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Build BEST TO LAST

Applying Lifecycle Cost Assessment for New Building Asset Management

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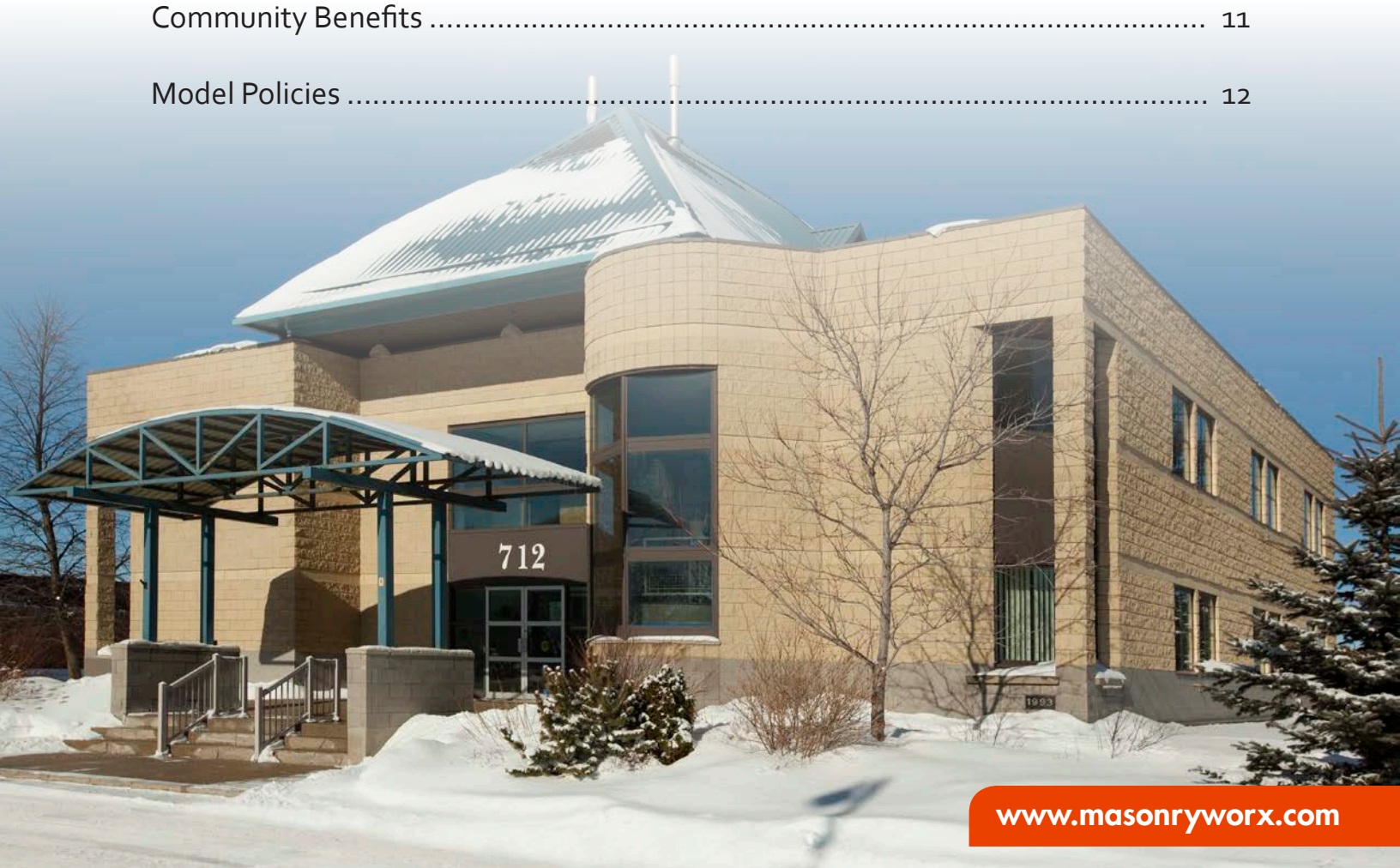


Ontario's **Infrastructure Challenges**

Ontario and Canada have both placed renewed interest in recent years in building newer and more resilient public infrastructure. With new challenges facing infrastructure projects in terms of what they will have to endure over their lifetimes, it is absolutely vital to get each new piece of infrastructure right.

Infrastructure is about more than roads, bridges, sewer pipes and power lines. Almost all levels of government and the broader public sector are in the business of owning buildings.

With taxpayers demanding more and more responsibility and accountability on the part of public institutions as to how public money is spent, it is important that public buildings represent sound, long-term investments which continue to give back to the public over time. This has been recognized at the provincial level through various initiatives in recent years and remains front-of-mind among planners. Ontario's broader public sector is also beginning to confront the idea of asset management and lifecycle-based planning.

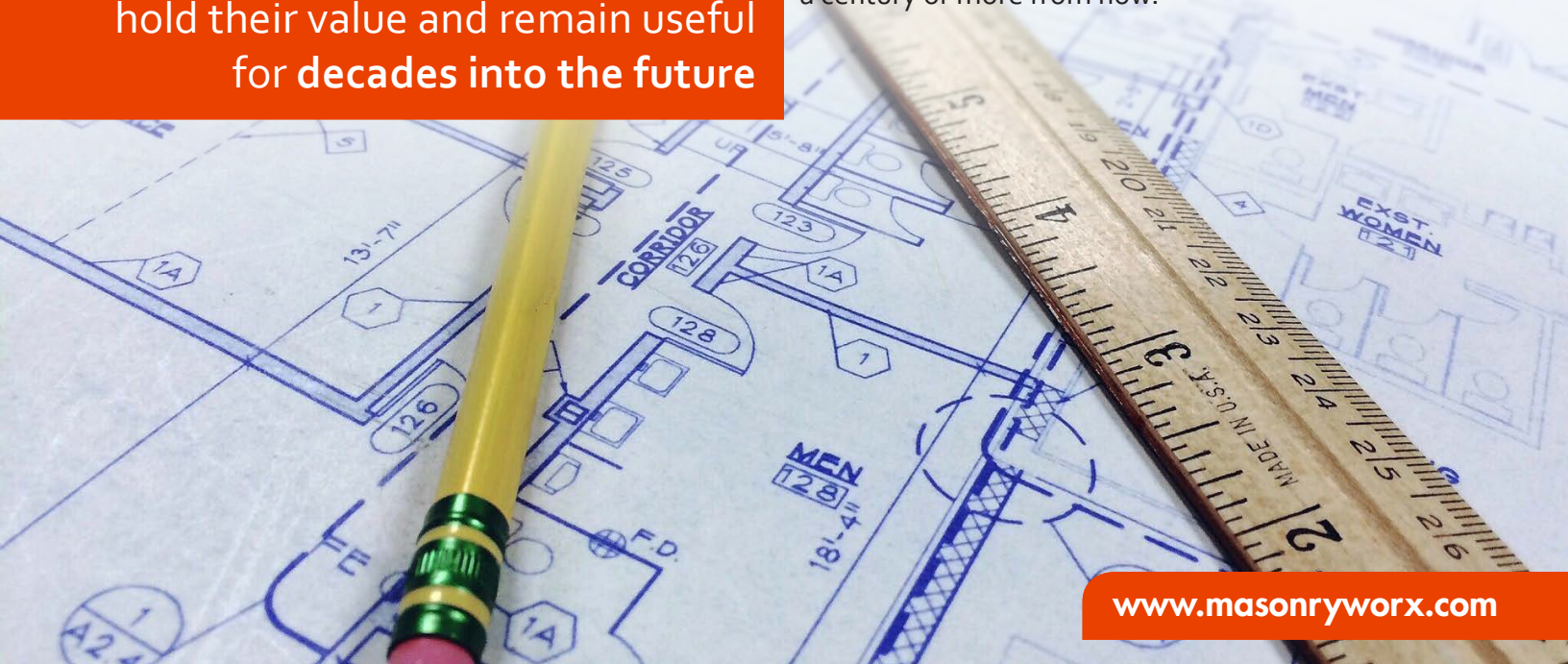
Also looming is the threat of climate change and the adverse weather impacts it will bring. The Government of Canada notes that "the climate of Canada... is expected to undergo substantial change," including risks of extreme weather events such as heat waves, heavy rainfalls, flooding, droughts and forest fires. Moreover, "the climate impacts we are seeing today are expected to persist and worsen as a result of past and present-day emissions."

The overall environmental footprint of a building must be considered along with cost. Smart assets add as few emissions as possible over their lifetimes. That means building with low-emission materials which do not need to be frequently replaced, generating more carbon through production and transportation.

Public infrastructure must meet these and other competing conditions. It should be strong enough to withstand extreme weather impacts while also being cost-effective. It should provide public bodies with a strong asset which can be continuously used with as little maintenance as possible. It should contribute to local economic prosperity. And it should demonstrate not just excellent costs over time, but also a strong aesthetic, place-making appeal.

Approaching new public buildings with an eye towards the building materials used for both the structure and the exterior of the building is a simple way for Ontario's broader public sector to meet these objectives. Masonry creates enduring, robust buildings which save money over the lifecycle of the building, deliver an extended lifespan and are likely to be there a century or more from now.

Well-designed infrastructure assets hold their value and remain useful for **decades into the future**

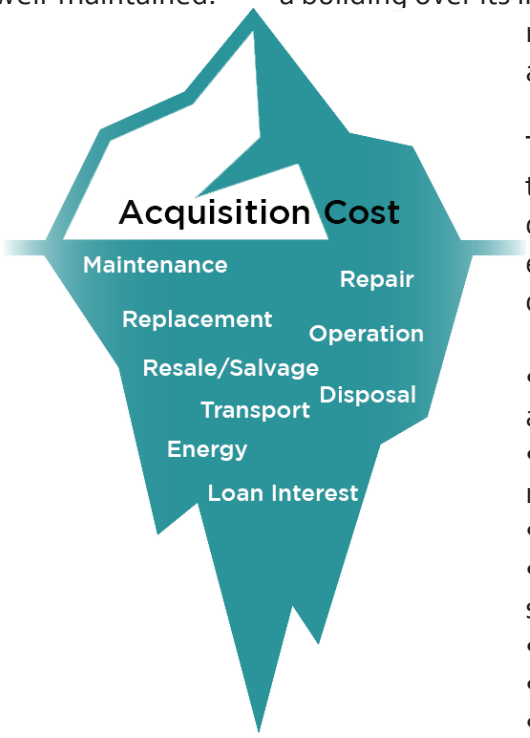


Lifecycle Cost **Assessment**

Lifecycle cost assessment originated with the United States military in the 1960s, when the Pentagon realized that the up-front cost of buying military hardware only represented 25% or so of the total costs – that is, they could purchase equipment like jets and tanks for a price, but the largest expense would come from keeping them operating and well-maintained.

According to the National Institute of Building Sciences, a Congressionally-authorized non-governmental organization in the United States:

> *LCCA can be applied to any capital investment decision in which relatively higher initial costs are traded for reduced future cost obligations. It is particularly suitable for the evaluation of building design alternatives that satisfy a required level of building performance but may have different initial investment costs, different operating and maintenance and repair costs, and possibly different lives. LCCA provides a significantly better assessment of the long-term cost-effectiveness of a project than alternative economic methods that focus only on first costs or on operating-related costs in the short run.*



The process for lifecycle cost assessment has its roots in ISO standards. The standards used are ISO 14040 and ISO 14044. These contain specific requirements and guidelines concerning lifecycle assessments from an environmental and sustainability standpoint, focusing primarily on the environmental impact of a building over time. However, the same process has been carried over to consideration of the total cost of a building over its lifespan not just in terms of environmental impact, but in terms of actual monetary cost.

The NIBC sees LCA as something to be performed early in the design process. This gives builders the opportunity to refine the design. Costs to consider include:

- Up-front costs of purchase or acquisition;
- Operation, maintenance and repair;
- Cost of replacement;
- Resale, salvage or decommissioning costs;
- Finance and loan costs;
- Fuel and energy; and
- Non-monetary factors.

In the United States and Europe, lifecycle cost assessment is beginning to see consideration for infrastructure projects as procurers, engineers and designers seek to build projects which will deliver the best possible return on investment and demonstrate the lowest lifecycle cost. The same process can be translated to Ontario to help planners and public works officials get the most out of their investment over time.

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Lifecycle and **Building Materials**

A public building represents an investment. Ideally, these buildings will become assets which can serve the community for generations to come. That means choosing building materials which will last.

Ontario has many heritage public buildings still in use today. Guelph's Old City Hall, built in the 1850s, remains in use as a Provincial Offences Courthouse. Belleville City Hall, built in 1873 with limestone and red brick, remains home to City Council. In London, the Middlesex County Court House, built from locally-quarried stone in the late 1820s, still houses county administrative offices. In Kingston, the 1844-era limestone city hall still houses the seat of local government. These and other masonry structures, built with concrete block internal structures and masonry exteriors, have stood the test of time.

Most institutional and public buildings should be built with a long-term view - that is, the intention that they should be permanent buildings. A lifespan of at least 50 to 70 years should be contemplated as planners and designers consider new structures. With that lifespan considered, it becomes important to consider the longevity of that building's elements.

All building materials, both structural and external, should be chosen with an eye towards the cost of failure, repair and expense of maintenance over time.

For a building which will last 100 years, for instance, it makes little sense to build it with building materials which will only last 20 years. While those materials may cost less up front, they will require replacement multiple times over the life of the building, causing costs to escalate. By contrast, other materials - particularly brick, stone and block masonry - have much longer lifespans and do not require repeated replacement over the life of a building. A permanent or long-lasting structure should not be built with temporary materials, inside or out.

This calculus should be a best practice conducted for all new public buildings. Wise planners and engineers should conduct a lifecycle cost assessment as part of a three-screen approach for sustainability - an approach which considers three factors:

1. **Building materials with the lowest possible carbon footprint.**
2. **Materials with the lowest lifecycle costs - e.g. long-lasting materials with little maintenance.**
3. **Materials which are the best available solution.**

Most public buildings should be built for longevity. Long-lasting public buildings survive to become the iconic buildings of tomorrow. Well-designed buildings with resilient masonry structures go on to become the next generation's permanent infrastructure assets. Even if their purpose changes with time, these buildings can be adapted and reused.

Today's new builds are tomorrow's **heritage landmarks**

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Asset Management and **Public Buildings**

Asset management is intended to help governments maximize the benefits of a piece of infrastructure, manage the risks involved, and ensure that the infrastructure is satisfying the public. Good asset management takes a long-term perspective by helping governments get the most out of infrastructure and spotting opportunities for renewal early.

While many public assets are projects such as roads and bridges, public sector entities are also involved in the construction of public buildings. Provinces own office buildings, hospitals and transit stations; municipalities own town halls, courthouses, fire halls and libraries; police departments own headquarters and detachments; school boards own schools and administrative buildings; universities and colleges own many buildings not only on campuses, but throughout the community. Public buildings are important assets which the public sector must manage.

Taxpayers expect governments to invest responsibly. Smart asset management, with an eye towards longevity, can help to meet that objective.

Infrastructure should be built to last for at least 50 to 75 years

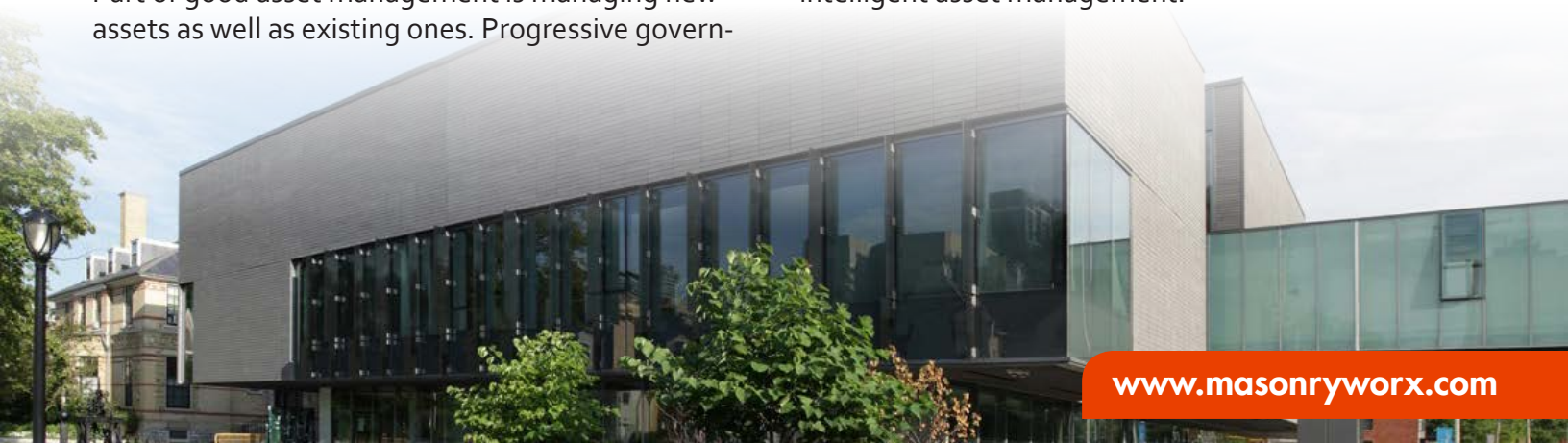
On its own, the up-front cost of an asset does not tell the whole story. Will the asset require maintenance over its lifetime? Will the up-front expense be justified by lower maintenance requirements in the future? This consideration of lifecycle costs can show that paying more upfront for infrastructure is the right investment because that will reduce costs overall over the lifecycle of the asset.

Part of good asset management is managing new assets as well as existing ones. Progressive governments and public agencies must consider how to build smart assets which stand the test of time. A smart asset is one which provides excellent service at low cost over time, and which can be put to other uses even late in its life, if necessary.

A proactive approach to maintaining a public building is to build it out of something that does not require extensive maintenance, will not require replacement for multiple decades and will not deteriorate when exposed to weather or urban conditions. Some exterior building materials, by contrast, are susceptible to weather damage, while some interior ones are vulnerable to fire, mould and other hazards. The cost of building with cheap materials to save money at the outset is higher maintenance costs down the road.

Masonry is cost-effective in terms of up-front expenditure. An analysis based on a low-rise model building found that facing the exterior of the building entirely in brick costs less than it would to cover an entire building in EIFS. Where masonry truly saves in comparison to other building materials is that brick, stone and block, internal and external, do not weather rapidly, do not suffer hail or wind damage, and can last a lifetime without the need for major maintenance.

Masonry products are resilient against climate change. They are low-maintenance materials which can last a century or more. Masonry buildings are excellent candidates for adaptive reuse. Building with masonry satisfies many of the key requirements of intelligent asset management.



Carbon **Sequestration**

Public institutions are expected, now more than ever, to contribute to Ontario and Canada's fight against climate change by reining in carbon emissions.

The masonry sector has been working to do its part to fight climate change.

Carbon sequestration technology, such as Carboclave and CarbonCure, removes CO_2 emissions from the atmosphere by trapping them permanently inside concrete blocks. CO_2 is captured from local industrial suppliers across the country, purified and liquefied, then injected into wet concrete during the mixing process. Once there, the CO_2 is chemically converted back into limestone and becomes permanently locked within the concrete block, never to be released into the atmosphere.

Utilizing carbon sequestration ensures that carbon can be locked up permanently within a concrete block. Blocks manufactured with carbon sequestration technology may also be eligible to contribute LEED points when used in a building.

Concrete is one of the few materials in the world with the capacity to utilize carbon to both its own benefit and the benefit of the environment. Estimates suggest that concrete curing can provide noteworthy CO_2 reductions - 30 million to 300 million tonnes per year. By 2030, the carbon-based products sector could consume seven billion metric tonnes of carbon per year by 2030.

Concrete block is more sustainable today than ever. Building with block, inside and outside the building, builds the sustainable structures of tomorrow.

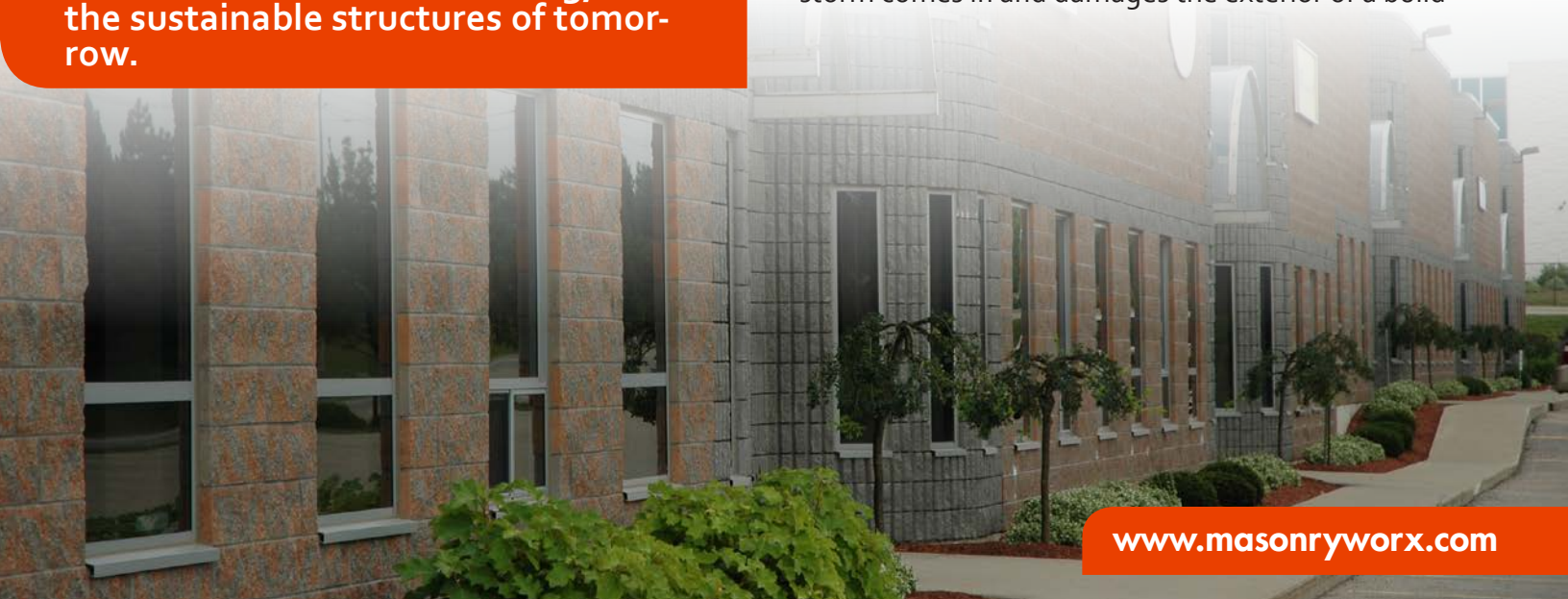
Resisting **Climate Change**

Climate change is increasingly being recognized as a major threat public infrastructure will have to face. Resilient, long-lasting infrastructure must take into account the increased number of inclement weather events Ontario will face as the years progress.

The United States Global Research Program identifies a number of visible impacts of climate change. These include heat waves, droughts and heavy downpours. Canada's insurance industry, through its Actuaries Climate Index, also identifies that the nation is getting wetter: In Ontario, the average number of days with heavy rain or snow has been outside the norm since 2008. Studies have also shown that Canada is likely to experience more wind gusts, especially late this century, than has been historically expected. This makes it imperative to plan for the implications of an Ontario climate which is windier, stormier and hotter than it has ever been.

The concept of climate resilience is not a new one, and speaks to important factors such as ensuring the systems in place within a community are sufficient to withstand and rebound from extreme climatic events. However, the concept of infrastructure resilience also extends to building stock. The buildings of tomorrow must have the capacity to withstand the extreme weather events associated with climate change.

The importance of materiality is as important for public bodies as it is for Ontario homes. Any time a storm comes in and damages the exterior of a build-



ing, it is public funds which must go towards repairing the damage. Intelligent asset management would instead favour simply building with materials which are not prone to wind, fire and hail damage.

Reducing energy consumption is also a vital concern when it comes to mitigating climate change.

While glass is a quick and inexpensive building material, it is associated with higher energy usage than other materials. Multi-unit residential buildings with high thermal transmittance envelopes, such as glass, require HVAC systems with up to 50% more capacity.

The amount of **carbon sequestered** in all the **block** sold in Canada over the past decade is equivalent to taking **159,702 cars off the road** and **80,229 homes off the grid**

Masonry materials, by contrast, have excellent thermal mass properties, helping to regulate temperatures in summer and winter. Brick, block and stone are low-maintenance materials and ideal for resilience against extreme weather events. Accordingly, masonry materials are favoured by many Ontario municipalities in their Urban Design Guidelines.

A recent study found that energy savings of 15% can be achieved in residential high-rises by instead changing the window-to- wall configuration to include a combination of masonry and glass. For office towers, savings of 10% can be achieved.

If builders of public buildings are serious about addressing their carbon footprints and creating infrastructure in a sustainable, environmentally-conscious manner, the way buildings are designed must be changed. This means building both the structure and exterior of new buildings with more sustainable material, such as masonry, and reducing the prevalence of buildings with expensive energy costs and demands.

Structural **Concrete Block**

Building a long-lasting asset requires a comprehensive approach, considering the life cycle of all building elements. Beyond considering the exterior, it is very important to choose building materials for the interior structure which are resilient, durable and capable of going for years without incurring major maintenance costs.

In all of these respects, from an asset management standpoint, concrete block remains the ideal building material for structural construction.

Masonry and Math:
A Sample Lifecycle Cost Assessment

For a sample building in Toronto, with an assumed **50-year lifespan**:

The total life cycle cost of building with **concrete block walls** will cost

$634,692

over the life of the building

Building it with wood walls will cost

$1,400,275

Building with masonry today means **saving money tomorrow**

In Ontario, public buildings were traditionally built with structural components based around concrete block, and many buildings with such a structure remain in use to this day. In subsequent years, the concrete block sector has continued to modernize, adopting sustainable technologies such as CarbonCure.

As with exterior building materials, internal structural elements should be assessed based on lifecycle cost assessment. That assessment should take into account more than the up-front costs of the building materials involved. It must weigh the cost of maintenance and replacement of those materials, it must consider the lifespan of the materials against that of the building, and it must consider the cost of repair should the material be compromised or lost. This calculus leads to a need for a durable building material which resists damage and is immune to as many environmental factors as possible.

With masonry construction, load-bearing block eliminates the cost of a building frame because the structure itself is also the enclosing wall. Further, a structural wall designed with concrete block is also a fireproof surface, provides significant mass for maintaining temperature, provides stability and is highly resistant to infiltration. Masonry also contributes to internal air quality in that it does not collect mould, as other internal building materials might.

In terms of risk-avoidance, masonry is particularly notable in that concrete block doesn't burn. The Province of Ontario already recognizes this in the Ontario Building Code: Two-hour (or less) firewalls must, under the current Code, be constructed only of masonry or concrete when they separate buildings, in buildings with floor areas including care or detention centres, and in buildings higher than four storeys. A well, all firewalls not built with masonry must meet the standard of masonry and concrete. In the event of a fire, a block wall will continue to carry loads long after its established fire-resistance rating period has been reached.

The use of structural concrete block may also contribute to reducing the amount of insurance which must be paid on public buildings. Both the Insurance Bureau of Canada and the Fire Fighters Association of Ontario caution that owners of flammable buildings may face higher insurance costs.

At present, commonly-used drywall and wood-frame structural systems currently receive "acceptable" ratings in industry laboratory testing. However, these materials tend to burn faster in reality than lab testing implies. By the time staff are able to move tenants of a public building to safety, these materials may already be ablaze. The widespread use of lightweight oil-based and synthetic materials also adds to the problem of modern buildings being at times more flammable than those built with traditional concrete masonry.

A sample 50,000-square-foot building built with **block** sequesters carbon equal to taking **30 cars** off the road for a year or taking **15.1 homes** off the grid for a year

Beyond structural factors, concrete block can contribute to reducing a building's carbon footprint through carbon sequestration and carbon-capture technologies. Concrete block is known to be a CO_2 sink, absorbing carbon dioxide over its life - and the longer the block remains in use, the better its carbon footprint.

For reasons of longevity, permanence, sustainability and risk avoidance, wise planners and engineers should make use of concrete block as the key structural element in new public buildings. It can play a key role in the asset management process involved in building the resilient, long-lasting buildings of tomorrow.

Why **Masonry?**

Brick, stone and block have a number of advantages which can help public entities satisfy the need for smart, long-lasting infrastructure.

- **Masonry has favourable lifecycle costing,** owing to very high endurance and very low maintenance requirements.
- **Masonry is long-lasting and low-maintenance.** Brick, stone and block can last for a century or more without needing to be replaced. Its long lifecycle leads to cost savings over time.
- **Masonry is non-combustible,** does not attract mould and cannot be preyed upon by natural pests such as termites. It will not rust, rot or burn.
- **Masonry is resilient,** with the physical solidity to withstand the extreme weather events and temperature variations associated with climate change.
- **Masonry is reusable.** Masonry infrastructure assets are excellent candidates for adaptive reuse, ensuring the assets remain useful even if their initial function changes.
- **Masonry is a strong local Ontario industry** which contributes thousands of jobs and more than a billion dollars to the economy.

The **masonry** industry contributes approximately **$1.3 billion** to Ontario's economy

Masonry and the **Economy**

In Ontario, masonry is a local material and a part of our cultural heritage.

The majority of Ontario's oldest surviving heritage buildings are masonry buildings. Throughout Ontario, in communities of all sizes, one can find examples of city halls, courthouses and libraries built in the 1800s but still in use. Today Ontario continues to produce high-quality masonry, with enormous quantities of brick and stone being produced in the highly-populous Greater Toronto and Hamilton Area.

A number of Ontario cities are important in Canada's masonry sector. Masonry producers in Burlington, for instance, produce 55% of all the clay brick manufactured in Canada, much of it manufactured from high-quality Queenston shale excavated right here in Ontario. Large quantities of brick and block (both structural and architectural) are also produced in Brampton as well as other municipalities.

A recent market analysis found that the masonry sector in Ontario supports upwards of 14,000 jobs and contributes $1.3 billion to Ontario's economy.

Community **Benefits**

Ontario is the first jurisdiction in Canada to pass legislation to enable the consideration of community benefits in infrastructure planning and investment. These are defined as the "supplementary social and economic benefits" which may arise from an infrastructure project, including local job creation and training opportunities, improvement of public space, or other, similar benefits.

Supporting local jobs is an undeniable economic benefit. When Ontario's economy does well, Ontarians prosper. Building with Ontario masonry products ensures that the fruits of Ontarians' labour are being put to use to meet our needs within our own province.

Building with a locally sourced and manufactured product also has environmental benefits. Part of the calculus for determining what emissions a product gives off includes understanding how far it is transported from its place of origin to the job site. By building with local masonry, transportation emissions are reduced. The bricks do not have to travel nearly as far before they go into a building.

Building with local masonry is not only a smart Ontario decision, it is a sustainable environmental solution.

93% of Ontarians want to support **Ontario industries** wherever possible

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Model **Policies**

Progressive public-sector bodies must take a long-term, asset management-centred view of their built infrastructure by ensuring that new public buildings are built to a highly resilient, low-maintenance standard. It is vital for public buildings to utilize high-durability, low-maintenance, aesthetically-pleasing materials which will stand the test of time and contribute to local economies and character.

To achieve these goals, the following policies are recommended:

- Approach all new building-based infrastructure with an long-term asset-management mindset. Design new public buildings with a lifespan of no less than 50 to 75 years.
- Incorporate lifecycle costing for all building elements of new public buildings, including exterior building materials.
- Building materials should be chosen for their lifecycle costs, ease of maintenance and resilience against extreme weather events.
- Structural building materials should be chosen for their durability, longevity, sustainability and lifecycle cost advantages. Use concrete block as the preferred material for structural elements.
- Site designs that conserve energy will be encouraged. Encourage the incorporation of masonry materials into the upper levels of taller buildings to ensure less load is placed on HVAC systems.
- Exterior building materials should be of the highest design quality. Materials utilized for street-facing facades should be carried around the building to ensure a consistent level of resilience throughout the building envelope.
- Exterior building materials should be chosen for their functional and aesthetic quality. Use brick, stone and architectural block as the primary cladding materials for new buildings.
- Prioritize locally-sourced, resilient natural building materials such as masonry, which do not have to be trucked far beyond their origin. Through these policies, a reduction in transportation-related carbon emissions may be realized, while also supporting local economies.
- Prioritize the use of building materials which satisfy community benefits legislation, demonstrating supplemental social and economic benefits such as supporting Ontario's industry and sustaining local jobs.