

MITIGATE AND ADAPT

BUILDING OUR COMMUNITIES IN THE AGE OF CLIMATE CHANGE



CANADIAN PRECAST/PRESTRESSED CONCRETE INSTITUTE
INSTITUT CANADIEN DU BÉTON PRÉFABRIQUÉ ET PRÉCONTRAINT



NPCA

Precast ... The Concrete Solution



Eagle Ridge Apartments & Condos, Eagle Ridge Alberta, Canada

Total Precast Concrete Structures

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THE WEATHER WAS ONCE THE WORRY OF ONLY FARMERS AND PARENTS DRESSING CHILDREN FOR SCHOOL. TODAY, CLIMATE CHANGE MAKES FRONT PAGE AND BUSINESS HEADLINES. STORIES OF RECENT NATURAL DISASTERS AND THEIR IMPACT ON OUR ECONOMIES HAVE HEIGHTENED EVERYONE'S CONCERN – AND RIGHTLY SO.

After the recent catastrophic flooding in Louisiana and the devastating wildfires in Fort McMurray, Alberta Canada, North Americans are realizing that climate change is one of the biggest challenges facing the world. Tackling climate change is a top priority for all governments – at home and internationally. The world climate projections by the World Meteorological Organization show that past, and current, practices will influence the climate for decades. A climate projection is usually a statement about the likelihood that something will happen several decades in the future if certain influential conditions develop in contrast to a prediction. Climate change has already had far-reaching impacts on our infrastructure and can put performance and reliability at risk. This trend is likely to accelerate in the coming decades the main threats to infrastructure assets include damage or destruction caused by extreme weather events: coastal flooding and inundation from sea level rise, changes in patterns of water availability, and effects of higher temperature on facility operating costs. Some infrastructure may be indirectly if physical access or services to it (such as electricity and information and communications technology (ICT)

are disrupted. Therefore, besides efforts to reduce climate change, we need to prepare our infrastructure for the climate change that we cannot avoid.

Resilience is everyone's business and is a shared responsibility among citizens, the private sector, and government. Resilience is, quite simply, ... "making people, communities and systems better prepared to withstand catastrophic events – both natural and manmade – and able to bounce back more quickly and emerge stronger from these shocks and stresses" (Rockefeller Foundation, 2013). Increasing resilience to disasters requires bold decisions and investments that often appear to pit short-term thinking against longer-term interests. For example, should we relieve pressure on housing prices by relaxing building codes to allow for cheaper and lighter construction methods at the expense of safety? When building and/or repairing old infrastructure, should we focus on initial cost or finance larger investments that secure the functionality of that infrastructure against the uncertainties of climate change and other threats?

SUSTAINABILITY AND RESILIENCY -

MORE THAN JUST BUZZ WORDS

We have been hearing a lot about sustainable construction over the past few years. Now “resilient” is the new buzzword. Sustainability and resiliency are actually complementary concepts, where resiliency relates to a more short-term recovery from a recent crisis while sustainability describes a long-term balance between consumption and resources. Resilient construction and development may seem like a new trend, but the concept has been around for many years.

But What Exactly is Resiliency?

Resiliency can be defined as the adaptability of a system (communities) to maintain its functions and structure in the face of turbulent internal and external change.

The key attributes of enhanced structural resiliency are improvements in:

- Longevity (service life)
- Robustness (minimized potential for structural progressive collapse)
- Sustainability
- Life safety
- Durability
- Adaptability for reuse
- Resistance to disasters

Community resiliency has been defined as the “capability of a community to anticipate risk, limit impact, and recover rapidly through survival, adaptation, evolution and growth in the face of turbulent change.” According to the US Department of Homeland Security (DHS), resiliency is the ability of any system (infrastructure, government, business and citizenry) to resist, absorb and recover from or successfully adapt to an adversity. Turbulent change and adversity can refer to a range of various natural and man-made calamities including the following:

- Extreme weather (snowfall, tornadoes, hurricanes or flooding)
- Geological (earthquakes, tsunamis and volcanic eruptions)
- Man-made crises (terrorism, war, forest fires, pandemics or large-scale industrial accidents)
- Economic (company closing, recession or depression)

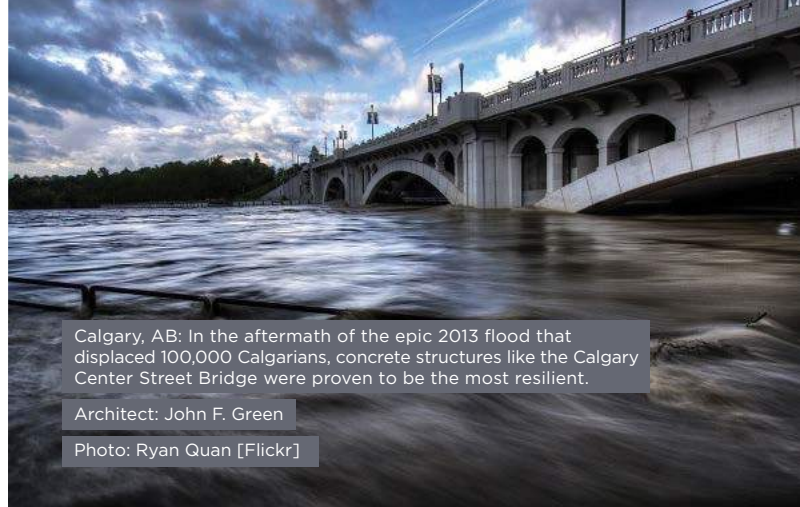
A community’s ability to recover from these events depends on many factors. The effects of the first three categories can be minimized with conscientious construction methods using durable, strong materials. Concrete is an example of such a material that is designed to absorb large static and dynamic loads, and resist damage due to snow, flooding and fires.

How Resilient Communities Differ From the Current Situation

The Resilience Loss Recovery Curve according to the Community and Regional Resilience Institute (CARRI) is the capacity of hazard-affected bodies to resist loss during disaster and to quickly recover afterwards. It helps explain how community function is affected by an acute disturbance and depicts response and recovery curves. Community functions decline swiftly as citizens respond to a disaster. A more resilient community can more quickly restart local services (utilities, businesses, schools) and chart a path to a “new normal.” The more resilient community incurs some losses but avoids additional losses because it has taken informed measures (anticipating threats, disaster response plans and

recovery strategies) to minimize the impact of the disturbance. Mitigation efforts of resilient communities include: improved land-use decisions and building code implementation; construction of resilient infrastructures; improved business and household planning to minimize loss; and a better orchestrated response of both citizens and local agencies.

Resilient communities may find opportunities to transform themselves and grow. Thus, a resilient community's "new normal" may be a higher level of function or it may be able to return to a level of function existing before the disturbance. The key to disaster recovery is not only to get essential services back up and running, but also to get people back to work. That means buildings and structures not only must resist the damages caused by an adverse event, but must be in a condition suitable to occupancy as soon as possible. Six years after a disastrous tornado, Greensburg Kansas is now the world's leading community in LEED-certified buildings per capita. The town is home to a half-dozen LEED-platinum certified and resilient buildings, including a New City Hall and the new 48,500-square-foot Kiowa County Memorial Hospital. Renewable energy powers the entire community, and the streetlights are all LED.



Calgary, AB: In the aftermath of the epic 2013 flood that displaced 100,000 Calgarians, concrete structures like the Calgary Center Street Bridge were proven to be the most resilient.

Architect: John F. Green

Photo: Ryan Quan [Flickr]



Otsuchi, Japan: A shipwrecked ferry rests atop a concrete building in the aftermath of the devastating Tohoku Tsunami of March 2011.

Photo: Hiroto Nomoto



Hodder Avenue Underpass Thunder Bay, Ontario

Ultra-High- Performance Concrete Bridge (UHPC)

Engineer: Hatch Mott MacDonald, Mississauga



Pavilion Desmarais Building, University of Ottawa, Canada

Precast Concrete's Role in Resiliency

The need for increased resilience through the design and construction of more robust, durable, long-lived, disaster resistant, safe and secure buildings and infrastructure has long been recognized by many entities and identified in many publications and programs. A trend in North America, especially for structures that are not owner designed, built, and occupied; is to maximize profitability by simply satisfying the least stringent provisions of the state/provincial and local building codes.

While this generally has some impact on the life safety of occupants, buildings and infrastructure built to minimum provisions of applicable codes tend to lack the robustness, durability, longevity, comfort, safety, and security necessary for community.

The need for enhanced resiliency of buildings and structures is becoming increasingly important nationally and globally and is a key component to economic, societal, and environmental viability. A 2011 United Nations report on disaster risk reduction identified that losses from disasters are rising faster than gains made through economic growth across all regions, threatening the economies of low- and middle-income countries as well as outpacing wealth gains across many of the world's more affluent nations. Recent major natural disasters and their impacts on national and global economies have heightened awareness and spurred activity to improve the nation's infrastructure.

The Missing Link

To date, most building code requirements have an emphasis on life safety, i.e. allow major damage or total collapse as long as the occupants can be evacuated prior to or during the event. Excessively damaged buildings and infrastructure have a slow recovery and may even prevent recovery for some neighborhoods. Most sustainability or green programs, codes, and standards focus primarily on energy, material, and water conservation; indoor environmental quality; and site selection and development. Each of these is an important aspect of sustainable building design and construction. However, the assumption that the basic building will be resilient is not inherent in these programs.

The Missing Link Problem

Often minimum requirements in many building codes are focused on life safety and do not provide the protection of buildings and their contents necessary to make them truly resilient buildings.

Unfortunately, this is consistent with the modern-day disposable mentality and results in buildings that satisfy the absolute minimum project requirements at the least possible initial cost.

Climate change is already damaging our global economy. Until recently, the usual thinking among macroeconomists has been that short-term weather fluctuations don't matter much for economic activity. But recent events have prompted a rethinking of this view

Extreme weather certainly throws a ringer into key short-term macroeconomic statistics. It can add or subtract 110,000 jobs to monthly North American employment data. It is now the single most watched economic statistic in the world, and generally thought to be one of the most accurate.

The global insurance industry tracks the number of natural catastrophes worldwide. The trend in catastrophes caused by weather, water, or climate has increased dramatically over the last 30 years. In 2015 Insurers paid out around \$27 billion for natural disaster claims with weather causing 94 percent of incidents, underscoring the challenge posed by climate change. Insured losses due to natural disasters in the United States in 2015 totaled \$16.1 billion, according to Munich Re, more than the \$15.3 billion total for 2014. These costs are borne by individuals, businesses, and governments.



Precast Concrete decentralized wastewater treatment system

Design for Resilience

Property losses due to disasters continue to escalate at a staggering rate. Since the 1970s, property losses by decade have increased by more than 3500%. Concrete is disaster-resilient material.

A town or city that features stronger, better built buildings, and the roads and services that support them is truly resilient. Its leadership recognizes the value of planning for potential disasters and has taken steps to ensure the community has the ability to survive with less housing, loss of employment, and critical services. Precast Concrete structures can play a vital role in building stronger communities.

There are a variety of ways to incorporate precast concrete to make structures more durable and disaster-resistant. Precast concrete architectural, structural and underground products like wall, floor, roof, drainage and structural systems offer an unsurpassed combination of structural strength and durability. Add hardened exterior finishes for walls and roofs, and your home or business will have the best combination of strength and security available.

Precast Concrete infrastructure serving as water and wastewater conveyance as well as housing electrical utilities, communication lines and other vital services will stand up to flooding, fires and other

disasters; thus preserving these services and contributing to a quicker recovery from crisis situations.

Builders, architects, and designers have come to recognize that more durable public buildings, private homes and businesses, often built with concrete to resist damage from natural disasters, reduce the impact entire communities have on our planet.

Communities built to last start with comprehensive planning, including stricter building codes that produce robust structures with long service lives. More durable buildings with high-performance features, including better disaster resistance, help promote community continuity, making cities and towns stronger and better able to successfully weather any challenge.

The residents of more robust cities and towns experience major benefits from the overall improvement of building resilience: fewer burdens on local services, a more stable local economy that provides consistent sources of money to run the municipality, and a more enduring legacy for future generations. Builders, architects, and designers have come to recognize that more durable public buildings, private homes, and businesses, often built with concrete, resist damage from natural disasters and reduce the impact communities have on our planet.



Northwest Building Minneapolis, Minnesota

Architects: Cermak Rhoades Architects

Photographer: Farm Kid Studios

Precast Concrete is a Climate Resilient Infrastructure Product

Precast Concrete Is Comfortable

The material has intrinsic properties of thermal inertia (allowing a more constant temperature both in cold and hot regions) and acoustic insulation.

Precast Concrete is Safe

Everybody knows that concrete does not burn! Not only is the structural stability maintained for longer periods, but concrete construction prevents the spread of fire from one building to another. It is sufficiently strong to resist impacts, blasts and natural catastrophes like earthquakes, tornadoes and floods.

Precast Concrete is Versatile

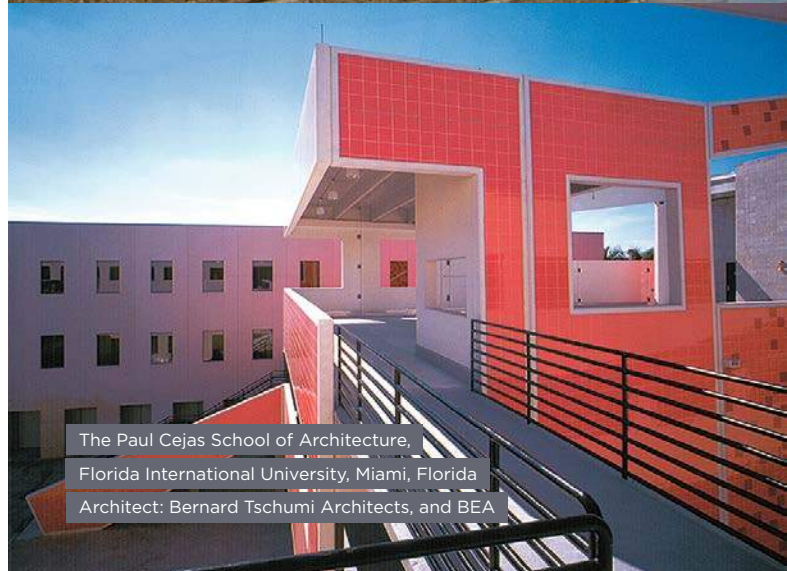
Concrete has another advantage: its mouldability which allows designers to copy classical details and/ or match the finish of materials. The concrete industry can source a wide range of aggregates locally and offer a tremendous variety of colours and visual effects.

Precast Concrete is Healthy

Indoor air quality is a concern for all of us. Concrete is stable throughout its life and does not need chemical treatment to protect it against rot and insect attack. This means that there are no emissions in the internal environment.

Precast Concrete is Optimized

Advanced technologies used in production create an improved quality product (i.e. reduced tolerances, thinner sections, engineered solutions) compared with other materials. Additionally, quality can be checked before a unit is inserted into the structure or site work!



Precast Concrete is Durable

Concrete lasts for decades. The Egyptians and Chinese used an ancient form of concrete for buildings and structures that still exists today. Concrete is used where the structural stability has to be maintained for long periods. Effective design detailing helps to lengthen the life of a concrete building; manufacturers can offer guidance on designing for durability.



Comstock Graduate Housing, Stanford University, Stanford, CA

Architect: Kenneth Rodrigues & Partners, Inc.

Precast Concrete is Ecological

Made of natural raw materials (stones, gravels, sand, cement), locally available almost everywhere and in an enormous quantity, concrete minimizes the whole life cycle impact on the environment when compared with other construction materials. Concrete units can be entirely re-used or recycled (almost 100% of a concrete building can be recycled, no matter how heavily reinforced).

Precast Concrete is Affordable

Concrete combines the excellent quality of factory production with a relatively inexpensive material. The costs to repair and maintain concrete structures are highly limited. There is therefore no need to compromise on quality to reduce costs; simply choose the best way to use locally available resources.

Precast Concrete is Fire Resistant

Concrete offers noncombustible construction that helps contain a fire within boundaries. As a separation wall, concrete helps to prevent a fire from spreading throughout a building. As an exterior wall or roof, concrete helps to prevent a fire from jumping from building to building. During wildfires, concrete walls and roofs help provide protection to

human life and the occupants' possessions within a building. Concrete helps contain a fire even if no water supply is available, whereas sprinklers rely on a water source. Concrete that endures a fire can often be reused when the building is rebuilt.

Precast Concrete is Tornado, Hurricane, and Wind Resistant

Concrete is resistant to tornadoes, hurricanes, and wind. Debris driven by high winds presents the greatest hazard to homeowners and their homes during hurricanes and tornadoes. Tests show that concrete wall systems suffer no structural damage when impacted by debris carried by hurricane and tornado-force winds.

Precast Concrete is Flood Resistant

Concrete is not damaged by water; concrete that does not dry out continues to gain strength in the presence of moisture. Concrete submerged in water absorbs very small amounts of water over long periods of time, and the concrete is not damaged. In flood-damaged areas, concrete buildings are often salvageable. Concrete dams and levees are used for long-lasting flood control. Concrete is heavy and will



Bellevue Youth Theater Bellevue, WA

Architects: Becker Architects

Photographer: Becker Architects for Bellevue Youth Theater

resist movement due to high flood waters. This helps keep vital underground infrastructure such as pipes, culverts, manholes and tanks in place, and increases the likelihood that they can be put back into service.

Precast Concrete is Not Affected by High Humidity and Wind-Driven Rain

Concrete is not affected by wind-driven rain and moist outdoor air in hot and humid climates because it is impermeable to air infiltration and wind-driven rain.

Precast Concrete is Earthquake Resistant

Structures built with reinforced concrete walls have a record of surviving earthquakes intact, structurally sound and largely unblemished. In reinforced concrete and precast concrete construction, the combination of concrete and steel provides the three most important properties for earthquake resistance: stiffness, strength, and ductility. Studies of earthquake damage consistently show well-anchored shear walls are the key to earthquake resistance in low-rise buildings. Optimal design conditions include shear walls that extend the entire height and are located on all four sides of a building. Long walls are stronger than short walls, and solid walls are better than ones with a lot of openings for windows and doors. These elements are designed to survive severe sideways (in-plane) forces, called racking and shear, without being damaged or bent far out of position. Shear walls also must be well anchored to the foundation structure to work effectively. Properly installed steel reinforcing bars extend across the joint between the walls and the foundation to provide secure anchorage to the foundation. Concrete walls have over six times the racking load resistance as framed wall construction.

Precast Concrete is Blast Resistant

Concrete has demonstrated blast resistance through tests. High performance concrete can be designed to have improved blast resistant properties. These concretes often have a compressive strength exceeding 100 MPa and contain steel fibers. These blast-resistant structures are often used in bank vaults and military applications.

Precast Concrete is Sustainable

Respecting customs, culture and values in the communities in which we operate, we consider operational excellence to include more than a

return to our shareholders; we also consider our employees and their families, the communities where we work and the impact on our environment. Our Corporate Social Responsibility commitment aims to achieve a balance of economic prosperity, environmental stewardship and social responsibility that extends beyond the economic life of our operations.

- We believe in building relationships within the communities in which we operate.
- We base our principles on accountability, transparency, ethical behaviour, human rights and respect for stakeholder interest.
- We ensure that personnel are trained in the above-mentioned principles and that a continual awareness program is in place to support that training.
- We have established Sustainability Committees within our concrete industries, which are responsible for directing our sustainability performance and striving for continuous improvements.





Perot Museum, Dallas, Texas

Architect: Morphosis, Culver City, CA

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The North American Precast Concrete Industry Associations; Canadian Precast/ Prestressed Concrete Institute (CPCI), the National Precast Concrete Association (NPCA) and the Precast/Prestressed Concrete Institute (PCI) are the body of knowledge and prime source of sustainability, research and technical information about precast and prestressed concrete in North America. Our interest is to stimulate and advance the common interests and general welfare of the architectural, structural, and underground and specialty precast concrete products industries, including safety and welfare of our employees and the public at large.



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