SUPPLEMENTARY MATERIAL FOR:


**Summary**

This appendix contains information that supplements the description of dynamic modeling of in-use cements stocks in the U.S. It includes a diagram of a generic life cycle for cement, figures showing the age distribution of bridges and housing in use in the U.S., a table showing nonfuel raw material consumption for the manufacture of cement and clinker in U.S, and it describes the probability density functions of lifetime distributions used in the study.

![Figure S1. Generic cement life cycle.](image-url)
Figure S2. Age distribution of in-use bridges in the United States (ca. 2004). (Data source: FHWA 2004).
Figure S3. Age distribution of in-use housing units in the United States (ca. 2003). (Data source: USDHS 2004).
Table S1. Contemporary nonfuel raw material consumption for the manufacture of cement and clinker in United States, 1995-2000.

<table>
<thead>
<tr>
<th>Material</th>
<th>Consumption * (Mt/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone, cement rock, coral, marble, other</td>
<td>111.0</td>
</tr>
<tr>
<td>Clay, shale, other</td>
<td>9.1</td>
</tr>
<tr>
<td>Sand and sandstone</td>
<td>3.4</td>
</tr>
<tr>
<td>Iron ore, millscale</td>
<td>1.4</td>
</tr>
<tr>
<td>Gypsum and anhydrite</td>
<td>4.4</td>
</tr>
<tr>
<td>Slags, fly ash, other ash</td>
<td>2.6</td>
</tr>
<tr>
<td>Other</td>
<td>0.1</td>
</tr>
<tr>
<td>Raw material equivalent of imported clinker</td>
<td>6.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>138.1</strong></td>
</tr>
</tbody>
</table>

* averaged over 1995-2000

Source: Van Oss and Padovani  (2002)

**Probability Density Function of Lifetime Distributions**

*Weibull distribution*

The probability density function, \( f(x; \alpha, \beta) = \left( \frac{\alpha}{\beta} \right) x^{\alpha - 1} \frac{e^{-\left( \frac{x}{\beta} \right)^\alpha}}{\beta^{\alpha}} \)

The cumulative distribution function, \( F(x; \alpha, \beta) = 1 - e^{-\left( \frac{x}{\beta} \right)^\alpha} \)

Where \( x \geq 0 \) and \( \alpha > 0 \) is the shape parameter and \( \beta > 0 \) is the scale parameter of the distribution.

*Gamma distribution*

The probability density function, \( f(x; \alpha, \beta) = \left( x^{\alpha - 1} \right) \frac{e^{-\frac{x}{\beta}}}{\Gamma(\alpha)\beta^\alpha} \)

The cumulative distribution function, \( F(x; \alpha, \beta) = \frac{\gamma(\alpha, \frac{x}{\beta})}{\Gamma(\alpha)} \)

Where \( x \geq 0 \) and \( \alpha > 0 \) is the shape parameter and \( \beta > 0 \) is the scale parameter of the distribution.

*Lognormal distribution*
The probability density function, $f(x; \mu, \sigma) = \frac{e^{-\frac{1}{2} \left( \frac{\ln(x) - \mu}{\sigma} \right)^2}}{x\sigma\sqrt{2\pi}}$

The cumulative distribution function, $F(x; \mu, \sigma) = \frac{1}{2} + \frac{1}{2} \text{Erf} \left( \frac{\ln(x) - \mu}{\sigma\sqrt{2}} \right)$

Where $x > 0$ and $\mu$ and $\sigma$ are the mean and standard deviation of the variable’s logarithm.

References

