The Truth About Uni-Bell’s Technical Brief on Cement-Mortar Lined Pipe

The combined effectiveness of the cement-mortar lining and the larger inside diameter of Ductile iron pipe results in less energy being required to pump through Ductile than it does through PVC pipe\textsuperscript{1,2,3}. This savings in energy occurs over the most important part of a pipeline’s service life – the operations phase. This phase overwhelms the manufacturing and installation phases, combined, because we expect our pipelines to serve for generations. This explains the Uni-Bell PVC Pipe Association’s (Uni-Bell) compulsion to disparage cement-mortar linings (CML), but not the carelessness of their attempts to do so. In their recent technical brief on the Hazen Williams C factor for CML, they mischaracterize references and cherry pick data – even citing data that isn’t related to CML performance.

Below is a table that provides facts related to the many false claims found in the Uni-Bell document.

### FALSE CLAIM

“DIPRA’s Testing Conflicts with its Own Recommendation”

- “A 12-inch cement-mortar lined iron pipe in Baltimore, MD had a degradation rate of 0.22 per year.”
- “A 12 inch cement-mortar lined iron pipe (sic) Greenville, TN had a degradation rate of 0.46 per year.”
- “Pipes from six other cities...showed declines between 0.22 and 0.46 per year.”

### FACT

DIPRA reported the results of 43 \textit{in situ} measurements of \textit{C} values for \textit{in-service pipelines} from 20 cities with pipes ranging in age from 5- to 77- years in service\textsuperscript{4}. In these tests, the head loss was measured for discrete lengths of pipeline, taking care to minimize the effects of minor losses from fittings, to determine the C factor for those pipelines. The resulting C values range from a low of 130 to a high of 148, with the average result being $C = 140$, which is the basis for DIPRA’s recommended C factor.

Uni-Bell’s calculation for the degradation of the C value is absurdly premised. Uni-Bell takes the measured results for 8 of the 42 C factors, subtracts each value from the average result of 140 and divides by the age of the pipe. So, based on only one reading in Baltimore, MD, Uni-Bell divines a degradation rate. The calculation is: $(140 - 136)/18 = 0.22$

Similarly, for Greenville, TN: $(140 - 134)/13 = 0.46$

However, in Greenville, TN, DIPRA has conducted three such flow tests, with the following results:

- At age 13, $C = 136$
- At age 29, $C = 137$
- At age 36, $C = 146$

Unsurprisingly, Uni-Bell purposely reported the C-value from Greenville, TN that would give the worst result. However, using the flawed Uni-Bell method, the results for Greenville, TN indicate the C value is improving over time and, at age 36, the C value in Greenville, TN resulted in a CML that is improving at a rate of 0.17 per year!
DIPRA’s tests provide definitive indications of the long-term effectiveness of the cement-mortar lining. The problems associated with unlined metal pipe were solved with the addition of the cement-mortar lining. Moreover, the value of cement-mortar linings has been documented time after time, including in several references cited by Uni-Bell in this technical briefing.5,6,7,8,9,10,11,12,13

Hudson14 references tests that measure C values, but he does so without explicit regard to the lining, and makes statements in support of the longevity of CML:

- “If individual C values (in Denver) for...cement lining were shown, it would be apparent that after 40 years of service, such mains retained their high carrying capacity, the average values being 130-135.”
- “The trend line of the C values for Atlanta...substantiates, along with those for the other sites, the theory that, in ferrous pipes without permanent lining, tuberculation takes place...(emphasis added)”
- “The trend curve of C values (in New Orleans)...shows that...the mains without permanent lining lost approximately 25% of their carrying capacity (emphasis added).”

Uni-Bell references an article by Sharp and Walski15 where we find, in the introductory paragraphs,

- “The equations presented provide a quick method for predicting C-factors (internal roughness) in unlined metal pipes (emphasis added)”
- “In modern cement-mortar lined and plastic pipes, internal roughness changes very slowly over the life of a pipe...”

This references an article by Peter A. Lamont16 who recognized modern theory of flow in pipes by noting that some pipes are “hydraulically smooth” where the values of C are essentially the same for all “smooth” pipes and are not affected by age. In Table 2 of his article, he listed a C factor for “hydraulically smooth” “spun cement-lined” pipe to vary between 147 and 153 depending on the size of the pipe – not the age. All of the deteriorating C values presented (which were the only ones Uni-Bell used) were for “uncoated cast iron.”

Uni-Bell cites the Pump Handbook by Karassik, et al.17. In the 2008 Edition we find Table 2 on page 11.36, “Values of Friction Factor C to be Used with the Hazen Williams formula” and the following:

- “Concrete or concrete lined, centrifugally spun” (emphasis added) pipe is assigned a C value of 135 and this value is the same regardless of the age of the pipe.

The quote is from a master’s thesis written by Mayank Khurana at Virginia Tech in 201718, but the thesis does not attribute a declining C factor for cement-mortar linings. The quote, itself, does not address cement-mortar lined pipe and the thesis presents no data or analysis that leads to such a conclusion.
Comparative Flow Tests – Cement-Mortar Lined Ductile Iron Pipe and PVC Pipe

DIPRA understands the significance of the results of the many field tests that have been performed on cement-mortar lined iron pipe. They demonstrate the general reliability of the cement-mortar lining over time and the “tightness” of the data is impressive.

Ductile Iron versus PVC Comparative Flow Tests

DIPRA has conducted side-by-side testing of in situ PVC and CML Ductile. Tests were performed in Blackwood, NJ\(^9\), Dothan, AL\(^{10}\) and Wister, OK\(^{21}\). The results demonstrated the energy advantages to pumping through CML Ductile Iron pipe, as shown below:

<table>
<thead>
<tr>
<th>Location</th>
<th>Year Installed</th>
<th>Year Tested</th>
<th>Pipe Size (in)</th>
<th>Flow Rate (gpm)</th>
<th>Pipe Material</th>
<th>Measured Inside Diameter (in)</th>
<th>C Factor</th>
<th>Velocity (f/s)</th>
<th>Headloss (f/1000f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackwood, NJ</td>
<td>1976</td>
<td>1986</td>
<td>12</td>
<td>750</td>
<td>CML DI</td>
<td>12.20</td>
<td>131</td>
<td>2.1</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PVC</td>
<td></td>
<td></td>
<td>11.53</td>
<td>138</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Dothan, AL</td>
<td>1981</td>
<td>1986</td>
<td>12</td>
<td>750</td>
<td>CML DI</td>
<td>12.28</td>
<td>137</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PVC</td>
<td></td>
<td></td>
<td>11.65</td>
<td>140</td>
<td>2.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Wister, OK</td>
<td>1969</td>
<td>1999</td>
<td>18</td>
<td>1000</td>
<td>CML DI</td>
<td>18.53</td>
<td>139</td>
<td>1.2</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>1998</td>
<td>1999</td>
<td>PVC</td>
<td></td>
<td></td>
<td>17.08</td>
<td>141</td>
<td>1.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Note the measured C values for each pipe material, above, as well as the actual measured inside diameters of the pipes. When normalized for flow, it is clear that there is a distinct advantage in energy savings when pumping water through cement-mortar lined Ductile Iron pipe compared to PVC pipe.

References

4. Ibid.