No Sustainability or Durability Without Resilience

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PORTICUS CSP – Engineers
National Construction Safety Team Advisory Committee (NIST), Chair
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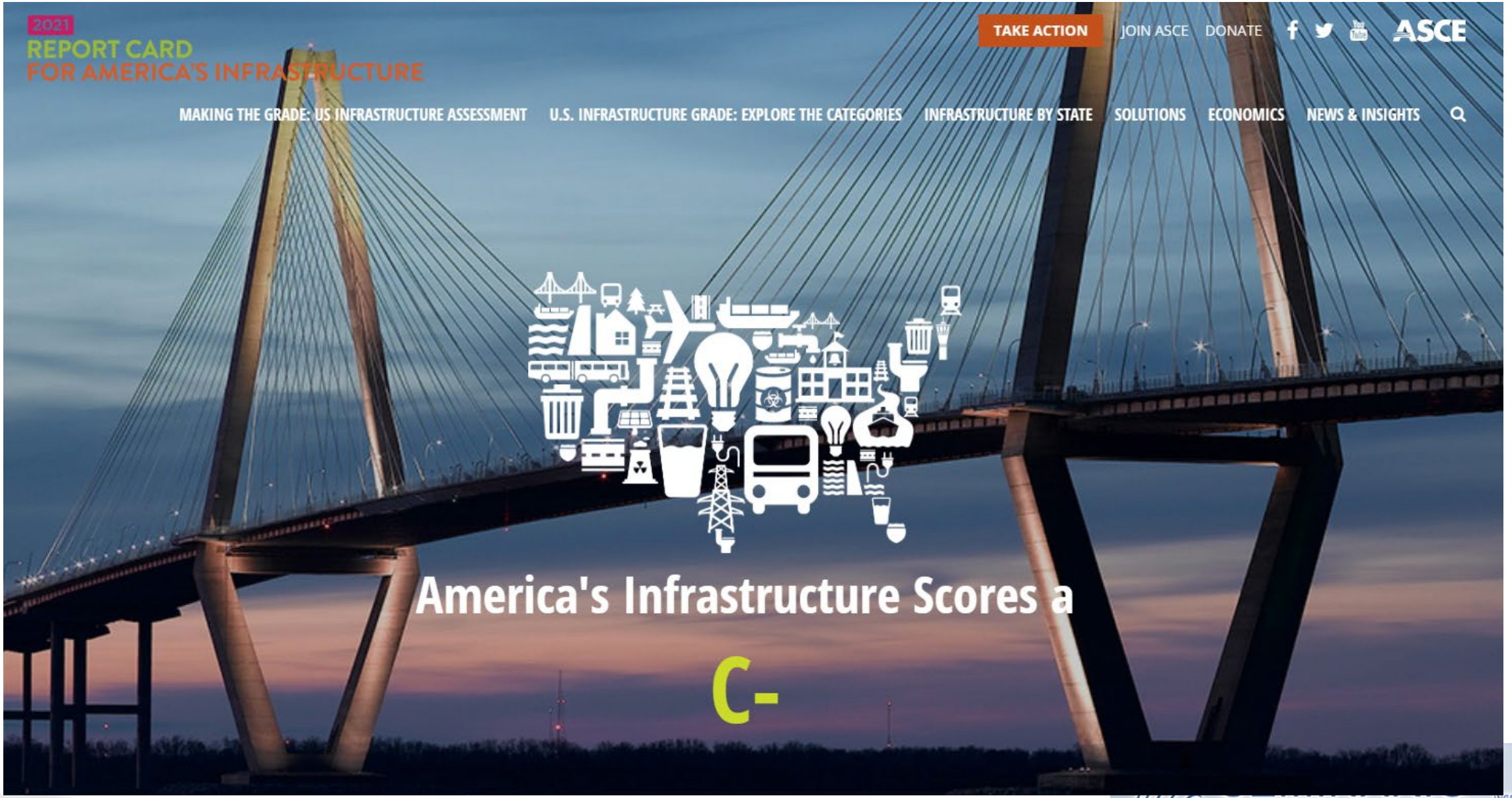
American Concrete Institute, President 2003-2004
Institute of Professional Engineers and Land Surveyors of PR, President 1994-1996
Chamber of Commerce of PR, President 2015-2016

American Society of Civil Engineers
REPORT CARD

2021


2021
REPORT CARD
FOR AMERICA'S INFRASTRUCTURE
TAKE ACTION
JOIN ASCE
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MAKING THE GRADE: US INFRASTRUCTURE ASSESSMENT
U.S. INFRASTRUCTURE GRADE: EXPLORE THE CATEGORIES
INFRASTRUCTURE BY STATE
SOLUTIONS
ECONOMICS
NEWS & INSIGHTS
America's Infrastructure Scores a
C-

There are 30,000 miles of inventoried levees across the U.S.,

and an additional 10,000 miles of levees whose location and condition are unknown.

There is a water main break every two minutes

and an estimated 6 billion gallons of treated water lost each day in the U.S., enough to fill over 9,000 swimming pools.

Growing wear and tear on our nation's roads

have left 43% of our public roadways in poor or mediocre condition, a number that has remained stagnant over the past several years.

The average age of our nation's dams

is 57 years.

Nearly 231,000 bridges,

in all 50 states,

still need repair and preservation work.


2021 REPORT CARD FOR
AMERICA'S INFRASTRUCTURE
G.P.A.
C-
AVIATION D+
PUBLIC PARKS D+
BRIDGES C
RAIL B
DAMS D
ROADS D
DRINKING WATER C-
SCHOOLS D+
ENERGY C-
SOLID WASTE C+
HAZARDOUS WASTE D+
STORMWATER D
INLAND WATERWAYS D+
TRANSIT D-
LEVEES D
WASTEWATER D+
PORTS B-

SUSTEINABILITY

SUSTEINABILITY

- Development that meets the needs of our generation without compromising the ability to meet the needs of future generations:
  - Dwelling
  - Foods
  - Social welfare
  - Health
  - Envorinment
  - Quality of Life

Live on the interests without touching the capital!

DR. RAMÓN CARRASQUILLO

Global Footprint

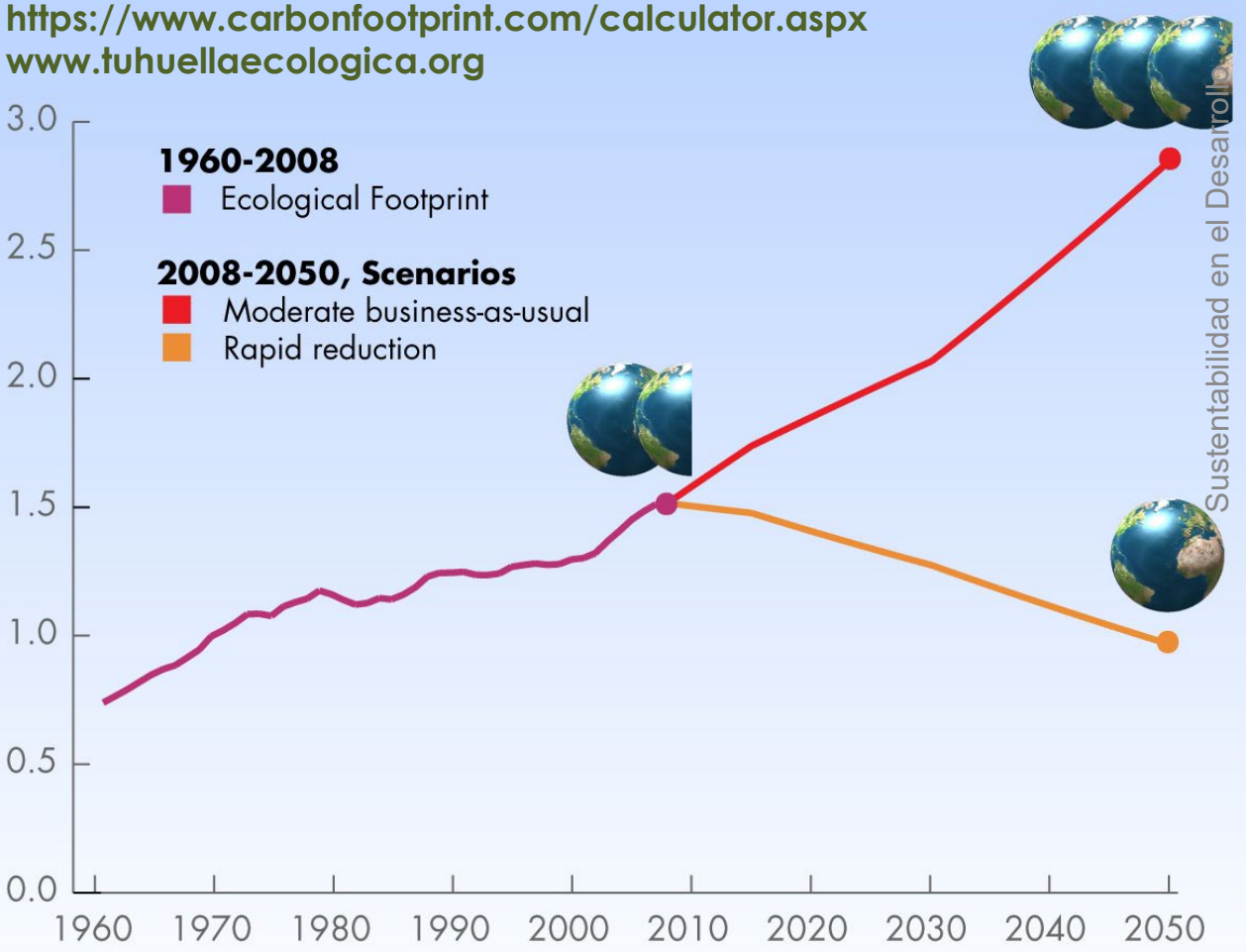
Today humanity needs the equivalent of 1.5 planets to provide the resources we use and absorb waste. This means that it takes the Earth one year and six months to regenerate what is used in a year.

Possible scenarios modeled by the United Nations suggest that if current population and consumption continue along the same lines, by the 2050s the equivalent of two planet Earths will be needed to sustain us.

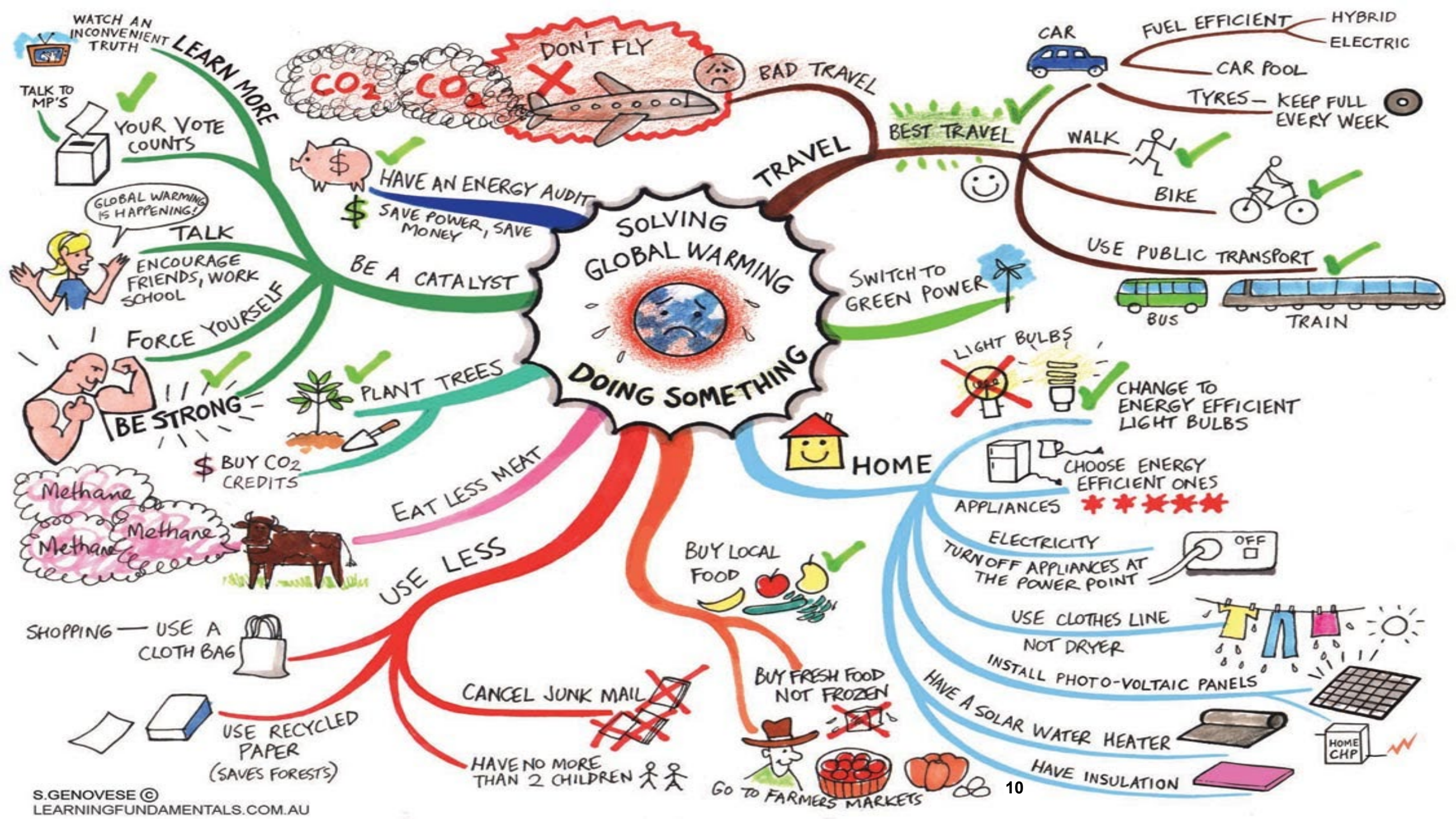
What's your footprint?

How does your life style impacts climate change?

https://www.carbonfootprint.com/calculator.aspx
www.tuhuellaecologica.org

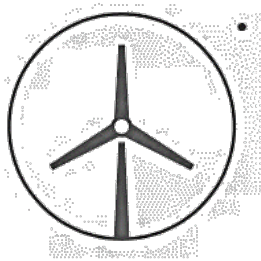


y-axis: number of planet earths, x-axis: years



GLOBAL CEMENT AND CONCRETE ASSOCIATION

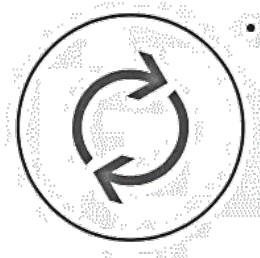
- Eliminating our direct energy-related emissions and maximising the co-processing of waste from other industries, which substitutes the use of fossil fuels involved in cement manufacture



- Reducing and eliminating indirect energy emissions through renewable electricity sources where available

- Reducing process emissions through new technologies and deployment of carbon capture at scale

- Reducing the content of both clinker in cement and cement in concrete, as well as more efficient use of concrete in buildings and infrastructure



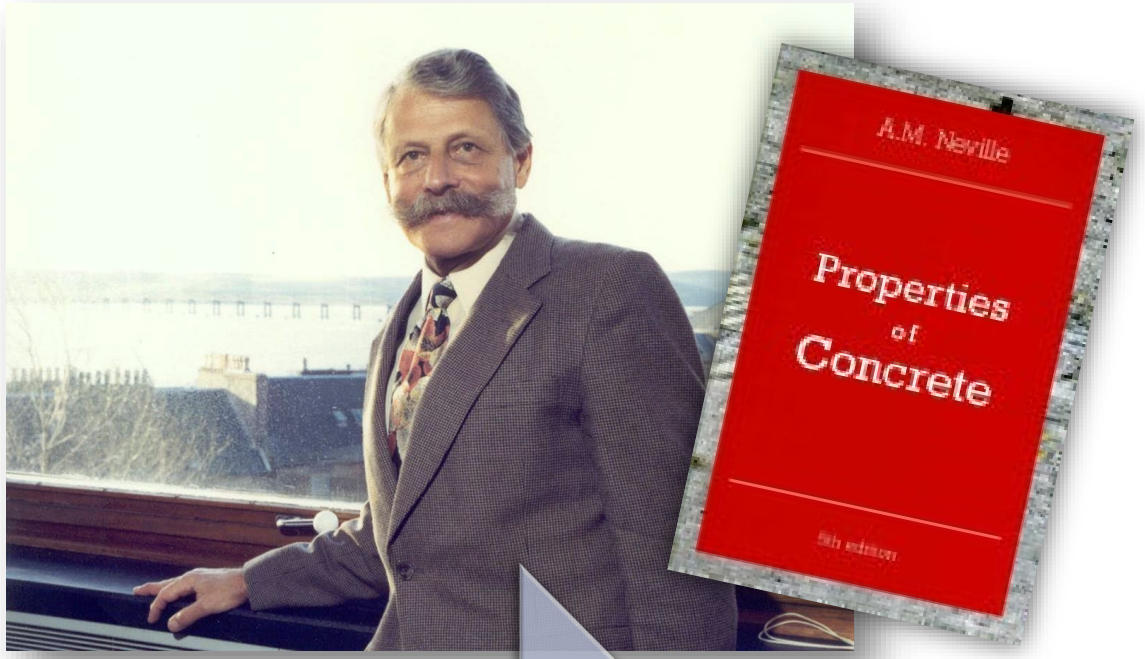
- Reprocessing concrete from construction and demolition waste to produce recycled aggregates to be used in concrete manufacturing

- Quantifying and enhancing the level of CO_2 uptake of concrete through recarbonation and enhanced recarbonation in a circular economy, whole life context

"Our climate goal is the commitment of our member companies to reduce the CO_2 footprint of their operations and products and to aspire to deliver carbon-neutral concrete to society by 2050. We will work across the entire value chain of the built environment to meet this aspiration in a circular economy and whole life context."

CONCRETE DURABILITY

Adam Neville (1923 – 2016)

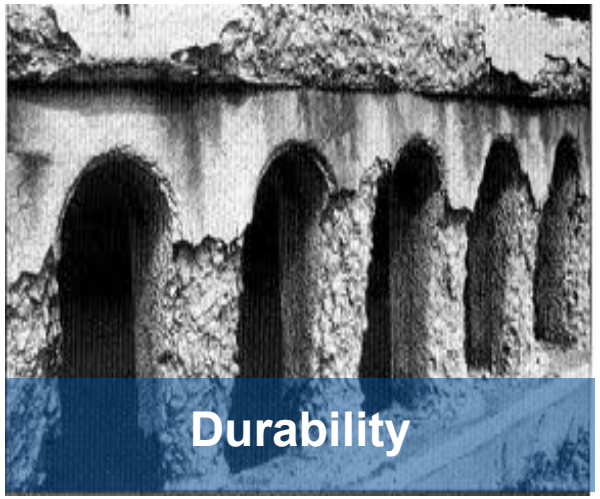


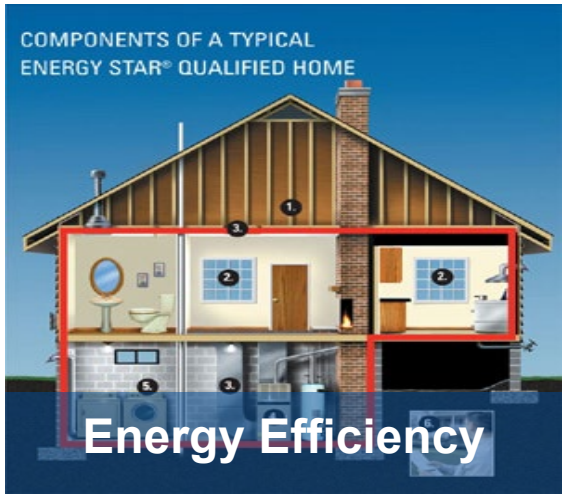
Aggregate | Cement | Additives | Cementitious Materials | Mix Design | Poured | Consolidation | Curing

DURABILITY

- Durability of concrete refers to the ability of concrete to resist deterioration due to weathering, abrasion, chemical attack or various environmental conditions (Mehta and Monteiro, 2017) while maintaining its strength and appearance integrity during its service life (Guo et al., 2018).

Construction Megatrends





Industry Demand

Producer

Economia

Low Cost of Mixture

High Retention of Workability

Quick pouring

Better Utilization of the Fleet

Contractor

Constructibilidad

Reduce Time of Construction

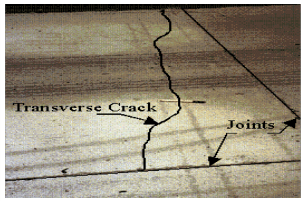
Improve pouring

No water in The Field

Engineer

Comportamiento

Development of Resistances



less Cracks

Better Durability

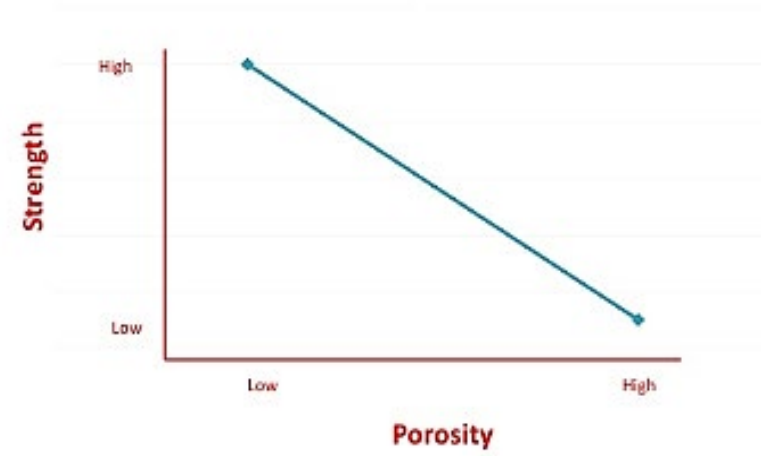
Owner

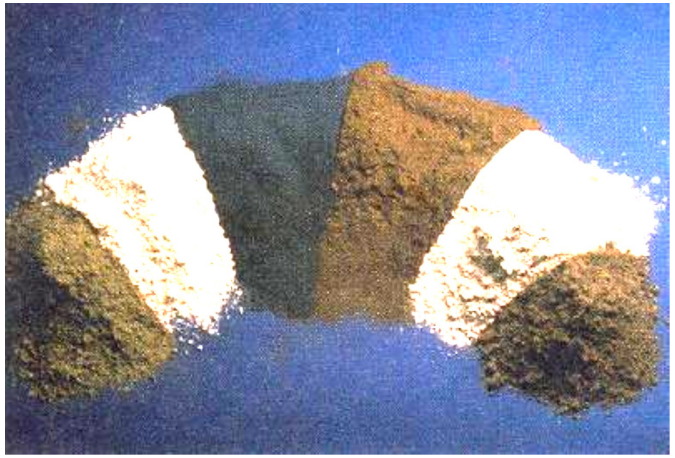
Longer service life	LEED Project Potential

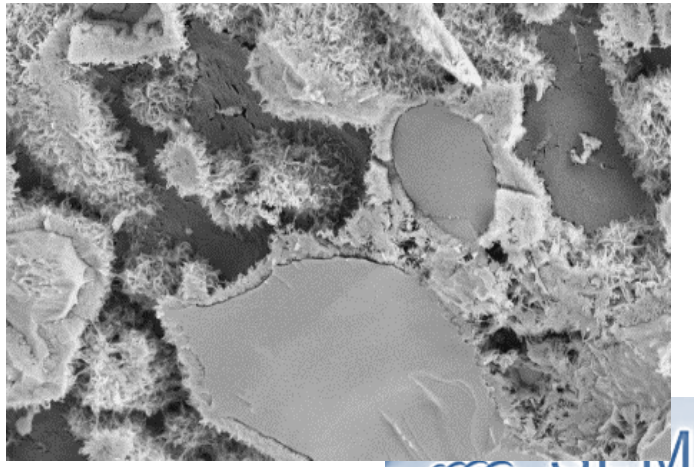
USGBC

Industry Demand

- High performance & durability
- Concrete with low carbon footprint
- Concrete mixes contain a high proportion of supplementary materials
- (SCM)Low water-to-cement ratio
- Long building life cycles







CONCRETE DURABILITY
Paradigm shifts needed in the construction practice

BY P. Kumar Mehta and Richard W. Burrows

THE MYTH

- It is a myth that durable and sustainable concrete structures can be built according to current practice when the materials and mixture proportioning are correctly specified, and the specifications are meticulously followed. This is because **the materials and the construction practice in the 20th century**, developed primarily to meet the need for **high-speed construction**, **have generally proven harmful to the durability of concrete structures exposed to severe environmental conditions**.

CHANGE #1

- The belief that society is being well served by high-speed construction is questionable due to dramatic changes during the 20th century. Globally, we do not have a labor shortage, but we do face a serious problem of man-made climate change which brings into the limelight the construction materials like steel and concrete that are being produced at a great cost to the environment. Therefore, **conservation of materials, not the construction speed, should be the new emphasis of the concrete industry in the 21st century.**

CHANGE #2

The belief that the higher the strength of concrete, the more durable will be the structure, is not supported by field experience. High-early strength concrete mixtures are more crack-prone and deteriorate faster in corrosive environments. Codes should be amended to stress this point adequately.

CHANGE #3

Many reductionistic or narrow solutions to concrete durability problems have been tried in the past without much success. **We must recognize the fact that durability cannot be achieved without a holistic approach**. In its report, ACI Committee 201, Durability of Concrete, does not consider the cracking durability relation, because cracking is not a part of the mission of this committee. Concrete cracking happens to be the responsibility of ACI Committee 224 which does not want to deal with durability. The root causes of many durability problems can be traced to this kind of reductionistic approach. By ignoring the cracking-durability relationship and by overemphasizing the relation between strength and durability, ACI 318 is not helping the cause of constructing durable and environmentally sustainable concrete structures. **A paradigm shift to a holistic approach to control cracking in concrete structures is necessary to create a much closer working relationship between the structural designer, materials engineer, and construction personnel than exists today.**

CHANGE #4

The belief that the durability of concrete can be controlled by controlling the w/cm is not correct because it is not the w/cm but the water content that is more important for the control of cracking. A reduction in the water content will bring about a corresponding reduction in the cement content at a given value of strength, which in turn, will reduce thermal contraction, autogenous shrinkage, and drying shrinkage of concrete. **Therefore, to achieve durability, the standard practice for selecting concrete mixture proportions will have to undergo a fundamental change.**

…CHANGE 4

Note that a **change in emphasis from the w/cm strength relation to the water content-durability relation will provide the needed incentive for a much closer control of the aggregate grading than is customary in the current construction practice**.

1. A substantial reduction in water requirement can be achieved by using a well-graded aggregate.
2. Additional reductions in the water content of concrete mixtures can be realized by the use of midrange or high-range water-reducers, high-volume fly ash or slag cements, and coarse ground Portland cements.

P. Kumar Mehta

In the 20th century, the concrete construction industry, driven primarily by the economics of higher and higher speeds of construction, increasingly used cements and concrete mixtures possessing high-early strength. Consequently, the field experience with many modern concrete structures shows that they are crack-prone and those exposed to severe environments tend todeteriorate much faster than their anticipated service life. To build environmentally sustainable concrete structures, it is clear that instead of strength, the 21st century concrete practice must be driven by considerations of durability.

RESILIENCE

RESILIENCE

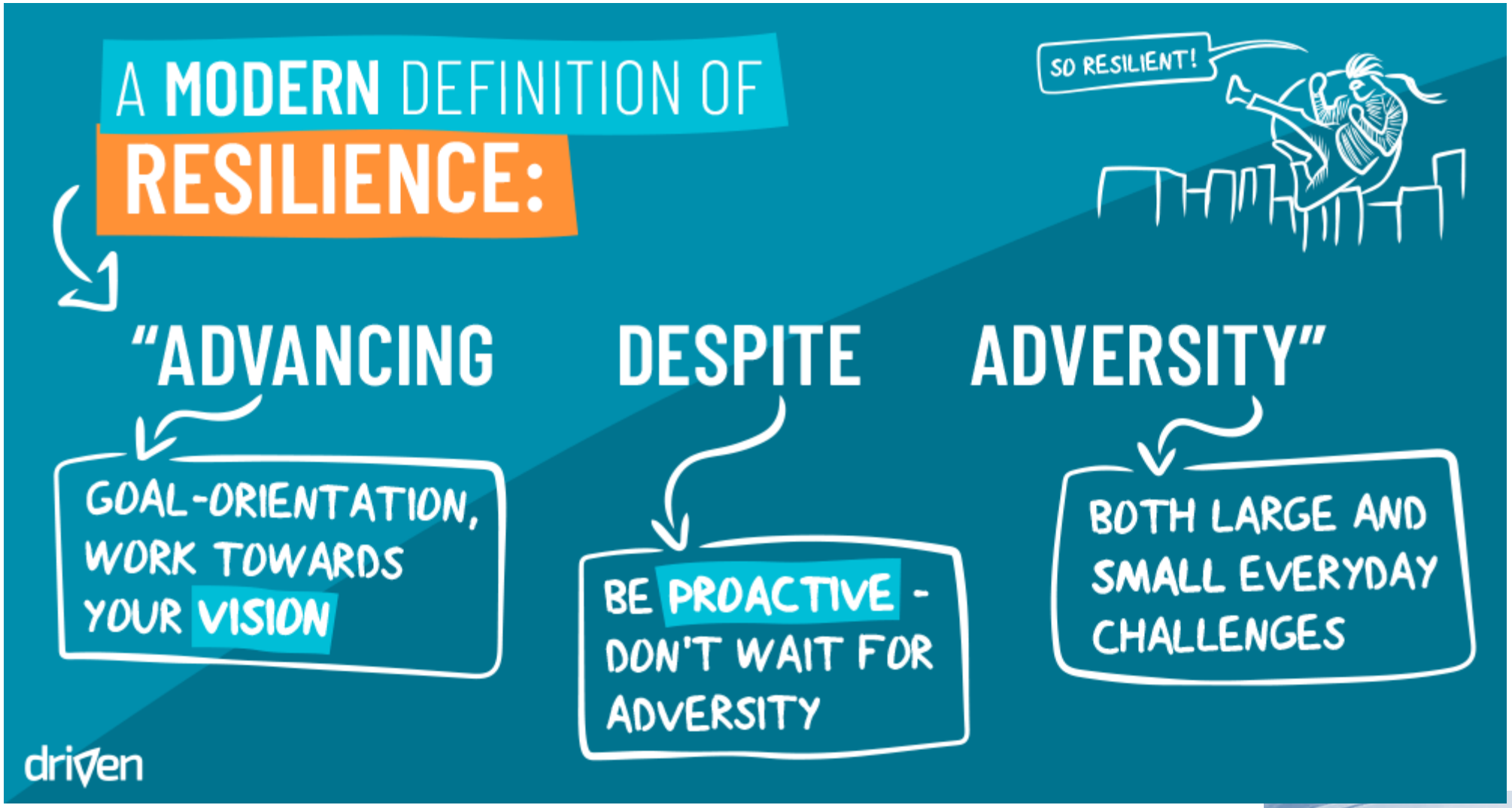
PERSONAL

- Fundamentally, resilience refers to positive adaptation, or the ability to maintain or regain mental health, despite experiencing adversity.

PHYSICS

- The ability of something to return to its original size and shape after being compressed or deformed.

Resilience is about advancing despite adversity.


A MODERN DEFINITION OF
RESILIENCE:
SO RESILIENT!
"ADVANCING
DESPITE
ADVERSITY"
GOAL-ORIENTATION, WORK TOWARDS YOUR VISION
BE PROACTIVE - DON'T WAIT FOR ADVERSITY
BOTH LARGE AND SMALL EVERYDAY CHALLENGES
driven

DR. CESAR CONSTANTINO

Building Resilience Index

Building Resilience Index is developed to facilitate design, construction, and retrofit of more buildings with resilience measures, aiming to contribute enhancing the overall climate adaptation of our cities.

Identify Risk

The App helps you identify applicable natural hazards and vulnerabilities based on the location and design of your building across four main hazard categories.

Wind

Downburst
Tornado
Storm (Cyclone, Typhoon, Hurricane)

Water

Urban Flooding
Tidal Flooding
River/Lake Flooding
Flash Flooding
Storm Surge
Tsunami

Fire

Local Fire
Wildfire

Geoseismic

Subsidence
Volcano
Landslide
Earthquake

Disclose Risk

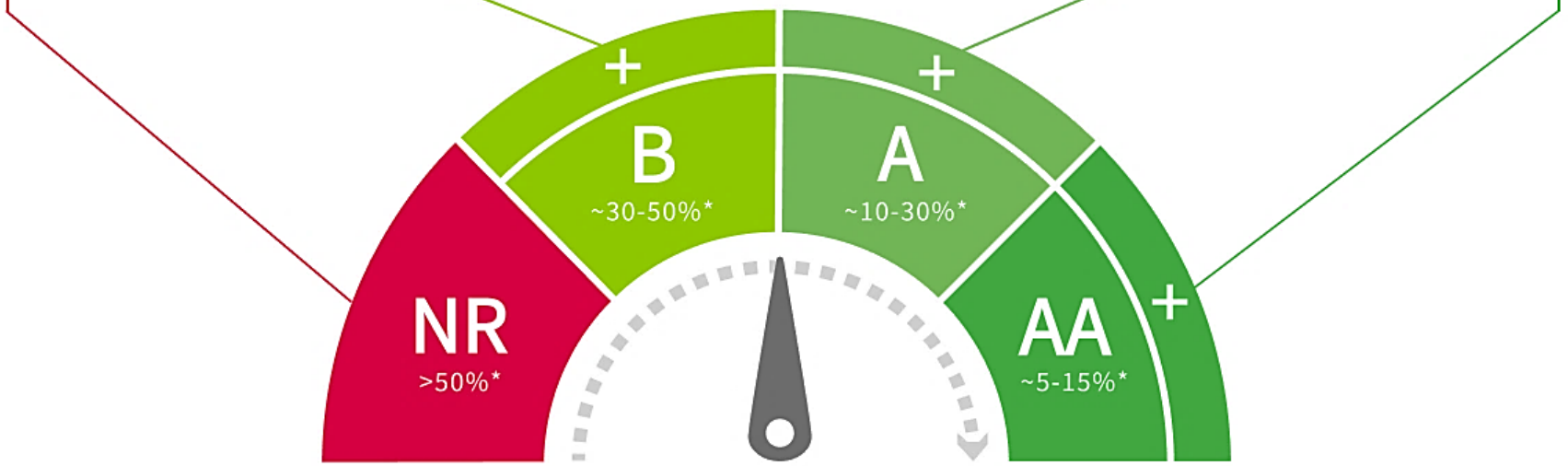
By using a standardized letter grade rating system, the App facilitates communicating resilience of your buildings to relevant parties, especially to banks and insurers.

The **building fails to incorporate recommended resilience practices** of Building Resilience Index. **It will likely not withstand** most applicable hazards, even at moderate level.

The **building incorporates some recommended resilience practices** of Building Resilience Index. It will likely withstand some applicable hazards at a moderate level.

The **building incorporates most recommended resilience practices** of Building Resilience Index. It will likely withstand some applicable hazards at a moderate-high level.

The **building incorporates ALL recommended resilience practices** of Building Resilience Index for all applicable hazards, which are generally set above the local building standards. It will likely withstand all applicable hazards at high level.



The rating followed by **'+' indicates** that the building meets all requirements of the identified Building Resilience Index rating, plus **recommended operational continuity measures.**

* Probable Maximum Loss (PML) current replacement cost, including structural and equipment, excluding operational costs.

BRI RATING LEVEL DESCRIPTION

Table 2. BRI rating level descriptions

Level	Probable maximum loss	Definition
NR	>50%	The building fails to incorporate most recommended resilience measures of BRI at a basic level.
B	~30%-50%	The building incorporates recommended resilience measures of BRI at a basic level.
A	~10%-30%	The building incorporates recommended resilience measures of BRI at a strong level.
AA	~5%-15%	The building incorporates all recommended resilience measures of BRI at a global best practices level.
+	~5%-15%	The rating followed by '+' indicates that the building meets all requirements of the identified BRI rating, plus a minimum number of recommended operational continuity measures.

Note: Any project with ratings NR, B and A will have structural and residual risks. For AA rating, a building may have residual risks.

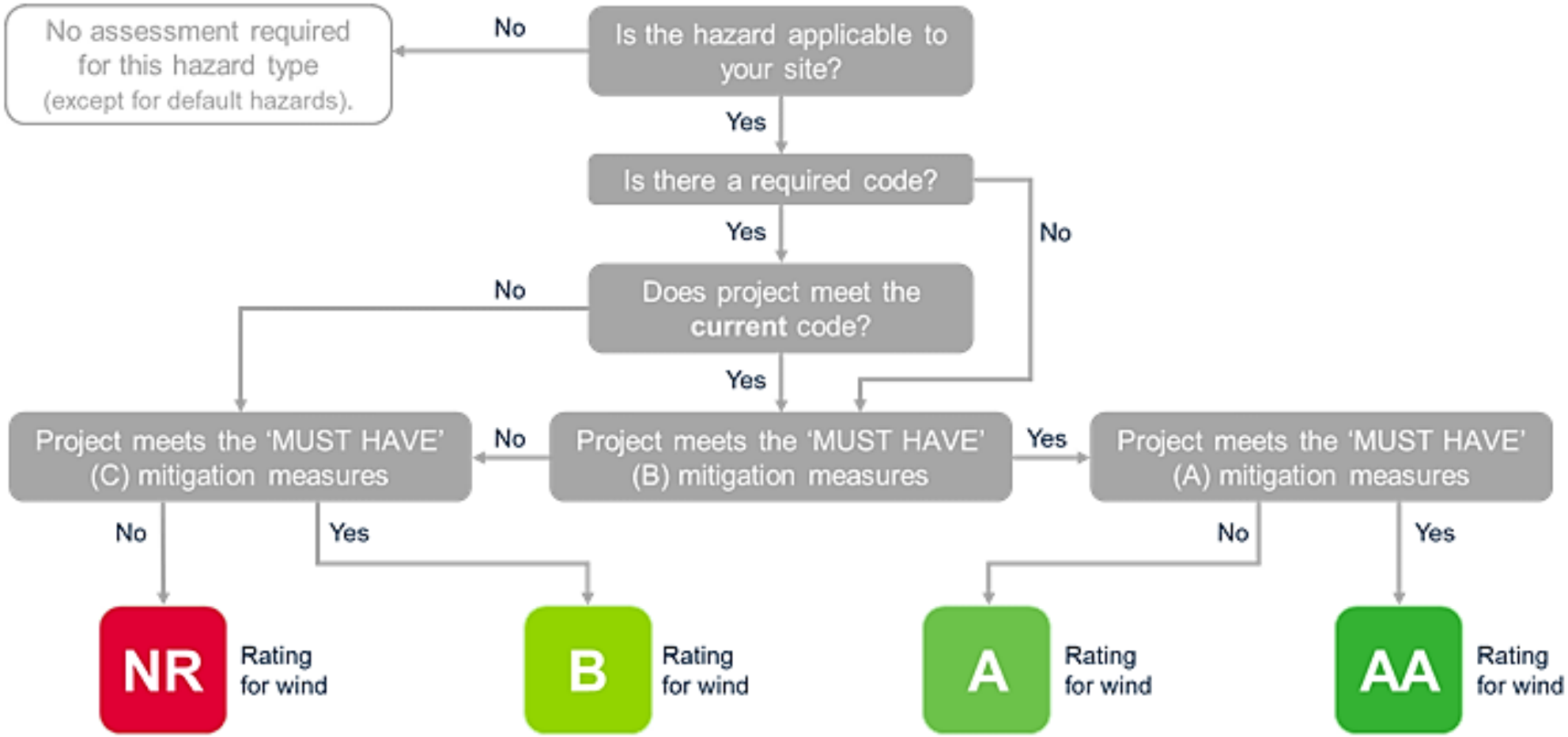


Figure 2. Rating process flow chart per hazard category

WIND

To be rated AA, buildings need to meet, or exceed the below wind speeds.

Table 3. AA level for wind hazards

Hazard Type	AA Level
Typhoon, Hurricane or Cyclone	290 km/h (180 mph)
Tornado	290 km/h (180 mph)
Downburst	200 km/h (125 mph)

Buildings in storm and tornado-applicable locations will be rated NR, if they cannot withstand a minimum 200 km/h (125mph) wind speeds, and 200 km/h (125 mph) for all other locations (downbursts being the default).

WATER

Table 6. High level for water hazards

Hazard Type	High Level	Comments
Tsunami	15 m (50 ft)	From mean sea level, up to 10 km (6.2 miles) from coast, based on land morphology.
Storm surge	6 m (20 ft)	From mean sea level, up to 2 km (1.2 miles) from coast, based on land morphology.
River/lake flood	6 m (20 ft)	From mean river/lake level, up to 2 km (1.2 miles) from river/lake, based on land morphology.
Flash flood	6 m (20 ft)	2 km (1.2 miles) from low point of terrain, based on land morphology.
Coastal/Tidal flood	6 m (20 ft)	From mean sea level, up to 0.5 km (0.3 miles) from coast, based on land morphology.
Local/Urban flood	3 m (10 ft)	From low point of terrain within 50 m (160 ft) radius, based on land morphology.

FIRE

Table 8. Time required to maintain the structural integrity on fire hazards

Impact	Maintaining Structural Integrity
Very Low	more than 10.0 hrs.
Low	5.0 -10.0 hrs.
Medium	3.1 – 5.0 hrs.
High	1.1 - 3.0 hrs.
Very High	1.0 hr or less

GEOSISMIC

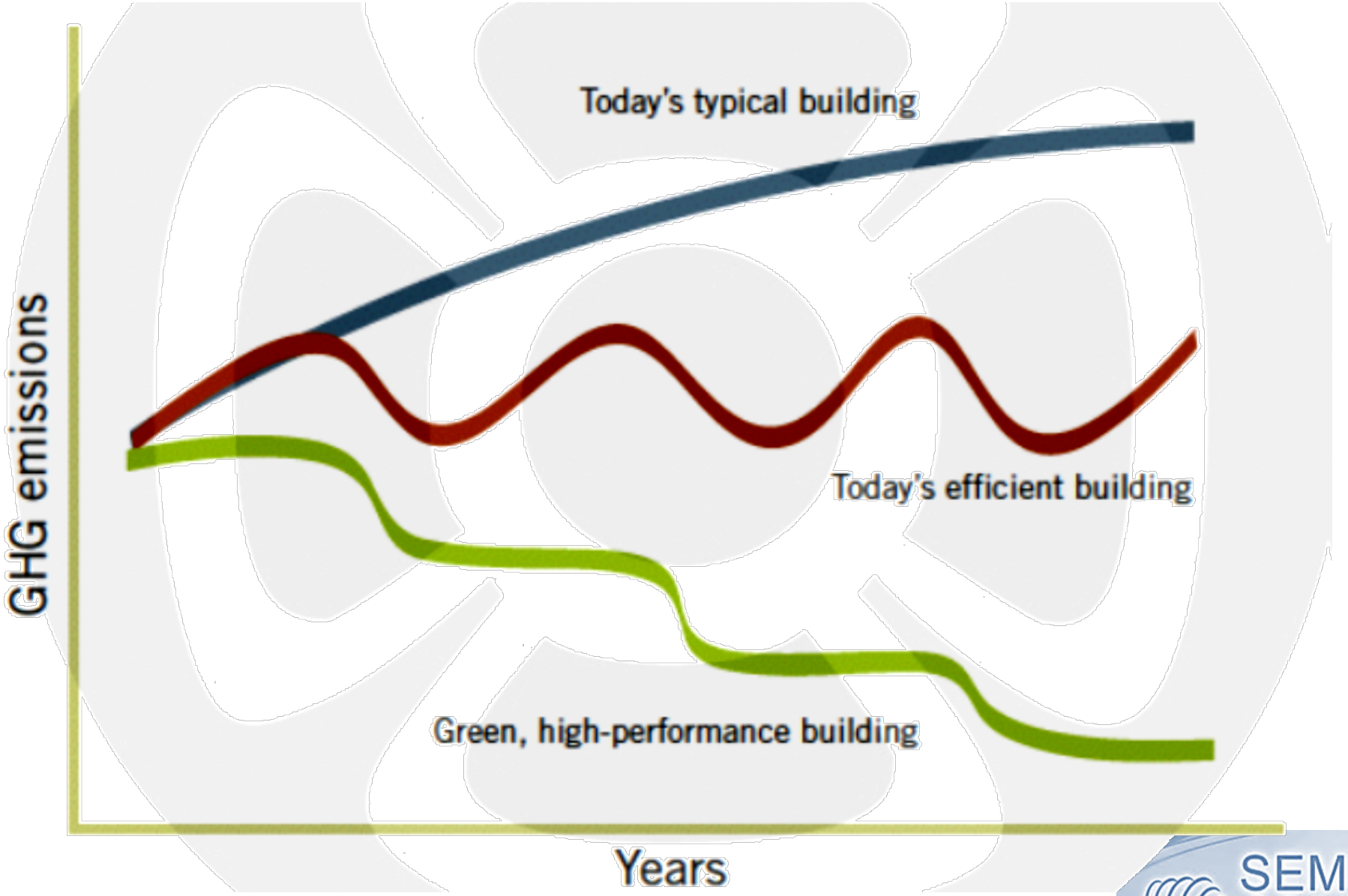
- There are three types of Geoseismic Hazards:
  - Earthquakes,
  - Landslides,
  - Volcanos and
  - Subsidence.

As geoseismic forces can be very powerful, the location of a building is a major risk factor, particularly for landslide and volcanic hazards. They can also be interrelated to other hazards. Example: Landslides can be triggered by earthquakes or heavy rain.

Lessons Learned About Building Resilience Following Major Earthquakes

- Strengthening resilience involves adopting the latest building codes for new construction and retrofitting existing buildings. We must also emphasize the importance of **refining resilience approaches based on global good practices**. Through such steps, we can apply lessons globally, enhancing safety and resilience in the face of natural disasters and climate change.

CONCLUSION


Today's typical building
Today's efficient building
Green, high-performance building
GHG emissions
Years


100
DAYS SMARTER
José Miguel
¿LES DIJE QUE SOMOS ABUELOS?
PIC•COLLAGE