Frequently Asked Questions

Key Sustainability Benefits of Post-Tensioned Concrete

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The sustainable business model focuses on what is known as the "triple bottom line" where three factors—environmental, economic, and social—are included in business decisions. While we often hear about the "green movement," the typical thought process is often limited to environmental factors only. True sustainability is much more. The post-tensioning industry has long been working toward structural efficiency and economy—concepts that form the core of why post-tensioned (PT) concrete is a truly sustainable structural framing solution. In this FAQ, the key benefits that PT concrete can provide toward more sustainable structures are discussed. For simplicity, the focus of the discussion is on commercial buildings, but can also be applied to almost any concrete structure.

It is a difficult question when determining the relative sustainability of a system is finding a baseline model for comparison. Are comparisons between precast concrete, cast-in-place concrete, structural steel, reinforced (nonprestressed) concrete, PT concrete, wood, or other systems appropriate? The fact is that there isn't truly a single baseline structure as sustainability incorporates all facets of design, construction, operation, maintenance, repair, and demolition—all that is cradle-to-grave (or cradle-to-cradle when considering the recycling and/or reuse of a building). Different approaches during the life of a building can have a large impact on major components such as energy use. However, building materials such as concrete and PT concrete are very well positioned to provide sustainable features that go well beyond the material itself, including sustainability benefits in falsework and construction time which reduce the overall carbon footprint.

Q What are the biggest benefits of concrete in general?

A Before specifically focusing on PT concrete construction, it is important to note some key benefits that concrete as a material can provide to building structures. A sampling of the major benefits is as follows:

THERMAL MASS AND ASSOCIATED ENERGY REDUCTIONS

In many climates, high mass coupled with the slow heat transfer properties of concrete can reduce heating and cooling energy needs that often result in smaller HVAC equipment requirements. High thermal mass reduces the effect of outside temperature spikes within a building and also delays peak inside temperatures to off-peak heating/cooling hours. However, the true benefits of thermal mass are maximized when coupled with optimal amounts of insulation and building orientation.

LONGEVITY/DURABILITY

Concrete has a long-established track record for providing durable and long-lasting structures. The alkaline concrete environment is effective in protecting reinforcing steel from corrosion, particularly in high-quality concrete with limited cracking.

RESILIENCE

Extreme events (manmade or naturally occurring) such as hurricanes, fire, terrorist attacks, and earthquakes can render a structure useless in a very short period of time—which is directly counter to the many goals of sustainable design. When properly designed, concrete has excellent and proven performance under these types of events.

ECONOMY

Concrete has long been a viable and economical framing solution that can be modified to decrease its overall environmental impact (such as with the use of industrial by-products) that do not necessarily increase construction cost; often times, such modifications can result in lowered initial cost.

USE OF RECYCLED MATERIALS AND INDUSTRIAL BY-PRODUCTS

Concrete mixtures have long used industrial by-products (such as fly ash, silica fume, slag) for their ability to enhance performance. The use of by-products plays an important environmental role by diverting them from landfills. Additionally, concrete structures at the end of their useful life can be recycled as crushed aggregate, as well as for recycling of reinforcing steel.

REDUCTION OF INTERIOR COVERINGS

Concrete can be used directly (without drywall, paint or, carpet) as a desirable interior surface with minimal or no additional treatment for both interior and exterior applications. The lack of finishes also means a reduction in production, installation, maintenance, repair, and eventual replacement of additional materials that in some cases can negatively impact indoor air quality.

SOUND INSULATION

Concrete has good sound-reflection properties that can be very effective in reducing noise transmission through walls and floors. This is particularly desirable in multi-family housing, hotels, and certain office and retail spaces.

Q What benefits does PT offer above standard concrete benefits?

A PT concrete can enhance the level of benefit from some of the items previously mentioned in addition to others:

REDUCTION OF MATERIAL USAGE AND REDUCTION IN CARBON FOOTPRINT

Reduction of material usage comes as the most preferred of the "reduce, reuse, recycle" choices. While recycling is often mentioned at the top of the list of environmentally friendly practices, it is even more sustainable to reuse materials directly. But instead of material reuse, it is far better to minimize material usage in the first place.

PT excels in reducing concrete volume. The precompression and load-balancing effects provided by PT in concrete members allow for longer spans with thinner structural members so that structural efficiency is maximized. This efficiency has a compounding benefit throughout the structural frame by reducing the overall self-weight transferred to columns, walls, and foundations and thus decreasing material requirements. Hence, the carbon footprint is minimized through a reduced amount of cement, lighter loads and fewer transportation trips. This also has an impact on the social aspect of sustainability by reducing traffic congestion and disruptions to the surrounding neighborhoods during construction.

In addition to reductions in reinforcement requirements that are directly related to more efficient member sections, PT also decreases nonprestressed reinforcement quantities and, in some cases, heavy reinforcement congestion. The reduced reinforcement congestion also means fewer onsite labor requirements for installation.

SEISMIC LOADS

Structures located in high seismic zones have the added benefit of reduced mass, which directly translates into decreased lateral loads in seismic force-resisting elements. This yields reduced material demands in both vertical and horizontal framing systems.

REDUCED FLOOR-TO-FLOOR HEIGHT

In specific applications, due to thinner slabs, typical building floor-to-floor heights can be minimized with corresponding reductions in both structural and non-structural material requirements. Reductions may be seen in piping for mechanical, electrical, plumbing, fire protection, curtain wall and masonry façade areas, concrete columns and shear walls, construction cranes and lifting time, interior finish use, freight, construction labor, and overall construction duration. A shorter building and/or smaller interior air volume to heat and cool can limit energy needs, quite significantly in some cases. In tall buildings, floor height reductions can also contribute to minimizing evacuation times for upper floors with additional indirect cost savings in vertical transportation systems (elevators and stairs), exterior cladding systems, and excavation requirements for below-grade levels.

LONGEVITY/DURABILITY

Concrete structures in general have excellent durability and longevity. Modern PT, in particular, was first used in buildings in the 1950's.[1] PT construction further improves this as structural members are generally designed to limit cracking under service loads. Uncracked members or members with limited cracking and high-quality concrete have outstanding durability characteristics as they limit the corrosion potential of reinforcement when exposed to corrosive elements. The active PT force also helps minimize overall deflections. In general, PT concrete construction has lower initial and maintenance costs.

REPAIR AND RETROFIT

The ability to provide active forces for strengthening enables structural repair to not only increase member capacity, but also reduce deflections and oftentimes close or reduce existing cracks/crack widths.

External PT is particularly well-suited for repair due to its relatively easy installation, access for monitoring future adjustments, and speed of construction.

It is apparent that each of the above factors can contribute to sustainability on the social, environmental, and financial levels. With no doubt, PT concrete has a major role in providing a sustainable building option. As an industry, PT construction is in a particularly enviable spot for the future of sustainable structures. We should continue educating the design and building industry of the contributions post-tensioned concrete structures lend to sustainable construction.

REFERENCE

1. PTI TAB.1-06, *Post-Tensioning Manual*, sixth edition, Post-Tensioning Institute, Farmington Hills, MI 2006, 354 pp.

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