6D-BuildTech Systems

Multistory Considerations

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One of the first questions that builders and developers typically ask about 6D-BuildTech is "how high can we go?" Although it would be satisfying to respond with a simple number of stories as a height limit, the real answer is that there is no hard limit to the height of a 6D-BuildTech structure. An assembly of 6D-BuildTech building blocks can be engineered to build a structure of virtually any height.

Factors that influence the design, construction, and cost effectiveness of tall 6D-BuildTech structures are the same as those that dictate the design of other types of structures. These include:

- **Plan geometry of building**: A tall, narrow building will generate much higher structural stresses due to lateral forces than a similar building with a wider base.
- **Gravity loads**: The live and dead loads that are carried by a structure have an obvious impact on the stresses that control structural design. A retail structure generates higher forces than an office building, and a residential tower can be designed for lower live loads than an office tower.
- **Design wind pressures**: Building Codes offer maps that guide the engineer regarding expected wind speeds at a given location, and these speeds combine with factors such as wind exposure to determine design wind pressures. Where a tall building is planned in a downtown environment amongst several other tall structures, wind tunnel tests are generally required to estimate the effects of wind currents resulting from the presence of neighboring structures.
- **Seismic forces**: Where a building is planned in a location that is seismically active, horizontal shears, overturning forces, and interstory drifts must be analyzed and the structure engineered to ensure satisfactory performance in resisting these actions.
- **Stiffness**: Because horizontal drift and vibration considerations can control the design of tall structures, the stiffness of a proposed structure is of heightened importance in the design of these structures.
- **Stability**: The taller a structure is, the more important it becomes for the design engineer to assess and ensure the local stability of members and the global stability of the structure.

Variables that can be manipulated by the structural engineer to enable very tall 6D-BuildTech assemblies include:

- **Concrete strength**: The 28 day design compressive strength of 6D-BuildTech components is generally 7000 psi (48 MPa). By manipulating the cement content, water/cement ratio, and admixtures in a given mix, the concrete strength can be increased to provide higher structural capacities where required, such as in the Frame Blocks at the base of a tall structure.
- **Block reinforcement**: 6D-BuildTech Frame and Spacer Blocks are generally built with one of a limited set of standard cages of 60 ksi internal steel reinforcement. Where high block stresses indicate the need, higher strength steel and/or additional reinforcing steel bars can be built in to deliver the needed

capacity. Such additional reinforcement might be required in heavily loaded columns at the base of a tall structure, or in Frame and Spacer Block beams that are subjected to high stresses due to wind or seismic forces.

- **Internal post-tensioning**: Although the use of only mild reinforcement is generally seen as a strength of the 6D-BuildTech system in the eyes of builders that have dealt with the issues of post-tensioning, it remains true that 6D-BuildTech components can be built with ducts or sleeved strands in cases where post-tensioning is desired. This option can dramatically increase the structural capacity of a 6D-BuildTech element.
- **External post-tensioning**: In structures such as a very tall but narrow tower, it may be desirable to incorporate vertical strands to globally post-tension a 6D-BuildTech assembly for resistance to overturning forces. A very long but narrow assembly might benefit from the horizontal post-tensioning of the Sculpted Floor Block™ diaphragm at each level. 6D-BuildTech can be configured to accommodate vertical and/or horizontal post-tensioning; either through ducts cast into the blocks or through external strands that are encased by protective sleeves.
- **Bearing pad thickness**: While low-rise 6D-BuildTech assemblies can be constructed with simple 1/8" thick pads between blocks, taller block assemblies can easily be built to incorporate thicker reinforced bearing pads, where the pad strength and thickness are engineered to safely transfer all structural forces.
- **Floor Block concrete density**: Standard 6D-BuildTech components utilize normal weight concrete, but the engineer has the option of specifying Sculpted Floor Blocks that are cast using light-weight concrete. This can significantly reduce the total gravity load generated by a tall structure.
- **Connector strength**: 6D-BuildTech structural assemblies generally carry all gravity forces through direct bearing onto underlying blocks and into the foundation. Threaded rod connectors tie the structure together for resistance to lateral forces. Standard connectors are 1" diameter A36 threaded rods. In cases where the analysis of a tall structure indicates high stresses in these connections, the engineer can specify higher strength steel, larger diameter rods, or even additional threaded rod connectors to limit stresses to the desirable range.
- **Sandwiched Frame Blocks**: At the lower levels of a high-rise conventional concrete structure, it is not uncommon to see columns that are several feet thick. 6D-BuildTech elements are built with a standard 8" thickness; Blocks of greater thickness could be produced within the same form, but the thickness must remain within practical limits to control block weight for handling and transportation. Where structural forces are high due to heavy floor loads or at the base of a tall structure, Frame Blocks can be sandwiched together to multiply the structural capacity. A pair of standard blocks yields a 16" thick column, three blocks sandwiched together yields a 24" thick column, etc. As long as the structure above is configured to deliver load uniformly to the Frame Block group, such a group can be engineered to deliver whatever capacity is required.
- **Widened cross-sections**: One of the greatest strengths of the 6D-BuildTech system lies in the standardization of blocks. But it is clearly possible to build forms to produce Frame and Spacer Blocks that feature increased column or beam widths. Special purpose blocks can be produced with relative ease, but tooling

costs, production floor area demands, and inventory control make job-specific production undesirable. For those reasons, the engineer of a very tall structure should first look to other variables described above to design a 6D-BuildTech assembly, but the widening of cross-sections remains a tool that can be employed.

- **Interface potential**: 6D-BuildTech offers extraordinary potential and flexibility in the construction of block assemblies to build complete structures, but the system also offers advantages in connecting to and interfacing with other conventional systems. Its modularity makes it easy to detail a complementary component, and the predictable connector pattern presented by every 6D-BuildTech element makes connections simple and economical. If an engineer needs to incorporate a precast or cast-in-place shear wall or elevator core, structural steel elements, or other framing systems, the connection points are available. The same advantages apply to the incorporation of perimeter walls of any construction.

The primary message is that 6D-BuildTech is a well-engineered ***Building Block***. When combined with quality engineering analysis and design, it is a building block that offers unprecedented flexibility to the engineer in building better, faster, and taller.