

THE LONG GRAY LINE

Reflections on concrete bridge progress

by William Nickas

In 1948, the history of prestressed concrete bridges in the United States began when a Belgian professor named Gustave Magnel oversaw the design, prefabrication, and testing of 160-ft-long girders used to construct the first prestressed concrete girder bridge in the U.S., the Walnut Lane Memorial Bridge in Philadelphia, Pa. As I noted in my editorial for this issue of *ASPIRE*[®], we can learn much about possible future improvements for the industry by reflecting on past achievements. As members of the bridge engineering community, we are part of a “long gray line” that connects what we do today, and what we want to do tomorrow, with the accomplishments of those who came before us.

Industry Progress

There are many ways to review the progression of our industry over the last seven decades. PCI issued a chronicle of the first 25 years compiled by industry pioneers titled *Reflections on the Beginnings of Prestressed Concrete in America*.¹ The American Society of Civil Engineers (ASCE) and other organizations periodically evaluate the health of our infrastructure. These “report cards” help educate us and our communities about the need for infrastructure investments and the revenue streams to pay for them (such as tolls or gas taxes). (For the ASCE report card, see www.asce.org/infrastructure.)

This article takes a different look at benchmarks of our industry’s progress. The Federal Highway Administration’s (FHWA’s) National Bridge Inventory (NBI) (see www.fhwa.dot.gov/bridge/nbi.cfm) is the source of the data used for comparisons. A bridge in the NBI database is classified by the material of its superstructure and the year it was built. So to start, let’s use the period 1977 to 2006 as the base period for an analysis of recent trends. During the 30-year period, NBI data indicate that 476,417 bridges were built and 25 of 52 states (for our discussion, “states” will be taken

to include the District of Columbia, and Puerto Rico) used some type of concrete (reinforced or prestressed) superstructure for at least 65% of the bridges built during the period. In contrast, during the most recent decade for which data are available, the period between 2007 and 2016, 123,158 bridges were built, 31 states met the 65% benchmark, and 35 states increased their use of concrete superstructure types. The states hitting the 65% benchmark in the 2007–2016 decade are colored in dark grey in **Table 1** and **Figure 1**. As shown in the light-gray portions of the table, an additional seven regions are above 50% concrete utilization. Overall, the market share for all types of concrete superstructures has increased from 68.7% in the base period to 71.6% in the last decade (an increase of 2.9%).

When examining the historical data, we gain further insight by looking at the types of crossings and the functional needs for the structures. In the base years of this study, shorter-span bridges (openings of 20 to 40 ft) were generally reinforced concrete whereas the long spans were typically constructed of prestressed concrete or steel. To better understand the progress of the prestressed concrete industry and its future growth potential, let’s consider only steel and prestressed concrete bridges, which generally represent the longer spans. **Table 2** and **Figure 2** focus on these longer-span bridges by comparing the number of steel and prestressed (pretensioned or post-tensioned) concrete bridges built: 175,180 in the base period and 48,095 in the most recent decade. The table also presents the percentage of prestressed girder bridges based on the total number of these two bridge superstructure materials for each period. Between 2007 and 2016, 32 states built more than 50% of their longer-span bridges with prestressed concrete (those shown in dark gray or light gray) and 21 regions had an increase in use of prestressed concrete of over 5% in the last decade. This represents a 5.8% increase in prestressed concrete use in the last decade


compared to the previous three decades.

Looking Forward

The data reviewed in this article demonstrate the notable growth of the concrete bridge industry in recent years—and that’s good news. However, a few questions remain about the growth potential of prestressed concrete. For example, 13 of the 52 regions still select steel over prestressed concrete 65% of the time. Why do these jurisdictions prefer steel? Is there capacity to deliver concrete bridges in those areas? Understanding what is driving trends will help us expand the growth we have recently experienced.

We need to choose benchmarks that help us move forward and improve. How shall we put other future priorities and technological innovations into historical context so we can effectively identify progress? For example, we know that new shallow concrete beam shapes can be used where span-to-depth ratios were previously seen as a de facto steel solution. We also can anticipate that accelerated bridge construction deliveries will need solutions that are constructible from off-the-shelf components, and prestressed concrete answers this need. Perhaps there are lessons to be learned from the long gray line of our seven decades as an industry that can help us toward this goal.

Reference

1. Prestressed Concrete Institute (PCI). 1979. *Reflections on the Beginnings of Prestressed Concrete in America*. Chicago, IL: PCI. 

EDITOR'S NOTE

The data presented in this article were collected from the FHWA NBI portal in July 2018. The author thanks Hank Bonstedt for his diligence in the tedious task of analyzing the decades of data. Bonstedt presented a review of concrete bridges in the Spring 2017 issue of ASPIRE.

Table 1. Comparison of All Types of Bridges and Concrete Bridges, 1977–2016

	States	30-Year Base Period, 1977–2006			Recent 10-Year Period, 2007–2016			Concrete % Change	
		All Types	Concrete	Concrete %	All Types	Concrete	Concrete %		
1	South Carolina	3811	3181	83.47%	666	634	95.20%	11.73%	South Carolina
2	Arizona	4072	3641	89.42%	904	859	95.02%	5.61%	Arizona
3	Mississippi	8897	8042	90.39%	1835	1732	94.39%	4.00%	Mississippi
4	Minnesota	7028	5720	81.39%	1774	1662	93.69%	12.30%	Minnesota
5	California	8307	7429	89.43%	1880	1736	92.34%	2.91%	California
6	Tennessee	10128	9134	90.19%	1584	1414	89.27%	-0.92%	Tennessee
7	Georgia	7186	5492	76.43%	1126	984	87.39%	10.96%	Georgia
8	Texas	23708	19590	82.63%	7901	6859	86.81%	4.18%	Texas
9	Nevada	1065	911	85.54%	282	242	85.82%	0.28%	Nevada
10	Louisiana	5614	4490	79.98%	1377	1170	84.97%	4.99%	Louisiana
11	Puerto Rico	990	908	91.72%	204	173	84.80%	-6.91%	Puerto Rico
12	New Mexico	1639	1286	78.46%	359	304	84.68%	6.22%	New Mexico
13	Alabama	6865	5527	80.51%	962	813	84.51%	4.00%	Alabama
14	Wisconsin	7906	6269	79.29%	1814	1530	84.34%	5.05%	Wisconsin
15	South Dakota	2077	1684	81.08%	469	395	84.22%	3.14%	South Dakota
16	Florida	6114	5159	84.38%	1968	1647	83.69%	-0.69%	Florida
17	Oregon	3077	2565	83.36%	620	501	80.81%	-2.55%	Oregon
18	Washington	3128	2616	83.63%	825	651	78.91%	-4.72%	Washington
19	North Dakota	1929	1498	77.66%	438	341	77.85%	0.20%	North Dakota
20	Colorado	4837	2999	62.00%	746	570	76.41%	14.41%	Colorado
21	North Carolina	8064	4187	51.92%	2543	1854	72.91%	20.98%	North Carolina
22	Hawaii	258	212	82.17%	32	23	71.88%	-10.30%	Hawaii
23	Illinois	15010	11709	78.01%	3210	2279	71.00%	-7.01%	Illinois
24	Kentucky	5715	4676	81.82%	1347	953	70.75%	-11.07%	Kentucky
25	Utah	1483	967	65.21%	540	382	70.74%	5.54%	Utah
26	Iowa	10798	7306	67.66%	2445	1712	70.02%	2.36%	Iowa
27	Pennsylvania	8560	5519	64.47%	4417	3074	69.59%	5.12%	Pennsylvania
28	Indiana	11446	7299	63.77%	2847	1949	68.46%	4.69%	Indiana
29	Kansas	9758	6168	63.21%	1983	1322	66.67%	3.46%	Kansas
30	Montana	2002	1235	61.69%	677	450	66.47%	4.78%	Montana
31	Ohio	14700	8578	58.35%	3918	2569	65.57%	7.22%	Ohio
32	Idaho	1782	1234	69.25%	508	325	63.98%	-5.27%	Idaho
33	Delaware	450	198	44.00%	112	70	62.50%	18.50%	Delaware
34	Nebraska	8050	4561	56.66%	1552	966	62.24%	5.58%	Nebraska
35	Michigan	5198	3262	62.75%	1500	933	62.20%	-0.55%	Michigan
36	Missouri	12464	6095	48.90%	3824	2269	59.34%	10.43%	Missouri
37	Oklahoma	9190	5866	63.83%	3040	1681	55.30%	-8.53%	Oklahoma
38	Virginia	5589	2763	49.44%	1418	775	54.65%	5.22%	Virginia
39	West Virginia	3887	2076	53.41%	793	395	49.81%	-3.60%	West Virginia
40	Arkansas	6075	3275	53.91%	1268	631	49.76%	-4.15%	Arkansas
41	Connecticut	2076	959	46.19%	339	165	48.67%	2.48%	Connecticut
42	Rhode Island	323	141	43.65%	104	49	47.12%	3.46%	Rhode Island
43	New York	8416	3038	36.10%	2197	1008	45.88%	9.78%	New York
44	Maryland	2698	663	24.57%	491	213	43.38%	18.81%	Maryland
45	Vermont	987	389	39.41%	389	166	42.67%	3.26%	Vermont
46	New Hampshire	1225	348	28.41%	396	161	40.66%	12.25%	New Hampshire
47	Massachusetts	1945	817	42.01%	506	198	39.13%	-2.87%	Massachusetts
48	New Jersey	2702	1292	47.82%	824	309	37.50%	-10.32%	New Jersey
49	Wyoming	1190	397	33.36%	223	78	34.98%	1.62%	Wyoming
50	Maine	924	274	29.65%	309	105	33.98%	4.33%	Maine
51	Alaska	948	309	32.59%	253	81	32.02%	-0.58%	Alaska
52	District of Columbia	132	40	30.30%	49	8	16.33%	-13.98%	District of Columbia
	Overall	282,423	193,994	68.69%	71,788	51,370	71.56%	2.87%	

≥5% improvement in concrete consumption in the last decade.

2016 National Bridge Inventory data downloaded in July 2018.

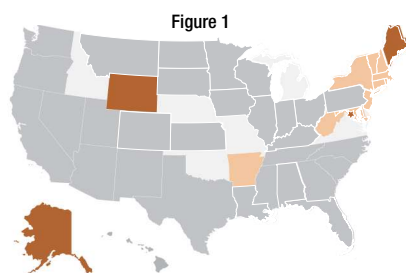


Table 2. Comparison of Steel and Prestressed Concrete Bridges, 1977-2016

	States	30-Year Base Period, 1977-2006			Recent 10-Year Period, 2007-2016			Prestressed Concrete % Change	
		Steel	Prestressed Concrete (PS)	Prestressed Concrete % of Steel & PS	Steel	Prestressed Concrete	Prestressed Concrete % of Steel & PS		
1	South Carolina	581	1460	71.53%	28	512	94.81%	23.28%	South Carolina*
2	Arizona	404	1327	76.66%	44	358	89.05%	12.39%	Arizona*
3	Minnesota	833	1720	67.37%	85	643	88.32%	20.95%	Minnesota*
4	Mississippi	515	2999	85.34%	85	602	87.63%	2.28%	Mississippi
5	California	714	3187	81.70%	137	859	86.24%	4.55%	California
6	Georgia	1572	1849	54.05%	128	627	83.05%	29.00%	Georgia*
7	Texas	3668	9004	71.05%	990	4539	82.09%	11.04%	Texas
8	Tennessee	938	3511	78.92%	158	718	81.96%	3.05%	Tennessee
9	Puerto Rico	82	600	87.98%	30	126	80.77%	-7.21%	Puerto Rico
10	Oregon	316	2237	87.62%	107	434	80.22%	-7.40%	Oregon
11	Florida	661	3302	83.32%	273	1081	79.84%	-3.48%	Florida
12	Nevada	142	284	66.67%	40	134	77.01%	10.34%	Nevada
13	New Mexico	320	613	65.70%	52	165	76.04%	10.33%	New Mexico*
14	Wisconsin	1320	2574	66.10%	250	734	74.59%	8.49%	Wisconsin*
15	Washington	404	1949	82.83%	160	467	74.48%	-8.35%	Washington
16	North Carolina	3688	2998	44.84%	588	1643	73.64%	28.80%	North Carolina*
17	Colorado	1703	1785	51.18%	156	383	71.06%	19.88%	Colorado*
18	South Dakota	326	776	70.42%	68	156	69.64%	-0.77%	South Dakota
19	Alabama	926	1419	60.51%	127	273	68.25%	7.74%	Alabama
20	Louisiana	768	811	51.36%	124	266	68.21%	16.84%	Louisiana
21	Montana	532	1049	66.35%	170	361	67.98%	1.63%	Montana
22	Kentucky	923	3990	81.21%	365	710	66.05%	-15.17%	Kentucky
23	Hawaii	34	137	80.12%	7	13	65.00%	-15.12%	Hawaii
24	Pennsylvania	2844	4102	59.06%	1262	2316	64.73%	5.67%	Pennsylvania*
25	Illinois	3239	7996	71.17%	910	1542	62.89%	-8.28%	Illinois
26	Utah	462	594	56.25%	152	231	60.31%	4.06%	Utah
27	Indiana	3250	4519	58.17%	822	1222	59.78%	1.62%	Indiana
28	Michigan	1544	2663	63.30%	478	704	59.56%	-3.74%	Michigan
29	Idaho	363	781	68.27%	152	216	58.70%	-9.57%	Idaho
30	North Dakota	343	898	72.36%	87	100	53.48%	-18.89%	North Dakota
31	Ohio	5952	5704	48.94%	1307	1412	51.93%	2.99%	Ohio
32	Missouri	6286	3135	33.28%	1498	1516	50.30%	17.02%	Missouri*
33	Iowa	2604	2934	52.98%	603	548	47.61%	-5.37%	Iowa
34	Delaware	223	122	35.36%	27	23	46.00%	10.64%	Delaware*
35	West Virginia	1712	1869	52.19%	391	322	45.16%	-7.03%	West Virginia
36	Oklahoma	3249	3211	49.71%	1347	1017	43.02%	-6.69%	Oklahoma
37	Rhode Island	170	83	32.81%	53	34	39.08%	6.27%	Rhode Island
38	Alaska	411	295	41.78%	125	80	39.02%	-2.76%	Alaska
39	Maryland	1857	236	11.28%	252	151	37.47%	26.19%	Maryland*
40	New York	4892	2017	29.19%	1116	590	34.58%	5.39%	New York*
41	Virginia	2773	786	22.08%	616	292	32.16%	10.07%	Virginia*
42	Massachusetts	1066	654	38.02%	282	133	32.05%	-5.98%	Massachusetts
43	Connecticut	1066	561	34.48%	163	76	31.80%	-2.68%	Connecticut
44	New Jersey	1186	882	42.65%	494	203	29.12%	-13.53%	New Jersey
45	Vermont	546	84	13.33%	202	77	27.60%	14.27%	Vermont
46	Nebraska	3292	1101	25.06%	558	210	27.34%	2.28%	Nebraska
47	Kansas	3463	824	19.22%	643	204	24.09%	4.86%	Kansas
48	Maine	577	123	17.57%	183	58	24.07%	6.49%	Maine
49	New Hampshire	784	119	13.18%	213	44	17.12%	3.94%	New Hampshire
50	District of Columbia	91	13	12.50%	41	5	10.87%	-1.63%	District of Columbia
51	Wyoming	743	135	15.38%	137	16	10.46%	-4.92%	Wyoming
52	Arkansas	2689	111	3.96%	621	42	6.33%	2.37%	Arkansas
	Overall	79,047	96,133	54.88%	18,907	29,188	60.69%	5.81%	

≥5% improvement in concrete consumption in the last decade.

Figure 2

2016 National Bridge Inventory data downloaded in July 2018.

*Indicates ≥5% improvement in concrete consumption in the last decade as indicated in Table 1.

