cross sections

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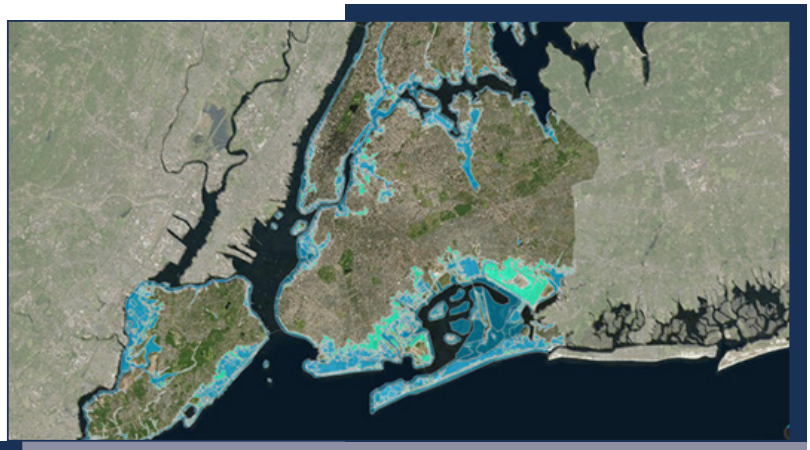

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PRESIDENT'S MESSAGE

YUNLU (LULU) SHEN, PE

Some may think that Structural Engineering has reached its peak. Humans have been building for thousands of years. Major construction materials like wood, masonry, concrete, and steel (iron) have been in use for centuries. Even skyscrapers have been around for almost 150 years. What else could be new?

The answer, as presented at our Annual Conference on February 8th, is "a lot". In the US, standardization of material properties and sections only began in the early 1900s and did not reach convergence until the middle of the century. Analysis and design methods supported by test data were only developed in the last few decades.

What struck me the most is how recently we have started to understand the loads imposed on our structures. "Accuracy in stress calculation is defeated because of the ignorance of loads causing stress", as our keynote speaker Professor Lou Geschwindner quoted from Minimum Live Loads Allowable for use in Design of Buildings, a 1924 report of the Building Code Committee of the US Department of Commerce. We saw significant changes to wind and seismic loads and load factors in recent years, as ASCE tried to establish more uniformity in return periods and probability of collapse across the country. Seismic loads are still being adjusted - Mr. Konstantinos Syngros (Associate, Langan Engineering) noted the significant increase in NYC ground motion in the most recent USGS National Seismic Hazard Model. Guidance is also being provided in the latest ASCE for new load types, some of which have gained increased intensity and prominence in recent years due to the effects of climate change. Ms. Jessica Mandrick (Partner, GMS) presented the new and markedly expanded ASCE 7-22 supplement 2 on Flood loads.

Although our profession has a long history of structural ingenuity, to consistently produce safe and reliable designs at a large scale is a relatively recent achievement, and one that is still on-going.

We are at an exciting time in our field. We are armed with a more in-depth understanding of materials and loads, and we have tools that can help optimize for cost and sustainability. We are increasing the available strength of materials like steel, concrete, and rebar, and expanding design possibilities of wood through the use of mass timber.

However, in an age with increasing capabilities of software and Artificial Intelligence, it is our understanding of design principles and enthusiasm for problem-solving, rather than the prescriptive use of equations, that enhance our value as Structural Engineers.

EDITOR'S MESSAGE

RIYA MANIAR, E.I.T.

The industry of structural engineering is constantly evolving. In the noteworthy book The Death and Life of Great American Cities by Jane Jacobs, the idea that the city is a living breathing entity, encompassed by the people, places and structures we are surrounded by, is explored while also talking about how these components lead to change. We often think of structural engineering as designing the bones of a structure, but in this context of a living city, we go beyond just the bones. In this context, we as structural engineers are the key mastermind behind the lungs, the veins, and even the heart of the city we live and progress in.

It makes sense in this way that our field is also constantly evolving as new challenges and technologies arise. This issue of cross sections explores both of these catalysts of change in our industry. Unleashing the Power of Ground Glass Pozzolans talks about the ground glass pozzolans in concrete and the performance and green impact of this emerging technology. The Evolution of NYC's Flood Hazard Maps, an article from our very own resilience committee, speaks on the development of flood maps and how climate change consequences have demanded a change in the way we design for disasters.

Riya Maniar, EIT

UNLEASHING THE POWER OF GROUND GLASS POZZOLANS:

INTEGRATING RECYCLED GLASS INTO HIGH-PERFORMING, LOW CARBON CONCRETE FOR SUSTAINABLE CONSTRUCTION

BY PATRICK A. GRASSO
PRINCIPAL
URBAN MINING INDUSTRIES

BY DENISE GRASSO
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INTRODUCTION

Concrete is the most widely used construction material globally, and the production of its key component, cement, contributes to about 7% of all global carbon emissions. This is a result of the energy-intensive manufacturing process involved. The growing demand for high-performance, low-carbon solutions stems from multiple forces at play. Building and construction contribute a significant portion of global carbon emissions and now with stricter carbon emission targets. New York State Executive Orders #22 and #23 are clear examples of such increasing pressure.

Aligning with global efforts to achieve carbon neutrality, the construction industry is undergoing a transformational shift toward adopting low-carbon materials and practices. Materials such as Ground Glass Pozzolans ("GGP") have emerged as important, new solutions that help lower the built environment's carbon footprint while improving structural integrity. Ground Glass Pozzolan is a revolutionary cement replacement made from 100% recycled glass. When used in concrete, it yields a higher performing "green" concrete that signifies higher performance at no additional cost. After a four-year effort involving well over 100 academic and industry leaders, spearheaded by Amanda Kaminsky, a national industry leader in sustainability, the new "ASTM C1866 Standard Specification for Ground-Glass Pozzolan for Use in Concrete" was published in April 2020, making it much easier for A&E firms to specify the material in concrete with a clear standard for its use.

Achieving Green Building Certifications and fostering a positive image among various stakeholders enhances a project's market competitiveness. Buildings and infrastructure built with high-performance concrete offer superior energy efficiency in several different ways. The thermal properties of concrete improve insulation, reducing the need for heating and cooling. Concrete batched with GGPs also creates a lighter colored finish which helps reduce the Heat Island Effect caused by darker impervious surfaces in our urban areas. These energy efficiencies reduce carbon emissions throughout structure and infrastructure lifecycles. Using regionally harvested, post-consumer material, such as recycled glass, further contributes to LEED and Envision Certification category budgets.

Incorporating high-performance materials with low embodied carbon also creates resilient structures that can withstand environmental challenges, natural disasters, and daily use deterioration. The use of GGPs minimize the need for frequent maintenance, repair, and reconstruction, reducing the longer-term replacement costs and thus environmental impact of construction projects.

The diminishing supply of other Supplemental Cementitious Materials ("SCMs") used to reduce CO2 in concrete, such as fly ash and slag, is also driving the need to find alternatives. The availability of fly ash, the post-industrial byproduct of coal-burning plants, is declining as we continue to close or convert coal-burning plants to natural gas. The fly ash that is available is also of variable quality as suppliers reclaim and process previously land-filled ash. Slag is the byproduct of basic oxygen furnaces used in steel manufacturing and, as those plants move to more modern and efficient electric arc furnaces, the supply of usable slag is also declining. So, while the demand to reduce the carbon footprint of concrete is increasing, the two primary SCMs that have historically been used to achieve these goals are in diminishing supply.

The 1,388-foot, 60-story skyscraper will be New York City's largest all-electric tower with net zero operational emissions. JPMorgan Chase New Global Headquarters Building New York City. Rendering by Foster + Partners

As a new, sustainable construction material, GGPs offer an available, renewable, and higher performing alternative to the industry. While in commercial use now at 20-40% cement replacement levels, GGPs can replace up to 50% of cement in concrete, reducing embodied CO2 emissions from the cement they replace on a nearly ton-for-ton basis. Even higher replacements can be achieved when used in ternary blends. Because concrete is the most abundant construction material in the world, the potential beneficial environmental impact of using GGPs in concrete is dramatic. Not only do GGPs reduce harmful greenhouse gasses, but they also produce a more durable, longer-lasting, and higher-performing concrete that significantly improves resistance to chloride penetration, sulfate attack, efflorescence, and freeze-thaw cycles. The consistently high percentage of silicon dioxide in bottle glass (+/-71%) is what makes GGP a high-performance SCM. The hydration process of the cement in a concrete mix creates a number of compounds including Calcium Silicate Hydrate ("CSH") and Calcium Hydroxide ("CH"). The CSH is the binder that gives concrete strength, but the CH only weakens the concrete and causes porosity. What makes GGP impart such high-performance characteristics to the concrete is that the silica atoms from glass react with the deleterious CH to create even more beneficial CSH, making the concrete stronger and more durable. These qualities have the potential to be especially beneficial in our nation's transportation infrastructure. Potential improved strength and lifespan of concrete structures means lower long-term replacement costs.

GGPs also mitigates a critical recycling problem: the abundance of unused post-consumer glass that chokes regional recycling streams and takes up valuable landfill space. Currently, glass bottle and fiberglass manufacturers repurpose less than one-third of our nation's post-consumer glass due to size, color, and condition complications alongside costly transportation methods. Repurposing glass as a SCM is helping to address this glass crisis as GGP can utilize virtually 100% of recycled glass, regardless of color, size, presence of ceramics or cleanliness.

A BETTER CLIMATE AND ENVIRONMENTAL SOLUTION FOR BOTH CONCRETE AND GGPS

With sustainability at its core, the use of GGP reduces the environmental impact of construction by repurposing post-consumer glass waste and ceramics regardless of their color or size. Its patented, low energy-intensive manufacturing process, versus that of cement, reduces CO2 emissions by about 95% of the cement it replaces in a mix. While cement may only make up about 15-20% by weight of a yard of concrete, it accounts for about 80% of the carbon footprint of that concrete. So, by replacing 50% of cement with GGP, the overall carbon footprint of concrete can be reduced by over 40%.

Using GGP in concrete offers other environmental benefits as well. When thoroughly cleaned and finely ground, mixed colored glass becomes a bright white material. As such, it can be used not only as a white cement replacement, but it can also brighten a gray cement mix. A brighter concrete finish is better at reducing the Heat Island Effect in our urban centers and helps reduce lighting demands in our parking garages and streets.

The concept of a circular economy is paramount to finding a cost-effective, large-scale sustainable solution for unwanted post-consumer recycled glass. UMI is taking local glass from both NY and CT at its new plant that serves the greater NYC metro market. Louis Grasso, Co-Managing Member at UMI said, "Bringing this innovation to our region creates a perfect

DeCicco & Sons Markets Image by studio rai

circular economy: we harvest and process virtually 100% of our recycled glass, and use it in local, sustainable building projects, while also reducing transportation emissions and costly landfill space. It's good business done while being good environmental stewards!" Integrating recycled glass into various concrete-based materials not only diverts it from landfills but also reduces the need for virgin-minded materials, thus promoting an eco-friendly and resource-efficient approach to construction.

1 Jave Street rendering Image by Lendlease

From a climate perspective, the best thing that we can do with glass is to use it as a cement replacement. Repurposing recycled glass into new bottles or fiberglass requires melting the glass at extremely high temperatures compared to the low energy GGP production process. Oregon's Department of Environmental Quality estimates that using glass in concrete is five times more impactful in reducing greenhouse gasses than putting it back to either bottles or fiberglass, regardless of the number of cycles considered.

REAL WORLD COMMERCIAL APPLICATIONS

Pozzotive® is an example of a Ground-Glass Pozzolan that has already been used in well over 250,000 cubic yards of cast-in-place concrete, more than 12 million structural and architectural concrete masonry units, 750,000 square feet of pavers, and 500,000 square feet of prestressed concrete planks in projects around the NYC area, such as the UN Plaza, Whole Foods in Brooklyn, and the new Second Avenue Subway stations throughout New York City.

Going back as far as 2010, entire multi-story housing projects such as The Hegman Residence, Via Verde and Navy Green were built with Pozzotive® in both their structural block walls and pre-cast concrete planking. NYC DOT and DDC, in conjunction with CCNY, have successfully tested the material in two entire city blocks of sidewalk pours. Now, both the NYC and NYS DOT, along with other agencies, have the material on their approved lists for use.

Additional examples demonstrating the viability of the material for use in large-scale, structural applications across Metro New York and beyond include:

Hallett's Point, Queens: The Durst Organization was among the first to incorporate pilot testing of Pozzotive® in the various structural elements of the first phase of this high-rise residential complex in Queens, NY. Expanding its use into the second tower, 25% of the cement in the entire foundation and 4-story pedestal base of the second phase were replaced with Pozzotive®.

Hallets Point

Image by The Durst Organization / Dattner Architects

JP Morgan Chase's new 2.2 million SF Global Headquarters at 270 Park Avenue is an engineering marvel and a prime example of how industry leaders are embracing sustainability and innovation. Specified for use by Fortunato Orlando of Severud Associates, the project incorporated a 40% replacement of its cement with Pozzotive® GGP in all of its building floor slabs. The material is also being incorporated into all the project's concrete block.

Along the waterfront of Greenpoint in Brooklyn, Lendlease is building *1 Java Street,* New York's largest geothermal mixed-use residential development with over 800 residential rental units, 30% of which are affordable. Pozzotive® GGP is replacing 40% of the cement in the project's foundation concrete, reducing chloride permeability and thereby improving durability.

DeCicco & Sons, a high-end regional grocery chain, is incorporating a 40% replacement in the over 1,500 yards of concrete used to build Edge on the Hudson, a state-of-the-art food store in nearby Tarrytown, NY. Much of the recycled glass used is locally sourced from the project's neighboring communities throughout Westchester County.

Newly built public sector projects with Pozzotive® in their concrete include *New Canaan Library, Ox Ridge Elementary School in Darien, Torrington High School and the Western HQ of CT's Department of Energy and Environmental Protection.*

From its CT plant, UMI is also seeding future new markets including the metro DC area. Here, two high-rise concrete towers are showcasing how a ternary blend of Pozzotive® and Slag can easily reduce the cement used in high-performance concrete by 50%.

1133 North Capitol Street NE stands as a shining example of how Pozzotive® GGP is making its early mark in the heart of the nation's capital and for use elsewhere in post-tensioned structural slabs. This 900-unit mixed-use project is using about 20,000 yards of concrete. Fully half of the cement is being replaced with a 50/50 Pozzotive®/slag blend used to create mix designs between 2,500 and 10,000 psi.

The Langston, a 12,000-yard high-rise project at Howard University, exemplifies the synergy between good climate design and higher education. Again, a ternary blend of 25% Pozzotive/25% Slag/50% Cement was employed in the construction process to achieve mix designs varying from 2,500 to 12,000 psi.

In a world where sustainability is paramount, the innovation, and environmental solutions that GGPs offer are a beacon of hope, offering structural engineers yet another path to create resilient and environmentally responsible projects without sacrificing performance. As we embrace the principles of sustainable construction, the integration of GGPs is a significant step towards a greener and more resilient future for structural design and the built environment.

COMMUNITY ENGAGEMENT, EDUCATION AND POLICY SUPPORT

Educating and engaging with community stakeholders who understand our recycling challenges and the need for sustainable development fosters a sense of collective responsibility, heightened environmental awareness and stewardship and support for innovative circular economic efforts. Repurposing and specifying previously unwanted, locally sourced, post-consumer waste glass in our local commercial and institutional building infrastructure projects is an ideal example that will clearly contribute to reducing material waste while enhancing performance, durability, and overall sustainability goals.

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THE EVOLUTION OF NYC'S FLOOD HAZARD MAPS

STRIVING TO MITIGATE FLOOD RISK: NYC'S TOOLS FOR RESILIENT DESIGN

BY ANA GALLEGO
PE

When Hurricane Sandy approached the coast of New York in October 2012, the Flood Insurance Rate Maps (FIRMs) in effect had been last updated by FEMA's National Insurance Flood Program (NFIP) in 2007.

Before Hurricane Sandy, the NFIP was in the process of redrawing outdated flood maps to reflect the full risk of flood damage to structures within the floodplain. These new Preliminary Flood Insurance Rate Maps (PFIRMs) released between 2013 and 2015 revealed an expanded floodplain in New York City that included twice as many structures in the high-risk zones as previous maps, nearly doubling the number of properties required to purchase flood insurance. The new flood maps also increased the height that the flood waters would likely reach in the '100-year' (1% chance of annual exceedance) flood by an average of 2 feet, with increases of more than 4 feet in some areas. These increases would have had a direct impact on insurance premiums which, at the time, were based on the Base Flood Elevation (BFE) relative to a structure's first occupied floor.

The revised PFIRMs were expected to go into effect in 2015 after review by an engineering team hired by the City of New York (the City). Instead, on June 26, 2015, the City filed an appeal stating that there were errors in FEMA's storm surge and offshore wave models that resulted in an overestimation of the 100-year storm floodplain and the height of the BFEs by more than 2 feet in some areas. This would have affected insurance premiums for thousands of structures.

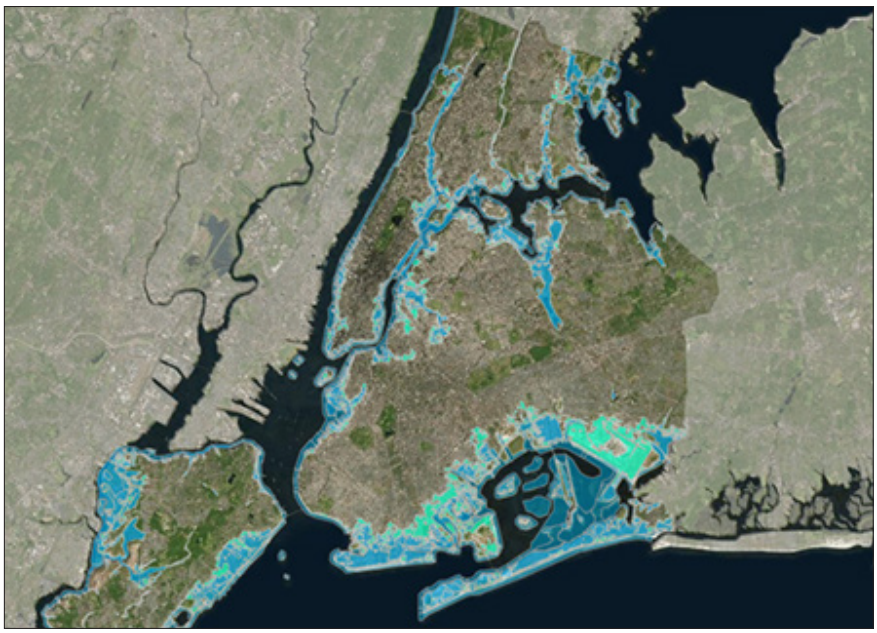

FIGURE 1: NYC FLOOD HAZARD PLANNER [https://www.nyc.gov/site/planning/data-maps/flood-hazard-mapper.page]

On October 17, 2016, the City and FEMA announced that they had reached an agreement to revise the New York City flood maps and provide more accurate flood hazard data for other coastal communities in New Jersey (Atlantic, Bergen, Burlington, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean, and Union counties) and New York State (Westchester County). These areas are covered by the Region II Coastal Restudy by FEMA.

Both the 2015 PFIRMs and 2007 FIRMs will be replaced for insurance and building code purposes following the creation and adoption of new flood maps. These maps are expected to be completed in July 2025.

The New York City Building Code (NYCBC) contains minimum flood

design requirements that have critical implications on building projects, most notably the recently updated Appendix G, "Flood-Resistant Construction." Until new flood maps are issued, the NYCBC will continue to reflect the most stringent design conditions between the 2015 PFIRMs and the 2007 Effective FIRMs.

The 2022 NYCBC went into effect on November 7, 2022 and introduced updates to Appendix G including enhanced design requirements that exceed those of the NFIP and the International Building Code. NYCBC's Appendix G regulates construction for both new and existing buildings in mapped flood hazard areas.

Since Congress requires that FIRMs reflect current hazards for insurance purposes, FEMA FIRMs do not include forecasted hazards for planning and building purposes . However, in an effort to encourage resilient design that includes future flood risks, the City published the Climate Resiliency Design Guidelines (CRDG-4) in May 2022. CDRG-4 incorporates the climate change projections from the New York City Panel on Climate Change (NPCC) and is intended to supplement the historic climate data that informs the building code. Similarly, FEMA is in the process of developing advanced interactive flood maps that help designers to better quantify local hazards and the possible range of future conditions.

It is likely that with the projected effects of relative sea-level change on future flood events and the inherent uncertainty of those projections, building codes and design standards will continue to revise and enhance design requirements for flood hazard areas.

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