Failure to achieve soil density Proctor criteria
- Lack of structural embedment around entire pipe
- Voids in haunch zone



DESIGN CODE PARAMETERS

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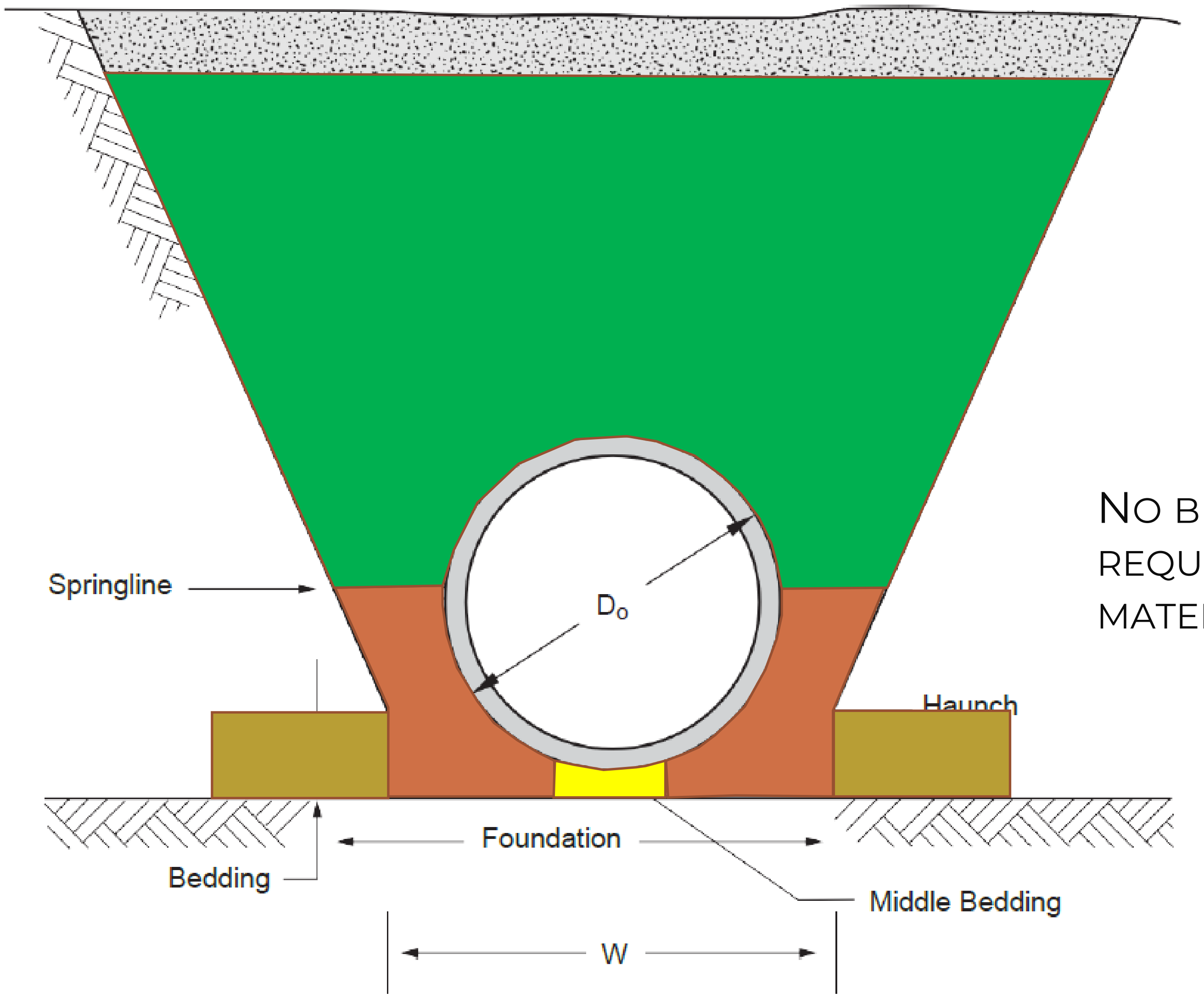
Concrete Pipe Trench Detail



NO BENEFIT TO CONCRETE PIPE SUPPORT BY REQUIRING THE HIGH COMPACTION OF SELECT MATERIALS ABOVE THE RCP SPRINGLINE.

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Concrete pipe bedding factors for embankment install – in the design code – were adjusted to account for voids in haunch.

12.10.4.3.2a Earth Load Bedding Factor for Circular Pipe

Earth load bedding factors, B_{FE}, for circular pipe are presented in Table 1.

For pipe diameters, other than those listed in Table 1, embankment condition bedding factors, B_{FE}, may be determined by interpolation.

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Fill Height Tables are based on:

1. γ_s = 120 pcfs
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition - this gives conservative results in comparison to trench conditions
4. A Type 1 installation requires greater soil stiffness from the surrounding soils than the Type 2, 3, and 4 installations, and is thus harder to achieve. Therefore, field verification of soil properties and compaction levels should be performed.

D-Load (lb/ft/ft) for Type 1 Bedding

Class I · Class II · Class III · Class IV · Class V · Special Design

	Fill Height in Feet													
Pipe Size (in)	15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	898	957	1016	1075	1134	1194	1253	1312	1371	1430	1489	1548	1607	1666
15	876	933	990	1048	1105	1163	1220	1277	1335	1392	1449	1507	1564	1621
18	865	921	978	1034	1091	1147	1203	1260	1316	1373	1429	1485	1542	1598
21	861	917	973	1029	1084	1140	1196	1252	1308	1364	1420	1476	1532	1588
24	861	917	972	1028	1084	1139	1195	1251	1306	1362	1418	1474	1529	1585
27	864	920	975	1031	1087	1142	1198	1254	1309	1365	1421	1476	1532	1588
30	870	925	981	1037	1093	1148	1204	1260	1316	1372	1427	1483	1539	1595
33	877	933	989	1045	1101	1157	1213	1269	1325	1381	1437	1493	1549	1605
36	885	941	998	1054	1110	1167	1223	1279	1335	1392	1448	1504	1561	1617
42	890	946	1002	1058	1115	1171	1227	1283	1339	1395	1451	1508	1564	1620
48	897	953	1010	1066	1122	1178	1234	1290	1346	1403	1459	1515	1571	1627
54	906	963	1019	1075	1131	1188	1244	1300	1356	1413	1469	1525	1581	1638
60	917	973	1029	1086	1142	1199	1255	1312	1368	1425	1481	1538	1594	1650
66	928	985	1041	1098	1155	1211	1268	1325	1381	1438	1495	1552	1608	1665
72	940	997	1054	1111	1168	1225	1282	1339	1396	1453	1510	1567	1624	1681
78	949	1006	1063	1120	1177	1234	1291	1348	1405	1462	1519	1576	1633	1690
84	958	1015	1072	1129	1186	1244	1301	1358	1415	1472	1529	1587	1644	1701
90	967	1024	1082	1139	1196	1254	1311	1368	1425	1483	1540	1597	1655	1712
96	977	1034	1092	1149	1207	1264	1322	1379	1436	1494	1551	1609	1666	1723
102	987	1045	1102	1160	1217	1275	1333	1390	1448	1505	1563	1620	1678	1736
108	997	1055	1113	1171	1228	1286	1344	1402	1459	1517	1575	1633	1690	1748
114	1008	1066	1124	1182	1240	1298	1356	1413	1471	1529	1587	1645	1703	1761
120	1019	1077	1135	1193	1251	1309	1367	1426	1484	1542	1600	1658	1716	1774
126	1030	1088	1146	1205	1263	1321	1380	1438	1496	1555	1613	1671	1730	1788
132	1041	1100	1158	1217	1275	1334	1392	1451	1509	1568	1626	1685	1743	1802
138	1052	1111	1170	1229	1287	1346	1405	1464	1522	1581	1640	1698	1757	1816
144	1064	1123	1182	1241	1300	1359	1418	1477	1536	1595	1654	1712	1771	1830

CPDPGN029-2 (Revised 6/24)

C12.10.4.3.2a

The bedding factors for circular pipe were developed using the bending moments produced by the Heger pressure distributions from Figure 12.10.2.1-1 for each of the standard embankment installations. The bedding factors for the embankment condition are conservative for each installation. This conservatism is based on assuming voids and poor compaction in the haunch areas and a hard bedding beneath the pipe in determining the moments, thrusts, and shears used to calculate the bedding factors. The modeling of the soil pressure distribution used to determine moments, thrusts, and shears is also conservative by 10 to 20 percent, compared with the actual SPIDA analysis.

Source: AASHTO LRFD Bridge Design Specifications, Section 12: Buried Structures and Tunnel Liners, 4th Edition, Association of State Highway and Transportation Officials, 2007.

RCP Design Code

- Provides Robustness
- Prepared For, Can Absorb:
  - Installation Accidents/Imperfections
  - Voids in Haunch
  - Not Dependent on Embedment Above Springline

Risks to Storm Pipes and Culverts

Accidents

- Specification Oversights
- Installation Imperfections
- Fuel Spills

Natural Incidents

- Groundwater
- Flooding / Overtopping
- Wildfires

Inherent Robustness


LIVE
FLOODING
WAKE & FRANKLIN CO.
WASHED OUT
401
abc11.com
6:02 86°

Groundwater Structural Impacts
on Storm Pipe

- ❑ Buoyancy Force
  - ❑ Mass of RCP is Beneficial
- ❑ Hydrostatic pressure
  - ❑ Active, Lateral Pressure
  - ❑ Reduces Soil Friction, Stiffness
- ❑ RCP Benefits from Active Support

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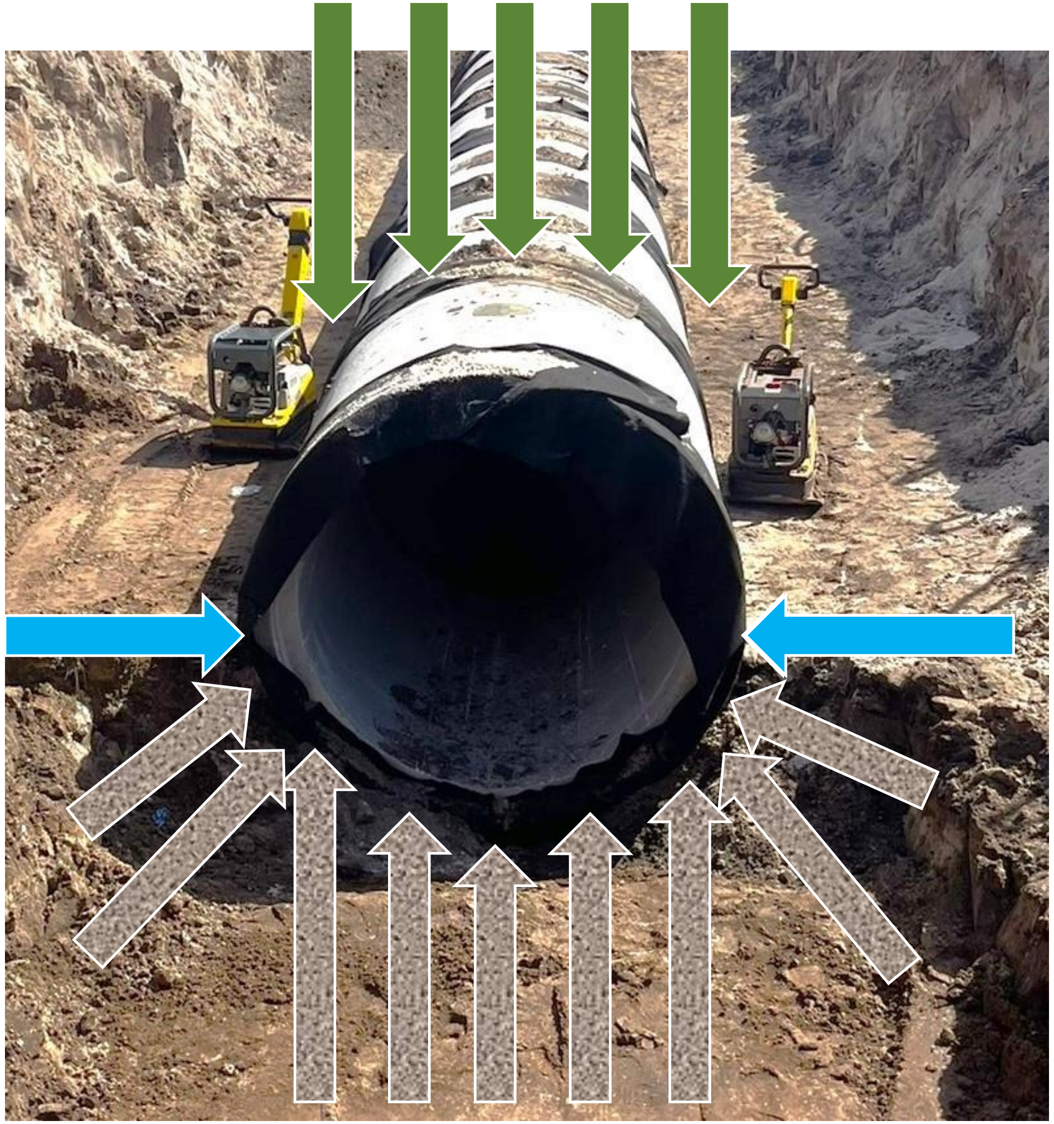

Lateral Pressures Benefit RCP Reaction to Vertical Loads

- Lateral pressures produce bending moments in the pipe wall that are opposite in direction to those produced by vertical loads.
- Therefore, every pound of lateral pressure that can reliably be brought to bear against the sides of a pipe increases its capacity to carry vertical load about one for one.

Dry versus Saturated Soil Conditions (For Reinforced Concrete Pipe)

Calculate bending moments about the invert.

Dry Soil Density 120 lbs/ft^3

Saturated Soil Density: 140 lbs/ft^3

Unit Weight of water: 62.4 lbs/ft^3

Buoyant Unit Weight of Soil = 57.6 lbs/ft^3

Active Lateral Earth Pressure Coefficient = 0.33

Assume a 90 degree bedding angle (this results in a bedding reaction across 70% of the bottom of the pipe)

With a 70% reaction at the bottom, the ratio of bottom reaction to pressure at the top is 1/0.7 = 1.43

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RCP Bending Moments: Reduced w/ Saturated Soils

For Dry Soil:

$$Md_{vert} := 0.222 \cdot p \cdot 1.43 \cdot r^2$$

$$Md_{horiz} := -0.250 \cdot K_a \cdot p \cdot r^2$$

$$Md_{Tot} := Md_{vert} + Md_{horiz}$$

$$Md_{Tot} = 0.235\,p \cdot r^2$$

For Saturated Soil

$$Ratio_{vert} := \frac{\gamma_s}{\gamma_d} \qquad Ratio_{eff} := \frac{\gamma_b}{\gamma_d} \qquad Ratio_{wat} := \frac{\gamma_w}{\gamma_d}$$

$$Ratio_{vert} = 1.167 \qquad Ratio_{eff} = 0.48 \qquad Ratio_{wat} = 0.52$$

$$Ms_{vert} := 0.222 \cdot Ratio_{vert} \cdot p \cdot 1.43 \cdot r^2$$

$$Ms_{horiz} := -0.250 \cdot Ratio_{eff} \cdot K_a \cdot p \cdot r^2 - 0.250 \cdot Ratio_{wat} \cdot p \cdot r^2$$

$$Ms_{Tot} := Ms_{vert} + Ms_{horiz}$$

$$Ms_{Tot} = 0.201\,p \cdot r^2$$

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APPENDIX C

COVER HEIGHT TABLES

General Notes

1. The tabulated values are recommended minimum dimensions to withstand anticipated highway traffic loads. Additional cover may be required to support construction equipment loads or highway traffic loads before pavement is completed. Some size thickness combinations may require minimum cover greater than those listed within this appendix.

2. Tabulated values are based on the guidelines found in the ***AASHTO LRFD - BDS*** and other general site design assumptions. Alternative values may be used in lieu of the values tabulated within this appendix based on site-specific calculations developed by suitable methods and detailed in the plans. The assumptions made for use in the development of the tabulated values include:
   a. 120 lb/cubic feet soil density
   b. The pipes will be installed at or above the established water table
   c. Pipe trench excavation per FDOT Specification 125-4.4
   d. Pipe trench backfill allowable soils, bedding, and compaction per FDOT Specification 125-8
   e. Pipes maximum deflection = 5 percent per FDOT Specification 430-8
   f. Pipes maximum strains per AASHTO

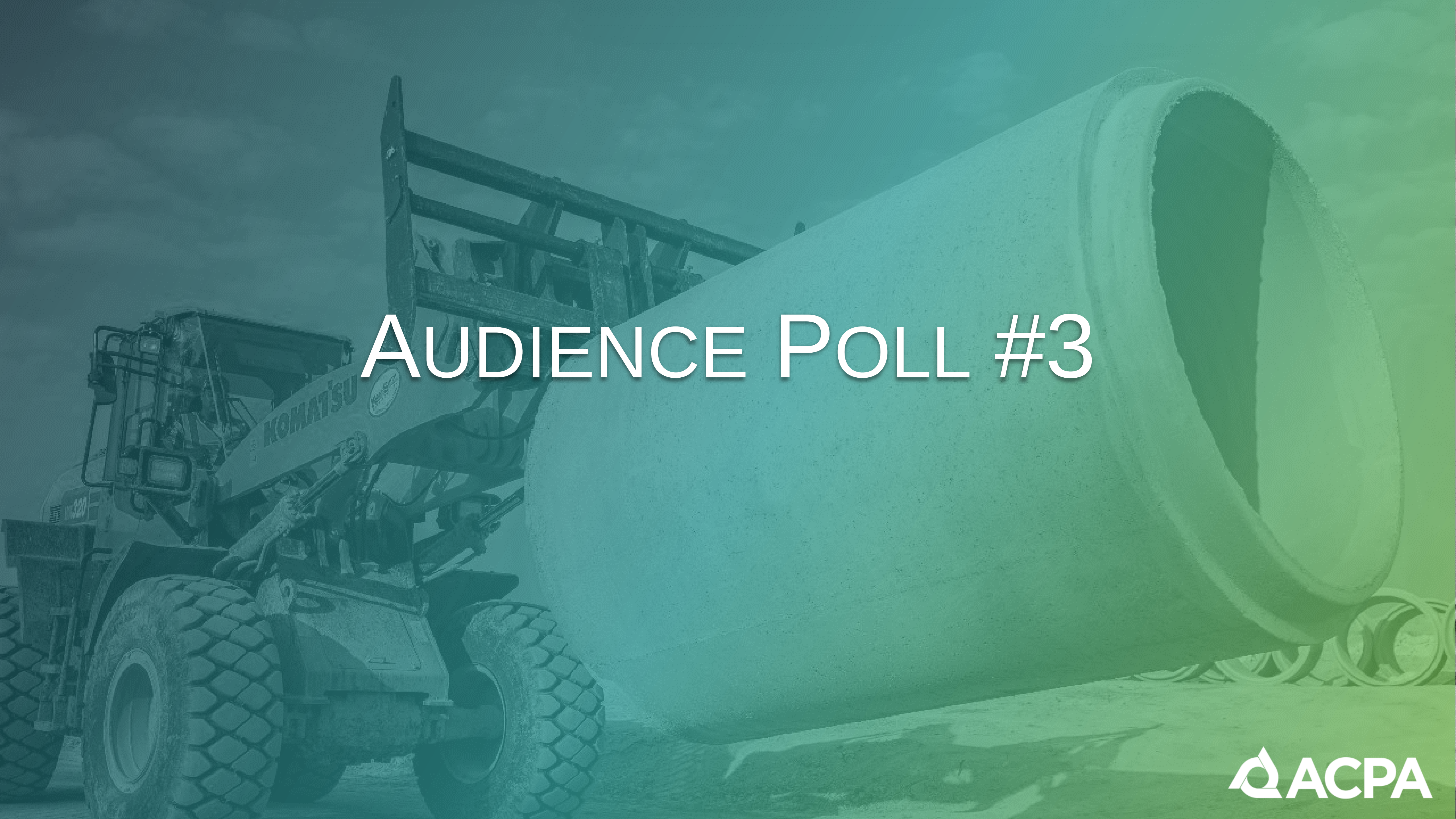
MAXIMUM RECOMMENDED COVER BASED ON VECHICLE LOADING CONDITIONS

PIPE DIAM.	CLASS I		CLASS II		CLASS III
	COMPACTED	DUMPED	95%	90%	95%
4" (100mm)	37 (11.3m)	18 (5.5m)	25 (7.6m)	18 (5.5m)	18 (5.5m)
6" (150mm)	44 (13.4m)	20 (6.1m)	29 (8.8m)	20 (6.1m)	21 (6.4m)
8" (200mm)	32 (9.8m)	15 (4.6m)	22 (6.7m)	15 (4.6m)	16 (4.9m)
10" (250mm)	38 (11.6m)	18 (5.5m)	26 (7.9m)	18 (5.5m)	18 (5.5m)
12" (300mm)	35 (10.7m)	17 (5.2m)	24 (7.3m)	17 (5.2m)	17 (5.2m)
15" (375mm)	38 (11.6m)	17 (5.2m)	25 (7.6m)	17 (5.2m)	18 (5.5m)
18" (450mm)	36 (11.0m)	17 (5.2m)	24 (7.3m)	17 (5.2m)	17 (5.2m)
24" (600mm)	28 (8.5m)	13 (4.0m)	20 (6.1m)	13 (4.0m)	14 (4.3m)
30" (750mm)	28 (8.5m)	13 (4.0m)	20 (6.1m)	13 (4.0m)	14 (4.3m)
36" (900mm)	26 (7.9m)	12 (3.7m)	18 (5.5m)	13 (4.0m)	13 (4.0m)
42" (1050mm)	23 (7.0m)	11 (3.4m)	16 (4.9m)	11 (3.4m)	11 (3.4m)
48" (1200mm)	25 (7.6m)	11 (3.4m)	17 (5.2m)	11 (3.4m)	12 (3.7m)
60" (1500mm)	25 (7.6m)	11 (3.4m)	17 (5.2m)	11 (3.4m)	12 (3.7m)

FILL HEIGHT TABLE GENERATED USING AASHTO SECTION 12, LOAD RESISTANCE FACTOR DESIGN (LRFD) PROCEDURE WITH THE FOLLOWING ASSUMPTIONS:
NO HYDROSTATIC PRESSURE,
UNIT WEIGHT OF SOIL (γ_s) = 120 PCF

ACPA

Audience Poll #3



ACPA

Risks to Storm Pipes and Culverts

Accidents

- Specification Oversights
- Installation Imperfections
- Fuel Spills

Natural Incidents

- Groundwater
- Flooding / Overtopping
- Wildfires

Wildfire & Other Fire Events

2018 Camp Fire

- Most destructive wildfire in California history
- Globe's most expensive disaster of 2018
- At least 85 fatalities
- 153,336 acres burned
- 18,000 structures destroyed
- Paradise lost 90-95% of all structures

Town of Paradise

November 24, 2018 ·

SAFETY ALERT: The Town of Paradise has discovered a creek culvert was compromised due to fire damage on Wagstaff Road at Clark Road. Please be advised that in addition to the closure of Wagstaff Road, crews are working to assess and identify additional culverts and roads within Town limits that may be compromised.

MELTED CULVERTS

AS A WIND-DRIVEN FIRE WITH LOW-FLYING EMBERS, MINIATURE FIRES WERE IGNITED INSIDE OPEN-ENDED CULVERTS AND, DEPENDING ON THE CONSTRUCTION MATERIAL TYPE, COMPLETELY BURNED OUT SEVERAL PIPES, COLLAPSING AND UNDERMINING THE ROADWAY…

Video Resource: *California Cities Defend the Line Against Disastrous Wildfires*, ENR Videos, Engineering News Record, April 25, 2019 (https://www.enr.com/videos?bctid=6029904164001).

ACPA

Town of Paradise

This photo is from a post. View post

Caltrans District 1
September 9 at 4:42 PM ·

View looking into a culvert located on U.S. 101 south of Willits.

1 Comment

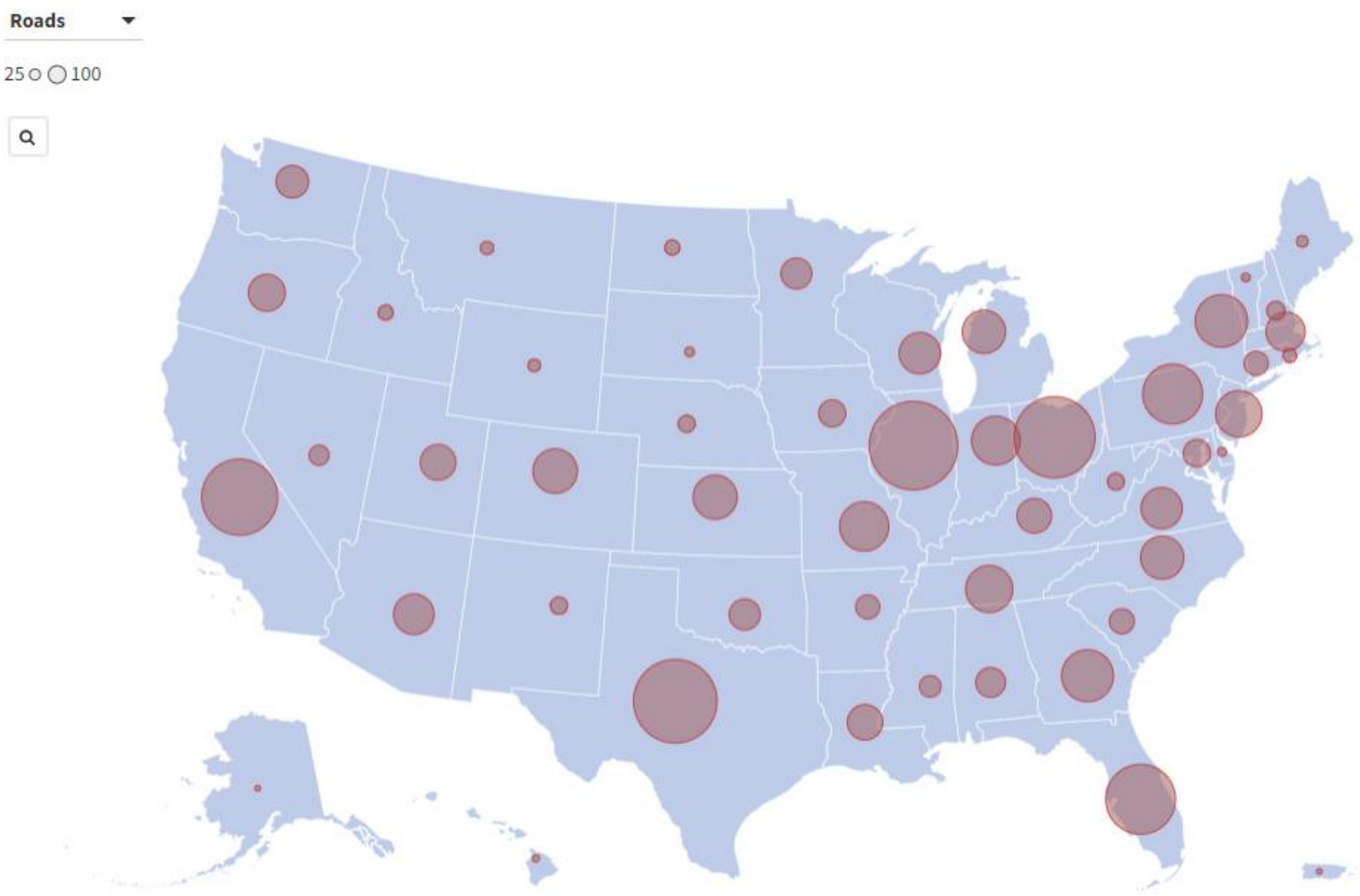
Like Comment Share

Andy Gray
Looks good
Like Reply 4d

Write a comment...
Press Enter to post.

Hazmat Incidents on Roads and Rail, 2013-2022

Hazmat incidents on roads and rails while vehicle was in-transit



Source: Pipeline and Hazardous Materials Safety Administration (PHMSA) • By Dilcia Mercedes, CBS News

2014 – 2024

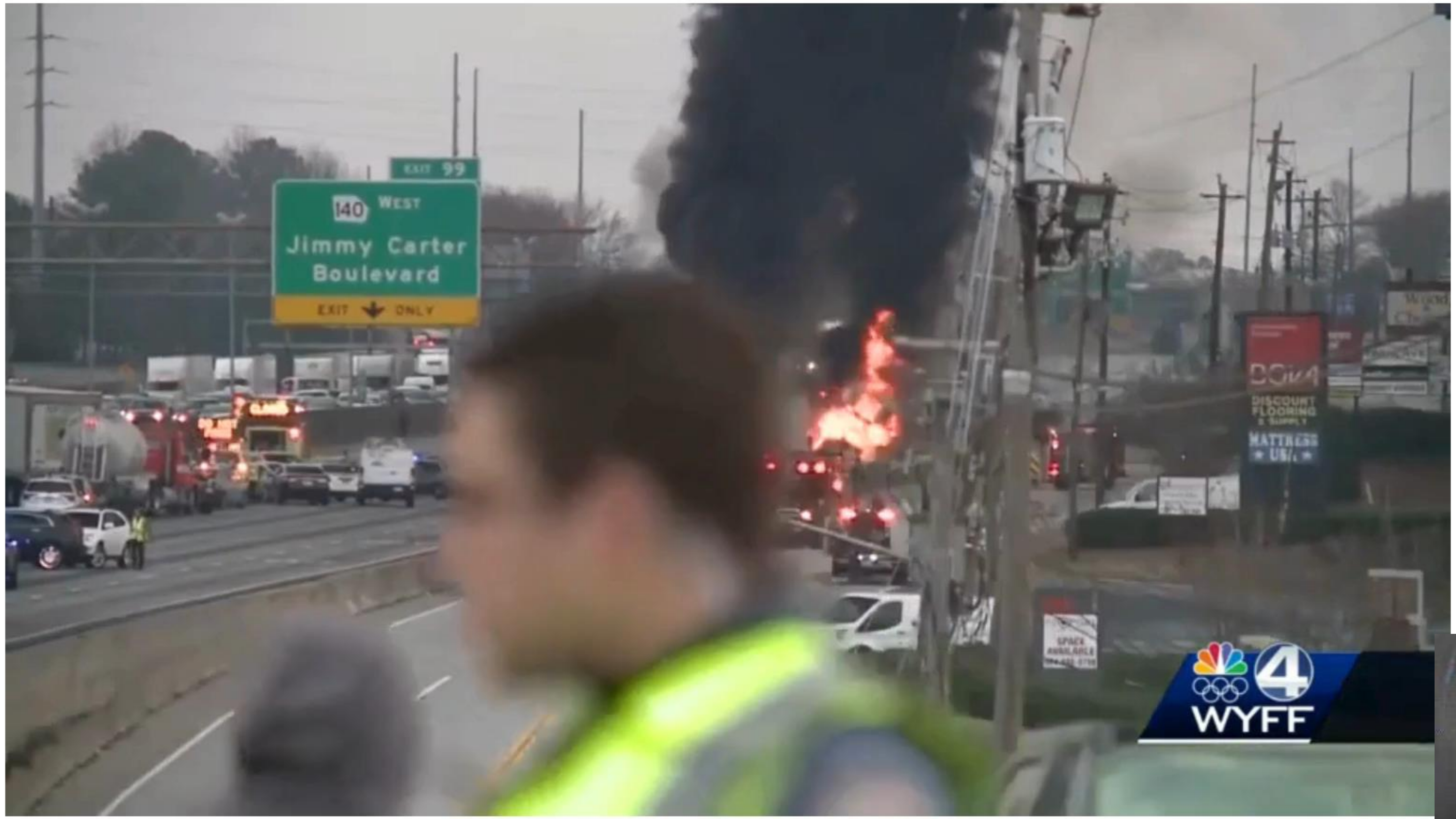
24,703: # Events for In-Transit Highway Flammable Spills

160: # Cases w/ Spill Entered Storm Sewer

90: # Cases w/ Roadway Closed

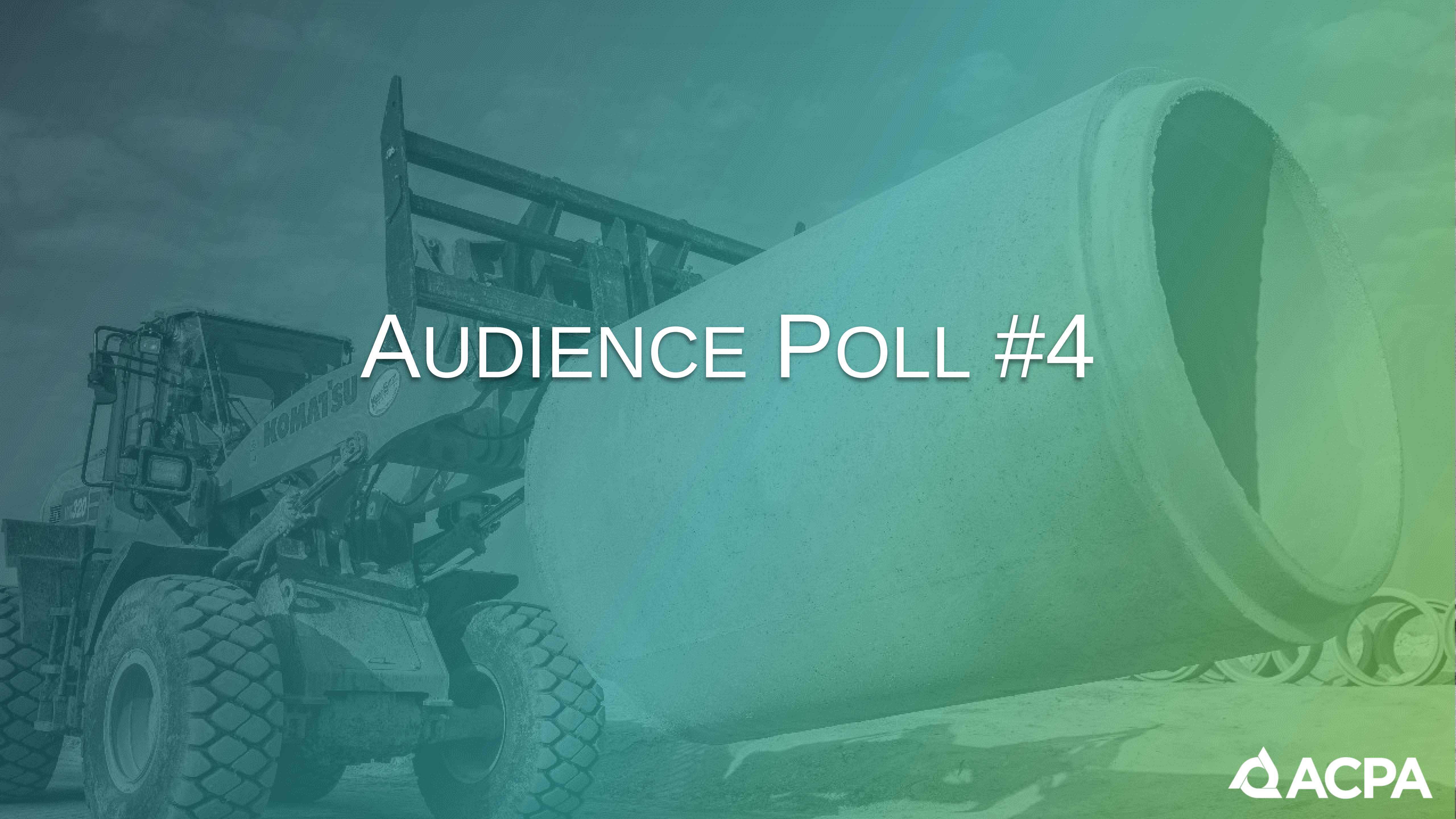
Source: HAZMAT Incident Report Search Tool, PHMSA

ACPA



Georgia DOT post-event CCTV inspections of the reinforced concrete pipes determined that there was no detrimental impacts to the pipes.

AUDIENCE POLL #4



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Resilient Attributes...

- Quality Control & Accumulative Experience
- Structural Redundancy
- Design Code Parameters
- Inherent Rigid & Physical Characteristics

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PROVEN RESILIENCE

THE INHERENT ROBUST CHARACTER OF REINFORCED CONCRETE PIPE, REDUNDANCY IN ITS DESIGN, AND ESTABLISHED PERFORMANCE FOR OVER A CENTURY ARE PROOF OF ITS RESILIENCE.

Thank You

Douglas J. Holdener, P.E.

Director – Florida Concrete Pipe Association

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American Concrete Pipe Association