

Smil Discussion – pp, 88-102

Plastics (p. 85-87)

1870-1900: Celluloid – cellulose nitrate and camphor

1907: thermoset molded at 150-160 deg C

1908: Cellophane

1910: General Bakelite, industrial molded plastic

Interwar period: PVC, cellulose acetate, neoprene, polyester, plexiglass

1938: nylon

1930s: polystyrene

1937: polyurethane

1933: polyethylene (packing), methyl methacrylate (paint, adhesive)

1941: polyethelene terephthalate (PET), PET bottle 1973

Postwar: polymers, Tyvek, Lycra, Kevlar

Plastics (p. 88- 89)

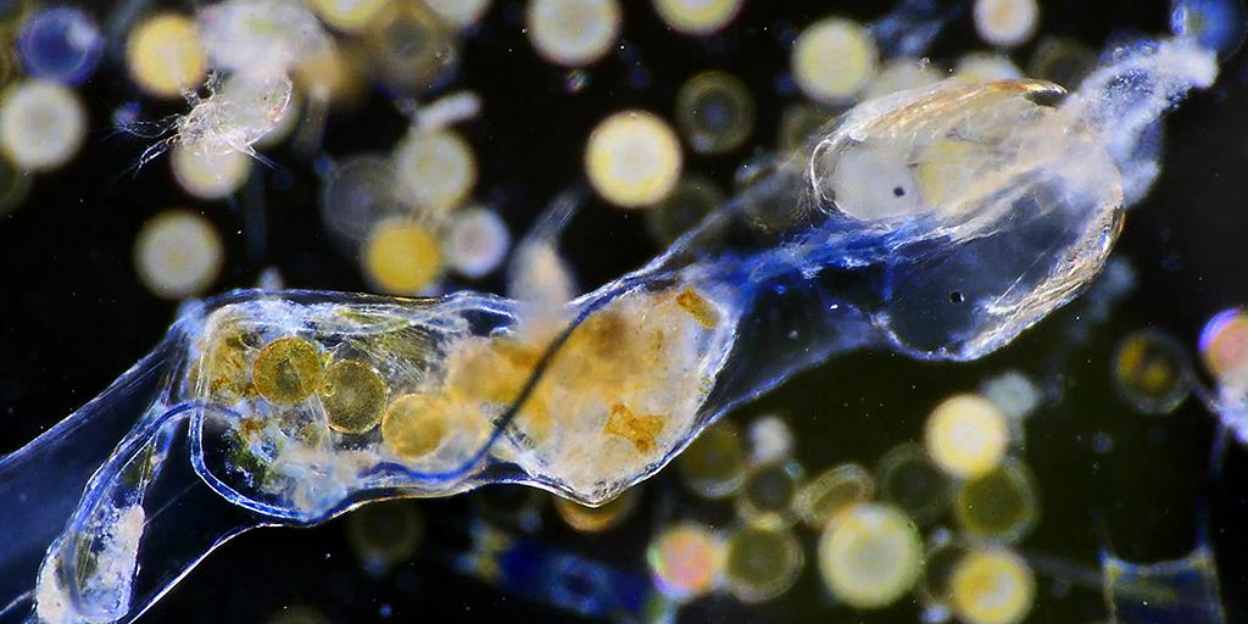
2000: 50 plastics on market

Global production: 20,000 T (1925) – 2 MT (1950) – 150 MT (2000) – 370 MT (2019)

Health care: PPE, PVC (25% health care products)

Pollution: ocean microfiber (<5mm diam) (90% “natural origin”)

- 50% cotton, 12% wool, 8% plastic (<https://www.science.org/doi/10.1126/sciadv.aay8493>)
- Natural microfibers can be toxic (textile chemicals)
- Microplastics – commonly found in food chain (plankton, fish, birds, mammals) – fish actively seek out b/c “attracted to odor”



- <https://twitter.com/PlanktonPundit/status/1483500693793259524>



- <https://www.theguardian.com/environment/2017/aug/16/fish-confusing-plastic-debris-in-ocean-for-food-study-finds>



- <https://www.theguardian.com/us-news/2023/feb/02/whale-hawaii-swallowed-fishing-gear-plastic>
- one sperm whale

Steel (p. 89-)

Iron: Earth's dominant element by mass (8x density of water), planetary core, 4th most common in crust (O, Si, Al, Fe = 6%)

Production: 2.5 BT (1.3 BT primary, 1.2 BT recycled)

3500 varieties, compressive strength ~ granite, tensile strength 15-30x granite

Carbon steel (90% market), alloy steel, stainless (10-20% chromium)

Construction: steel pile-drivers ram steel or steel-reinforced concrete, cantilevered & suspension bridges

Transportation: largest component (except jets), cars (90 M T/y), trains (15%) and tracks, ships, cargo containers

Manufacture: using steel machines

Oil exploration, production: pipelines, drills, storage

Environmental impact:

Reserve/Production Ratio (called Resource/Production Ratio by Smil) = (total reserves)/(amt used per year) = 300 y >> coal (114) > nat gas (53) > oil (51).

Recyclable: steel-arc smelters use as much electricity as a city of 150,000

- 30% annual output (70% US, 40% EU, 12% China, 100% “small steel producers”)
- Production ~ 2x recycled/y

Energy cost: 25 GJ/t (primary) > 5 GJ/t (recycled), total (2019) 34 exajoules (1 EJ = 10^{18} J, 6% world energy)

Emissions: 500 kg C/t -> 900 MT C/y (7-9% direct emissions) \approx concrete (3x prod but 1/3 C/t)

Concrete:

Large buildings, city infrastructure, roads

Compression strength: 100 M Pa (“African bull elephant balanced on a coin”).

Tensile strength: 2-5 M Pa, spans require steel-reinforced

1901: reinforced bridges

1903: first reinforced steel skyscraper

1930: pre-stressed (tensioned steel-reinforced)

2010: 164 km Danyang-Kunshan Grand Bridge

Interstate Highways: 50 MT cement, 1.5 BT aggregate, 6 MT steel

Airport runways: 1.5 m deep (e.g., Calgary – 4.27 km; 85 K m³ concrete; 16 Kt steel)

Hoover Dam: 3.4 M m³ concrete, 68 Kt steel

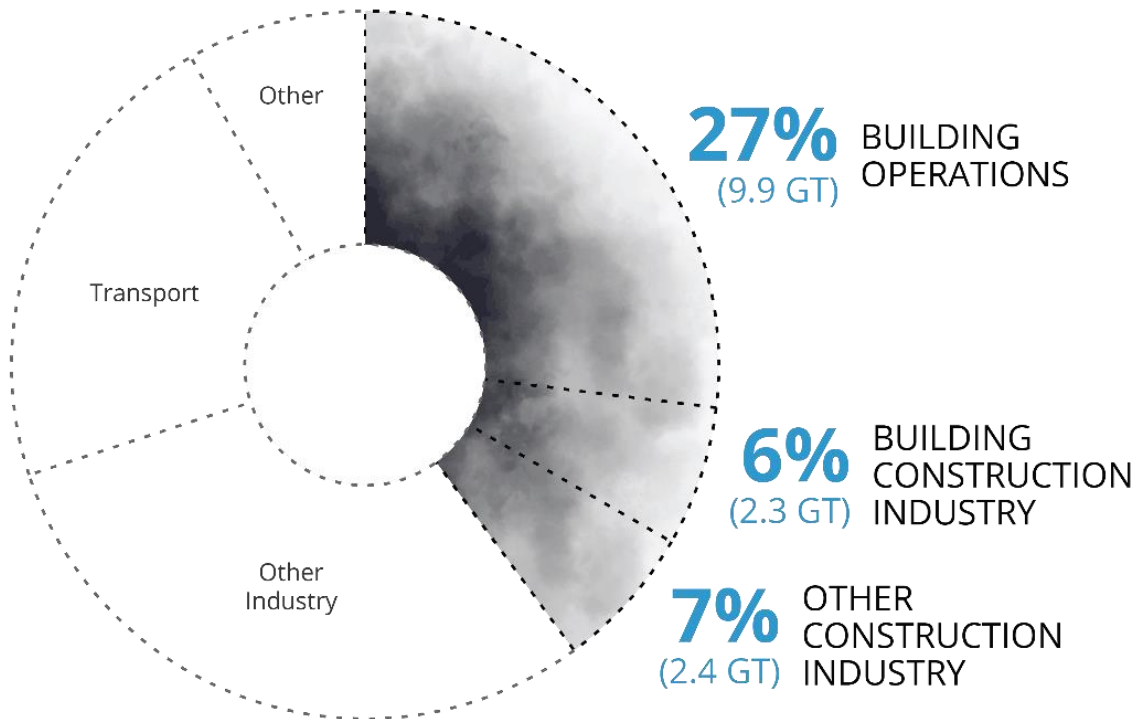
Three Gorges: 29 M m³ concrete, 256 Kt steel

US prod: peak 128 Mt (2005), now 100 Mt/y

China: 1980 (<80 Mt) \rightarrow 2019 (2.2 Bt/y > 50% global total), 2 y prod (2018-2019, 4.4 Bt) \sim 100 y US (4.6 Bt)

Global: annual prod \sim 50 y total (1900-1950)

Annual Global CO₂ Emissions



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Building Construction Industry and Other Construction Industry represent emissions from concrete, steel, and aluminum for buildings and infrastructure respectively.

Construction = 40% global emissions

Why World Bank head's resignation is good news for climate crisis fight

Fiona Harvey

Environment editor

David Malpass's decision to quit has delighted frustrated developing nations, donors, experts and campaigners



<https://www.theguardian.com/environment/2023/feb/16/world-bank-chief-david-malpass-resignation-climate-crisis>