SUPPLEMENTARY MATERIAL FOR:

Kapur, A., G. Keoleian, A. Kendall, and S. Kesler. 2008. Dynamic modeling of in-use cement stocks in the United States. *Journal of Industrial Ecology*, volume 12, issue 4.

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.

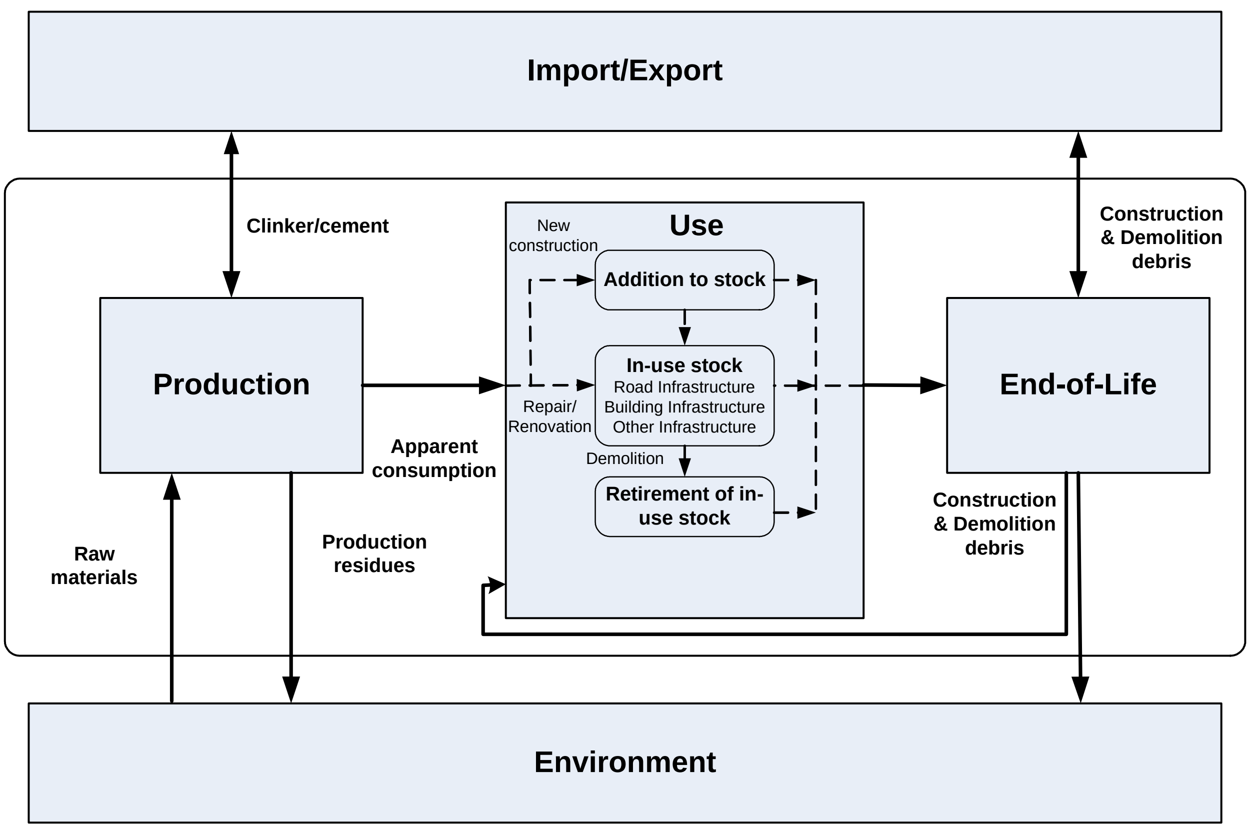

Figure S1. Generic cement life cycle.

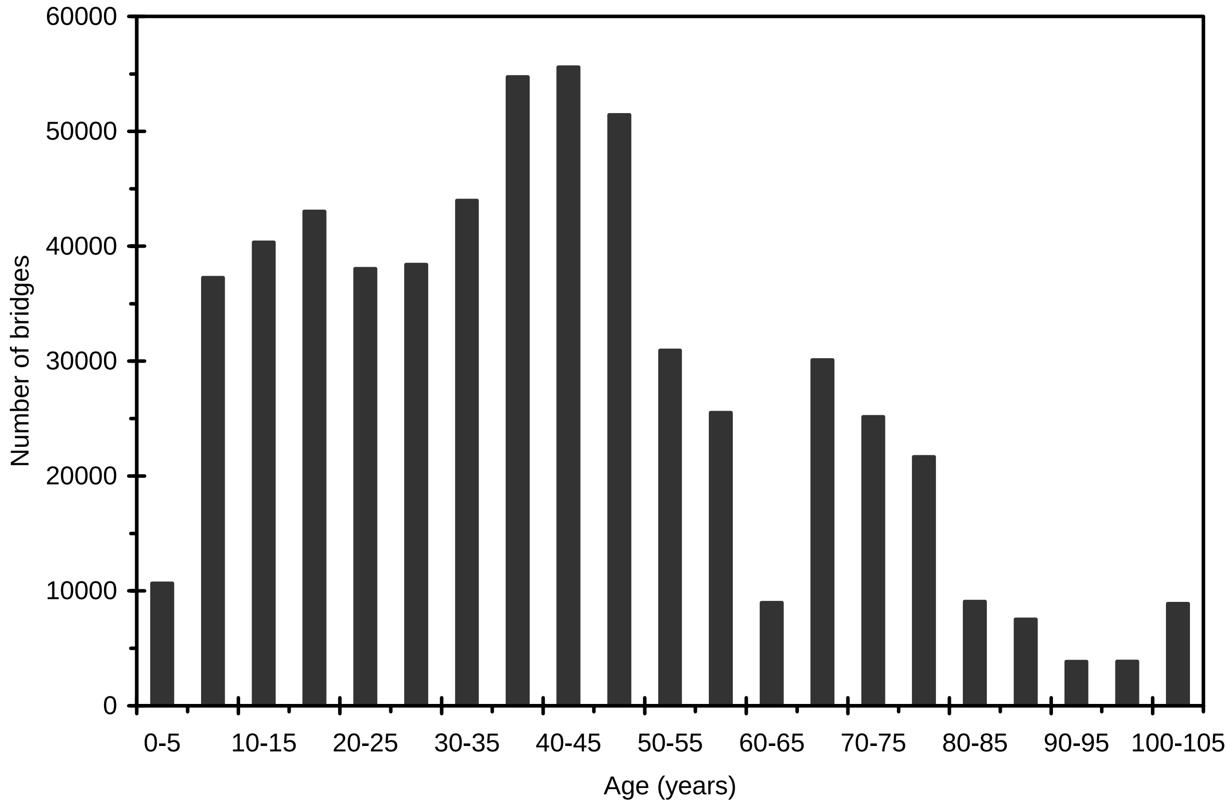

Figure S2. Age distribution of in-use bridges in the United States (ca. 2004) . (Data source: FHWA 2004).

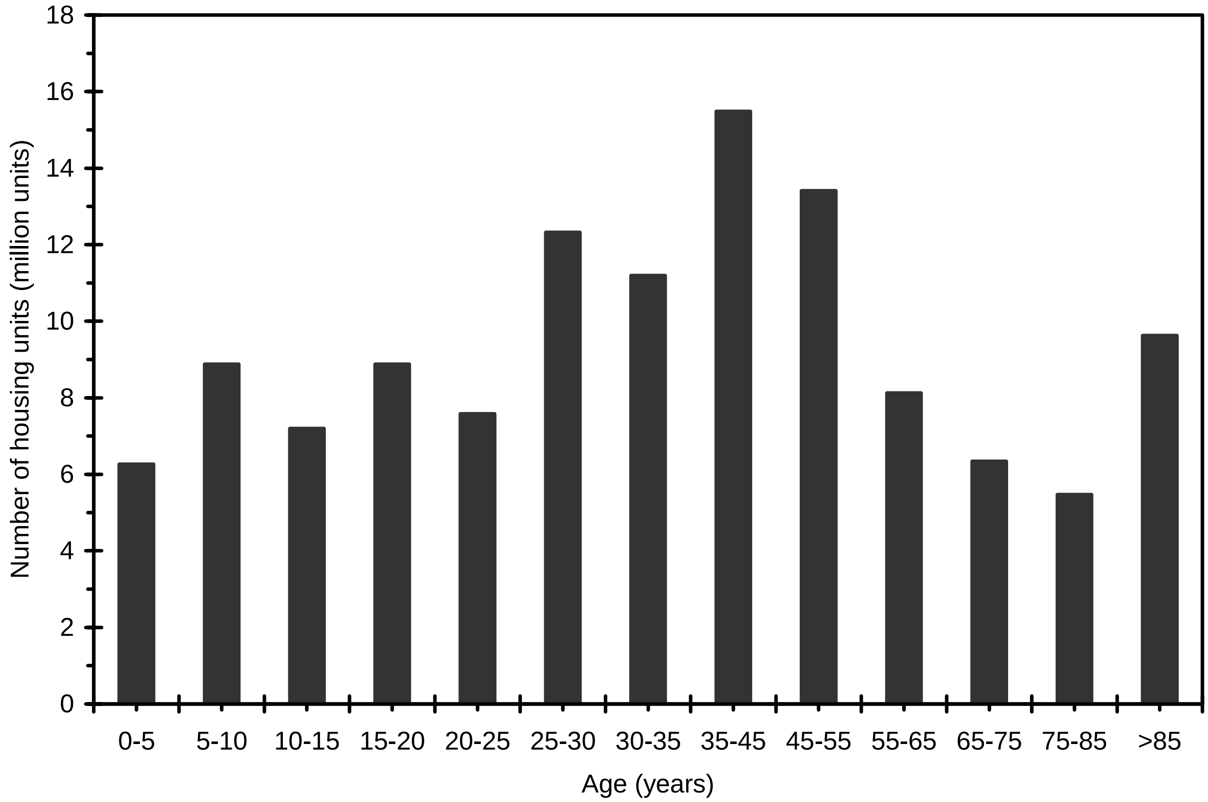

Figure S3. Age distribution of in-use housing units in the United States (ca. 2003) . (Data source: USDHS 2004).

Table S1. Contemporary nonfuel raw material consumption for the manufacture of cement and clinker in United States, 1995-2000.

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

* averaged over 1995-2000

Source: Van Oss and Padovani (2002)

Probability Density Function of Lifetime Distributions

Weibull distribution

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

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, $f(x;\alpha,\beta) = \left(x^{\alpha-1}\right)\left(\frac{\exp(-\frac{x}{\beta})}{\Gamma(\alpha)\beta^{\alpha}}\right)$

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

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, $f(x; \mu,\sigma) = \dfrac{e^{-\left(\frac{1}{2}\right)\left(\frac{\ln(x)-\mu}{\sigma}\right)^2}}{x\sigma\sqrt{2\pi}}$

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

Where $x > 0$ and μ and σ are the mean and standard deviation of the variable's logarithm.

References

FHWA (Federal Highway Administration). 2004. National Bridge Inventory—December 2004. http://www.fhwa.dot.gov/bridge/nbi.htm. Accessed March 2005.

USDHS (U.S. Department of Housing and Urban Development). 2004. *U.S. housing market conditions, 2nd quarter 2004*. Washington, DC: USDHS.

Van Oss, H. G. and A. C. Padovani. 2002. Cement manufacture and the environment, Part I: Chemistry and technology. *Journal of Industrial Ecology* 6(1): 89–105.