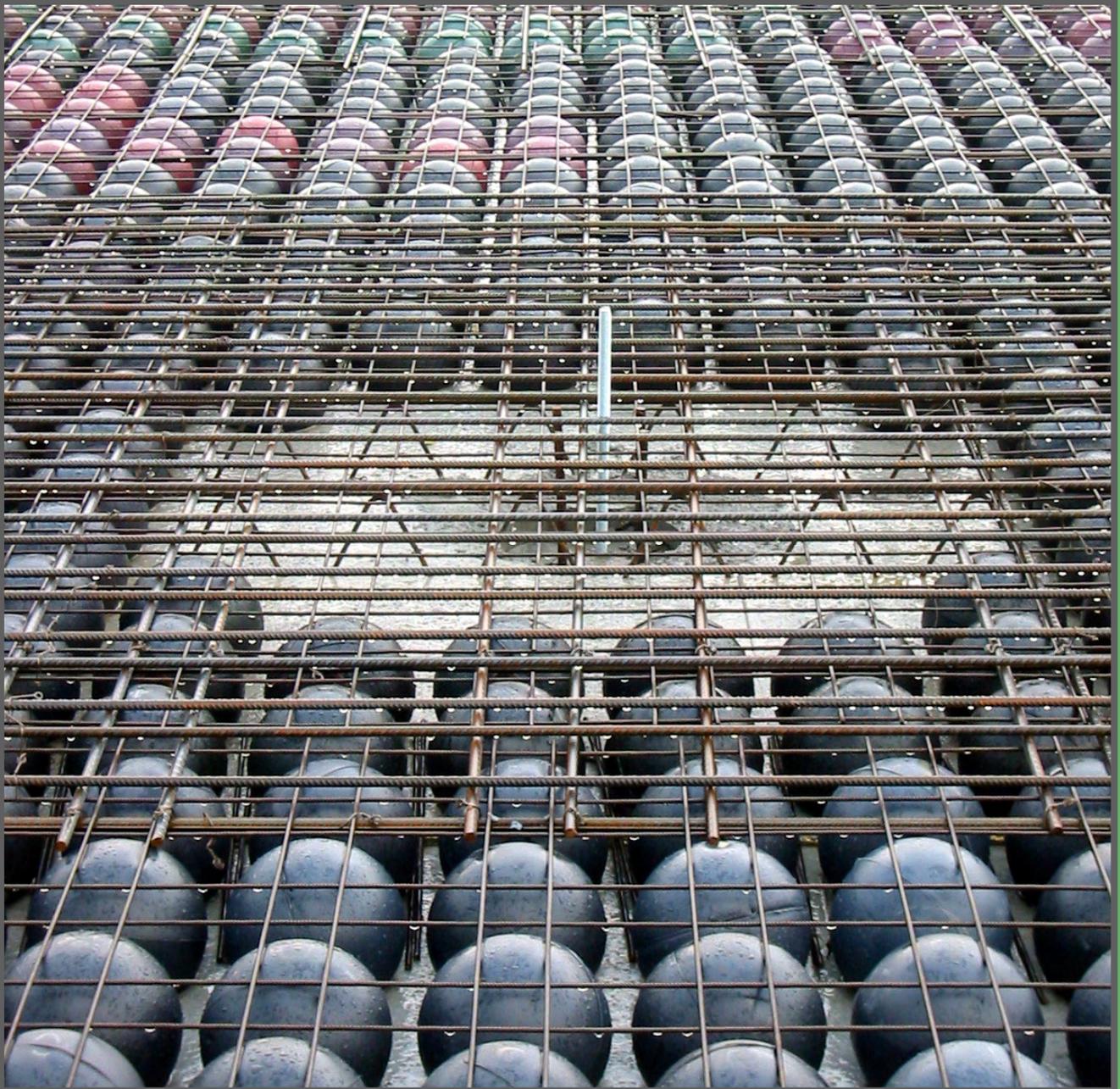
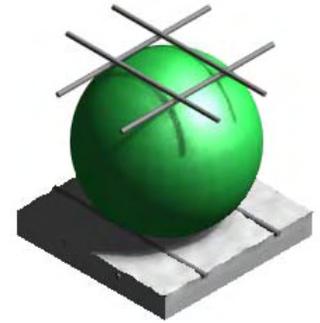


Bubble Deck



Introduction to BubbleDeck

BubbleDeck® is a pre-fabricated structure with superior characteristics to solid slab. Plastic balls serve the purpose of eliminating concrete which has weight but no carrying effect. BubbleDeck can reduce construction material weight up to 50%.



ECONOMIC ADVANTAGES

The amount of materials - concrete, columns, rebar, transfer beams and other materials is reduced by up to 50%:

1 kg recycled plastic replaces 100 kg concrete.

Slabs are factory produced and shipped to site as required. Transportation costs are substantially reduced. Shoring is considerably reduced and BubbleDeck slabs replace expensive formwork. Pre-fabrication and easy installation result in faster construction time. Less man hours equals lower costs and overhead. Clients get a design they want for a better price. Interior finishing is less costly. Life span of buildings is greater.

*The potential saving of a building designed in BubbleDeck is **25%** of the structural cost.*

SUPERIOR DESIGN

BubbleDeck allows for superior design flexibility - dramatic architectural shapes, larger spans and overhangs. No drop beams or carrying walls and fewer columns are required allowing for spacious and flexible interior layouts. Interior layouts are easily altered throughout a BubbleDeck building's lifetime. BubbleDeck conforms to engineering designs and building codes, has less weight and less seismic load. Build what you want not what you must - BubbleDeck has you thinking outside the box.

THE GREEN DECK

Less energy consumption - in production, transportation and construction. Less emissions - exhaust gases and vapors during production, transport and on-site; (CO₂ and other emissions - reduced up to 50%). Less material consumption - cement, aggregates, water, steel.

Every BubbleDeck component can be recycled.

RECOGNITION

BubbleDeck has undergone extensive testing at accredited facilities in Denmark, Germany and the Netherlands. BubbleDeck has received awards for innovation, performance, quality and environmental achievement.

BubbleDeck is engineered like a solid deck - but - BubbleDeck has greater benefits.



Introduction to BubbleDeck

OVERVIEW

BubbleDeck is a highly innovative, environmentally friendly, patented concrete construction system used for floor and roof slabs in high rise and institutional buildings. Developed by Mr. Jorgen Breuning, a Danish civil engineer, it has been used in Europe for ten years, where more than 400 buildings have been designed in BubbleDeck, including the 34 story Millennium Tower in Rotterdam. The BubbleDeck system:

- Reduces energy and materials use up to 50%;
- Reduces structural weight up to 50%;
- Enables materials recycling - input and at end-of-life;
- Enables 80% onsite labor savings;
- Shortens build time by months;
- Reduces structural cost savings up to 25%.

The market segment for the product is in the tens of billions of dollars annually and the company has the potential to achieve \$1 billion plus in revenues in the medium term.

THE PRODUCT

The technology is relatively simple – plastic spheres (“bubbles”) are used to displace much of the concrete otherwise poured for floor and roof slabs. The bubbles are configured within a steel cage composed of top and bottom layers of steel mesh held together by steel girders. The system is factory pre-cast offsite.

ENVIRONMENTAL BENEFITS

The BubbleDeck system is at the leading edge of green building design. Buildings designed in BubbleDeck can garner significant LEED (Leadership in Energy and Environmental Design) credits without additional design modifications¹. In addition to the reduction in energy and materials used, much of the material can be recycled. Key environmental attributes include:

- Up to 50% reduction in emissions of greenhouse gases/other emissions;
- Significant increase in thermal resistance.

In most cases, projects can move to a higher level of LEED certification simply by using BubbleDeck. This is a key advantage of the system as many governmental entities now require public sector buildings to achieve at least a bronze level certification under the LEED program. In addition, the system's positive environmental attributes are increasingly important to private sector developers, who are under pressure to reduce the environmental impact of new construction.

INNOVATION IN DESIGN

Compared to traditional concrete slab systems, BubbleDeck offers greater flexibility in design. It provides the same performance with less thickness compared to solid concrete, pre-cast filigree or hollow core slab floors. These advantages allow for:

- Larger spans with improved column placement;
- Easy accommodation of curved exteriors;
- Wider cantilevers and heavy load areas without drops, slab bands and lots of steel;
- Easy concealment of ductworks and conduits;
- Less use of false ceilings and dropped bulkheads, increasing ceiling height.

PROJECTS

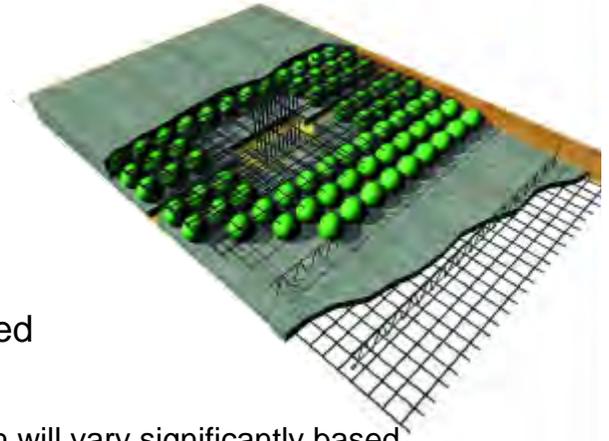
Projects representing 10 million square feet have been designed in BubbleDeck, primarily by **BubbleDeck Netherlands (BDN)**. In North America the Company has completed demonstration projects on both coasts. In June 2007 BDN was awarded its first large project, a 300 thousand square foot student residence complex at Ecole Polytechnique in Montreal, which is now in the construction phase. This university is considering 1 million square feet in additional BubbleDeck design. Harvard University is also designing a 1 million square foot project in BubbleDeck. Several additional developers are designing BubbleDeck projects in Seattle, Calgary and Vancouver.

¹ The LEED Rating Program, developed by the U.S. Green Building Council (www.usgbc.org), is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.



Design Criteria

- Gravity floor system design only*
- 2-Hr Fire-Rated Structure
- Normal-weight concrete (f' c as shown)
- No Live Load Reduction
- Typical Office Loads:
- Live Load = 40 psf + 20 psf (partitions)
- Dead Load = self weight + 15 psf superimposed



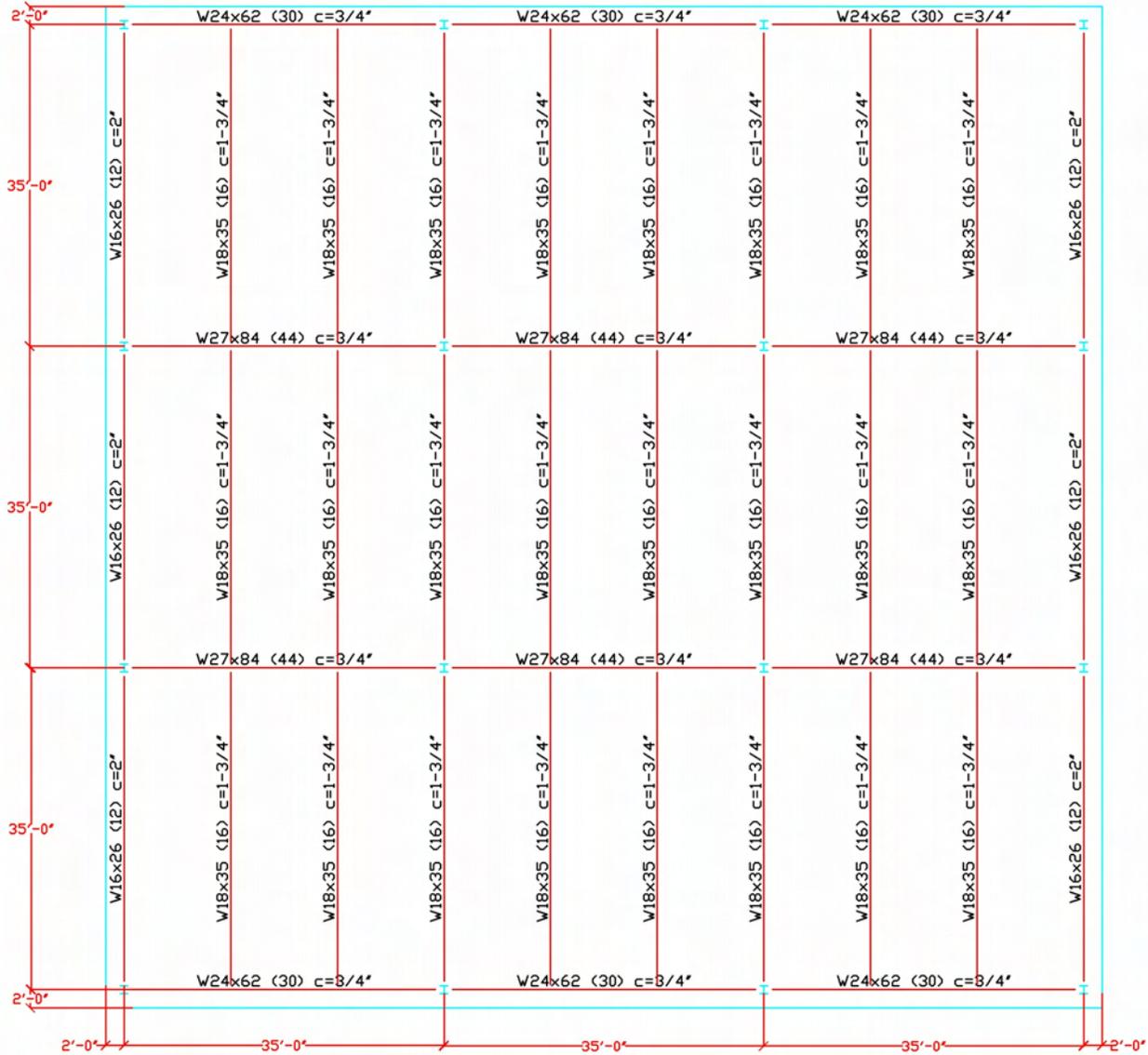
*Ignores associated column and foundation designs, which will vary significantly based on the floor system design.

BubbleDeck® Slab

Version	Slab Thickness	Bubbles	Span (Multiple Bays)	Cantilever Max Length	Span (Single bays)	Completed Slab mass	Site Concrete Quantity
	mm	mm	meters	meters	meters	Kg/m ²	m ³ /m ²
BD230	230	Ø 180	5 - 8.1	≤ 2.2	5-6.3	370	0.11
BD280	280	Ø 225	7 - 10.1	≤ 2.7	6 -7.8	460	0.14
BD340	340	Ø 270	9 - 12.5	≤ 3.3	7 - 9.6	550	0.18
BD390	390	Ø 315	10 - 14.4	≤ 3.8	9 - 11.1	640	0.21
BD450	450	Ø 360	11 - 16.7	≤ 4.5	10 - 12.5	730	0.25



7½" Composite Slab System Composite Steel Beams

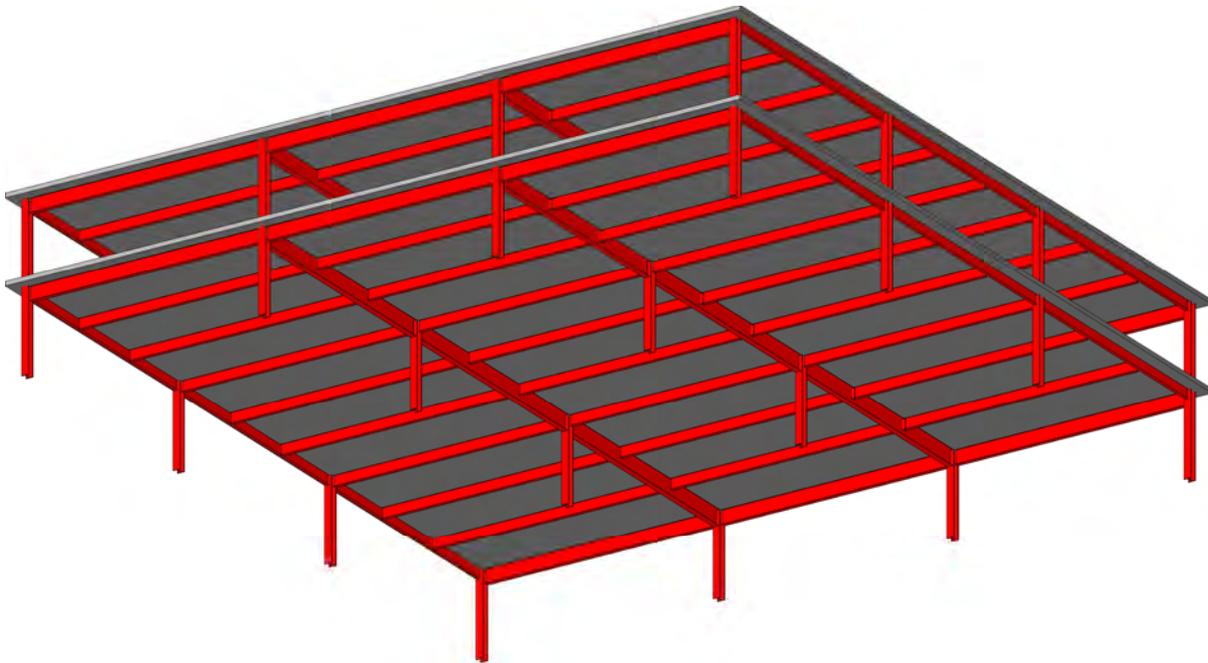
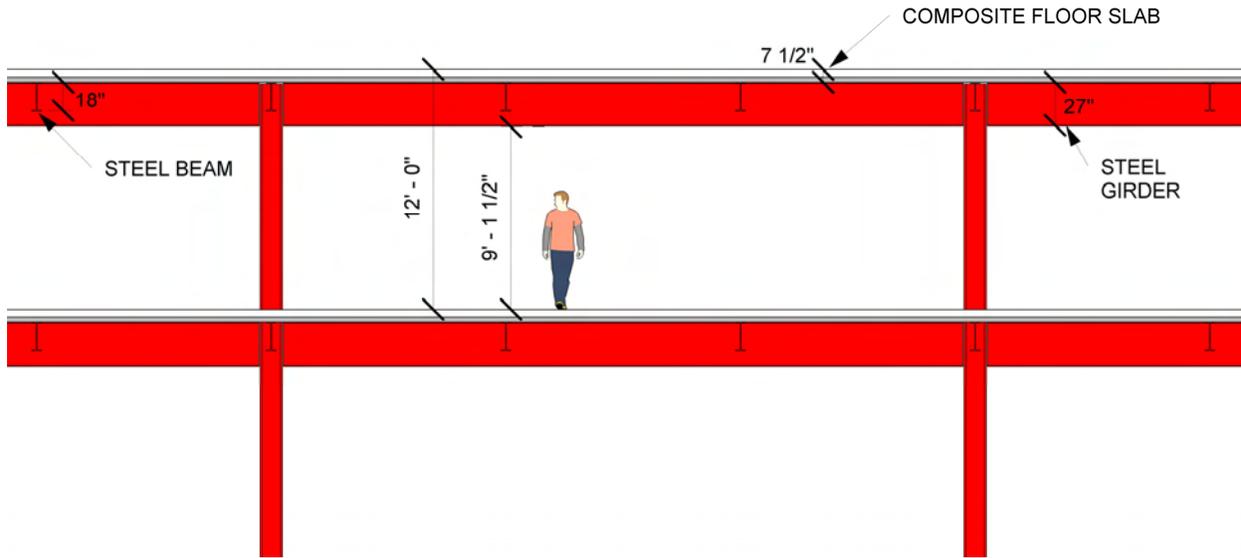


Composite Steel Beam Slab System (Self Weight = 84 psf)

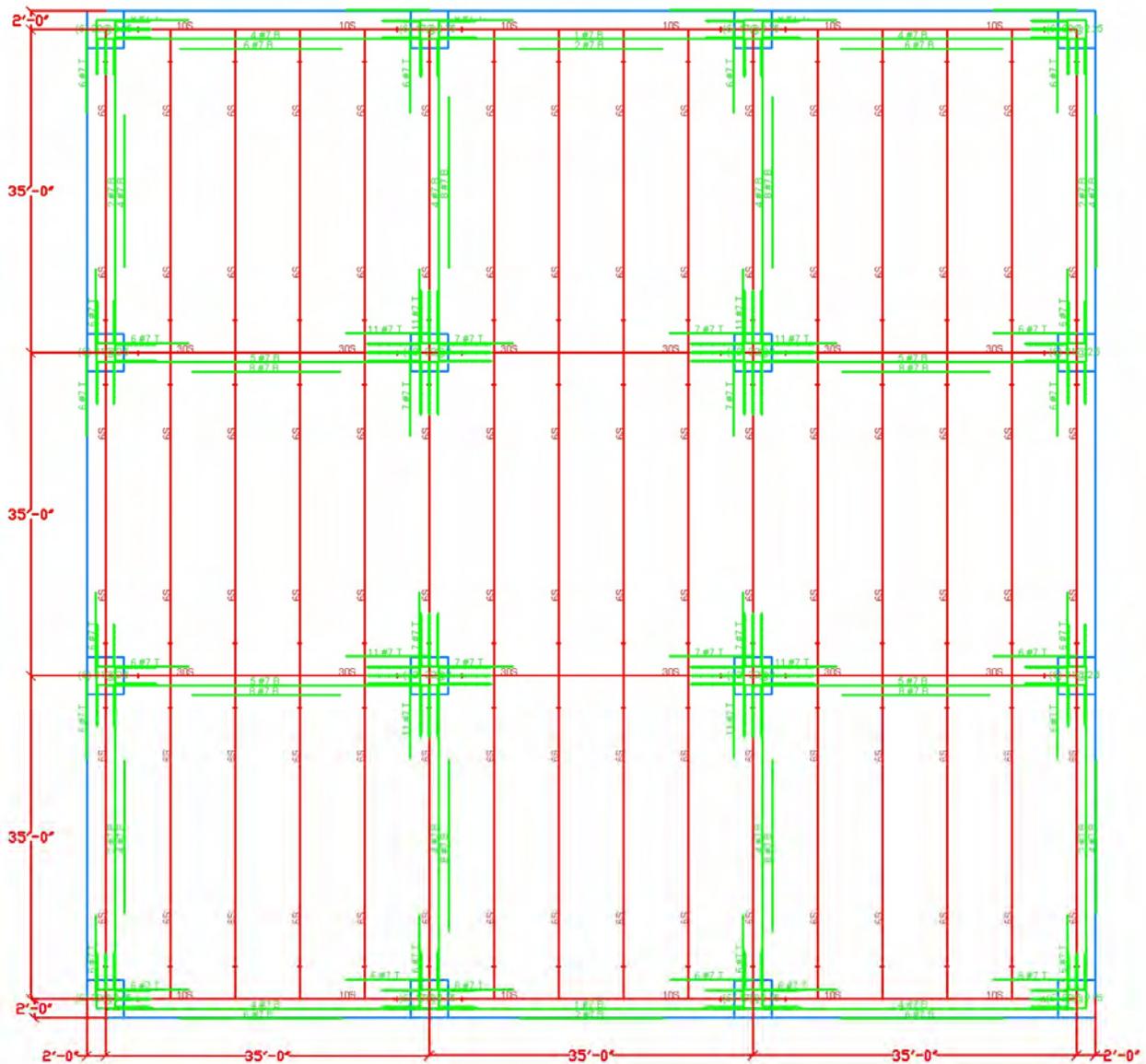
<i>Material</i>	<i>Quantity</i>	<i>Unit Cost</i>	<i>Field Labor Hours/ 100 Sq. Ft.</i>	<i>Cost/Sq. Ft.</i>
Concrete (4 ksi)	220 cu. yds.	\$142.50/cu. yd.	0.74	\$2.64
Structural Steel	32.8 tons	\$1.94/lb.	0.93	\$10.71
3" Composite Metal Deck	11881 sq. ft.	\$3.45/sq. ft.	1.12	\$3.45
Welded Wire Fabric	3393 lbs	\$53.50/100 sq. ft.	0.52	\$0.54
Shear Studs (3/4")	900 studs	\$2.45 ea.	0.13	\$0.19
Fireproofing	7043 sq. ft.	\$1.39/sq. ft.	0.95	\$0.82
Total:			4.39 hours	\$18.34



7½" Composite Slab System Composite Steel Beams



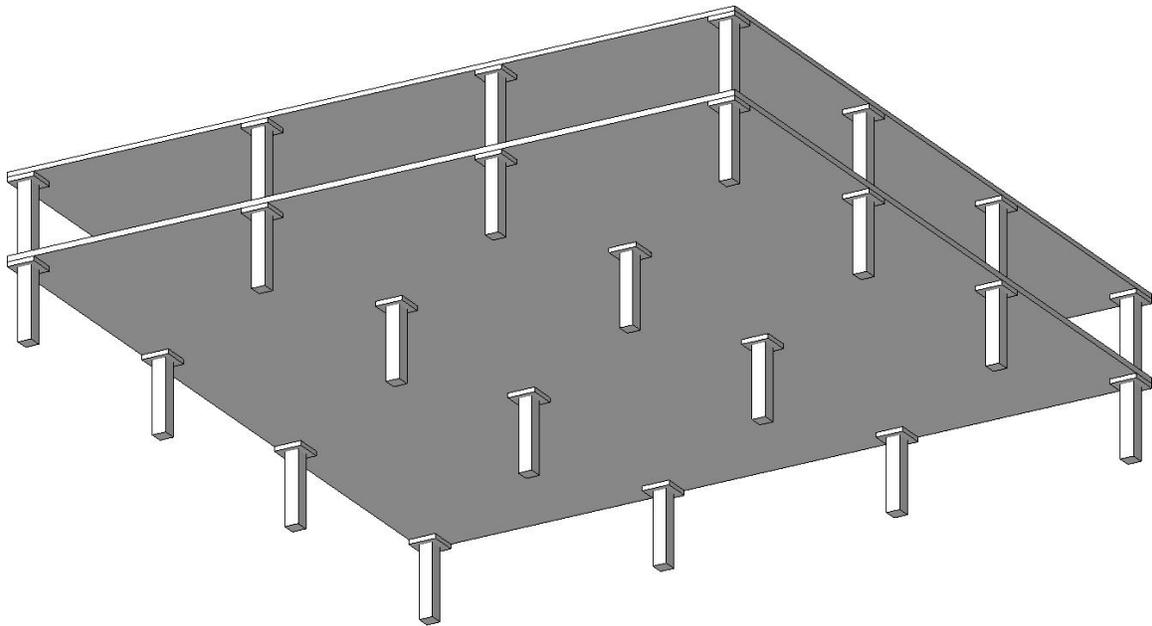
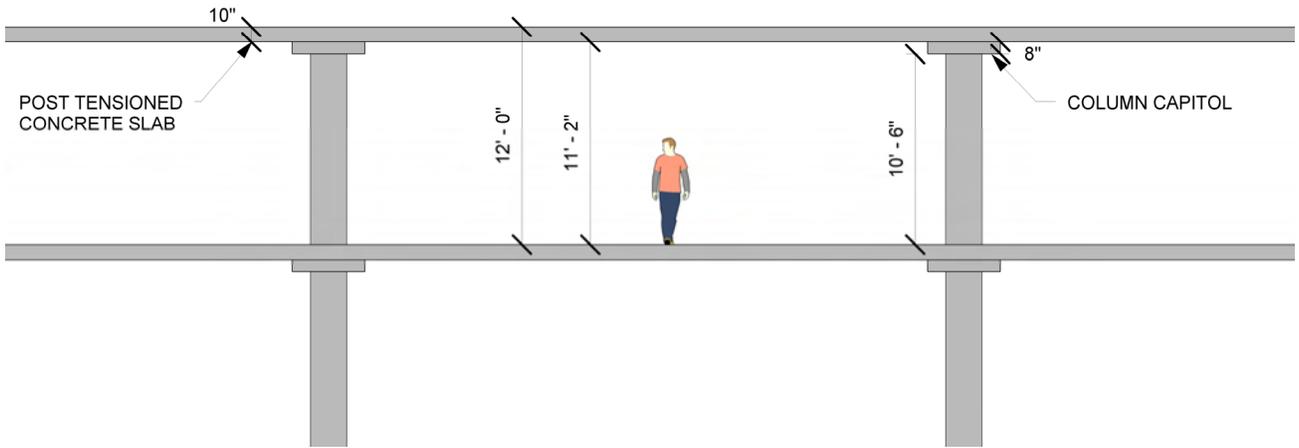
10" Post-Tensioned Slab 8" Column Capitals



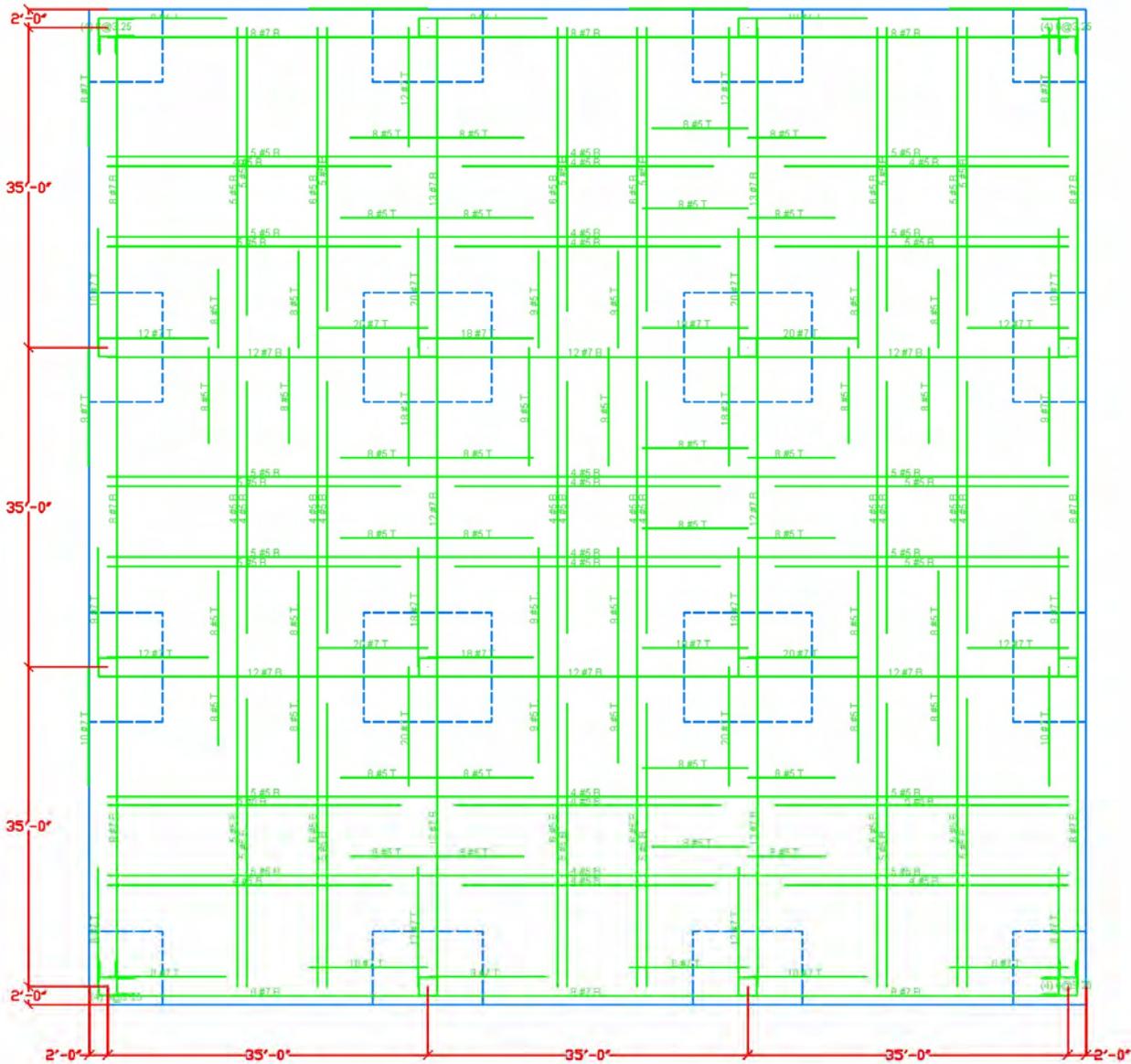
Two-Way Post-Tensioned Concrete Slab System (Self Weight = 130 psf)

Material		Quantity	Unit Cost	Field Labor Hours/ 100 Sq. Ft.	Cost/Sq. Ft.
Concrete (5 ksi)		373 cu. yds.	\$145.50/cu. yd.	1.26	\$4.57
Mild Steel		9.4 tons	\$1,875.00/ton	0.87	\$1.48
Post-Tensioning		9620 lbs	\$2.48/lb.	2.15	\$2.01
Shear Stud Rails (1/2")		2448 studs	\$2.12 ea.	0.33	\$0.44
Formwork & Shoring	Slab	11625 sq. ft.	\$8.00/sq. ft.	9.00	\$7.83
	Column Capitals	427 sq. ft.	\$370.00 ea.	0.36	\$0.50
Total:				13.97 hours	\$16.82

10" Post-Tensioned Slab 8" Column Capitals

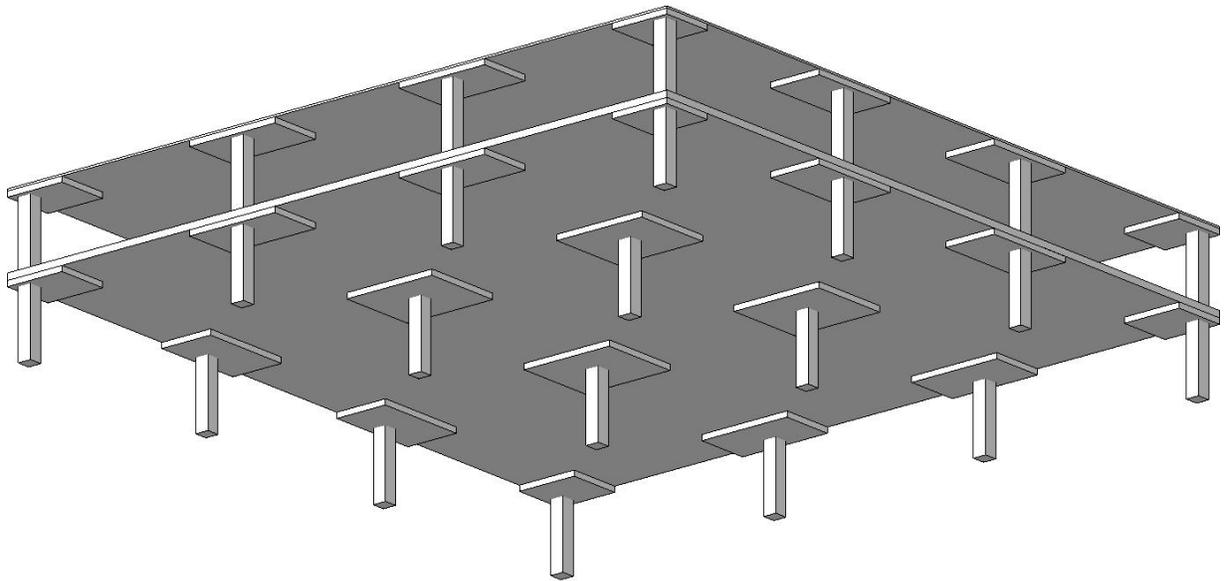
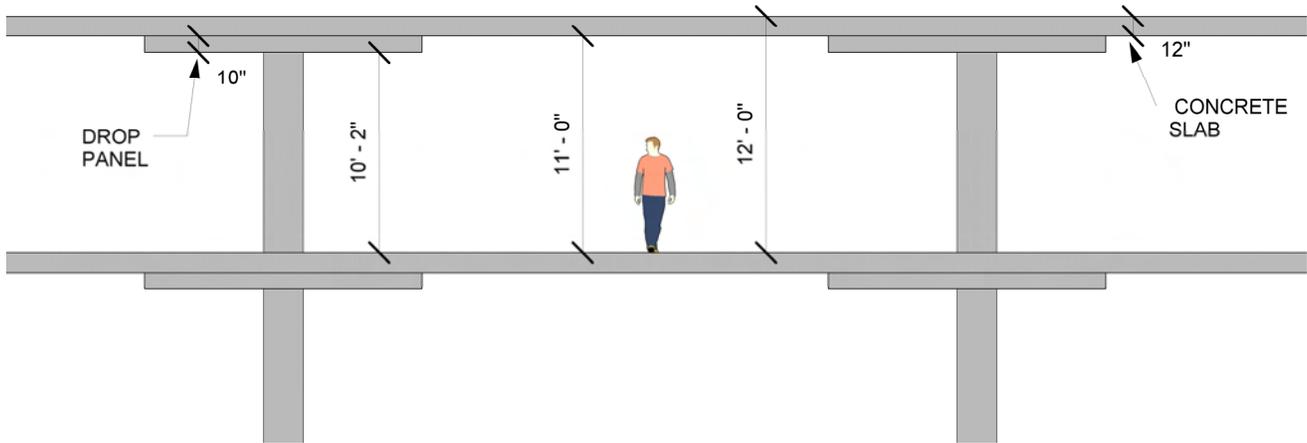


12" Concrete Slab 10" Drop Panels

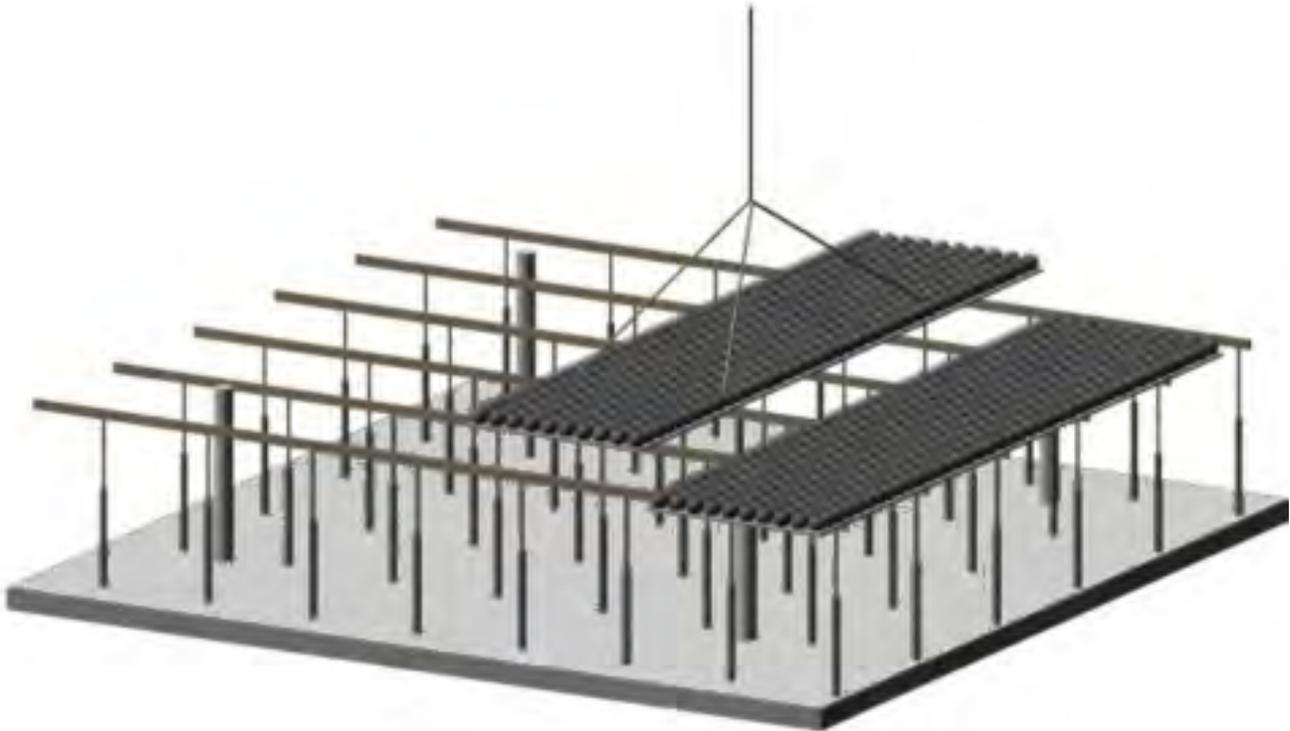
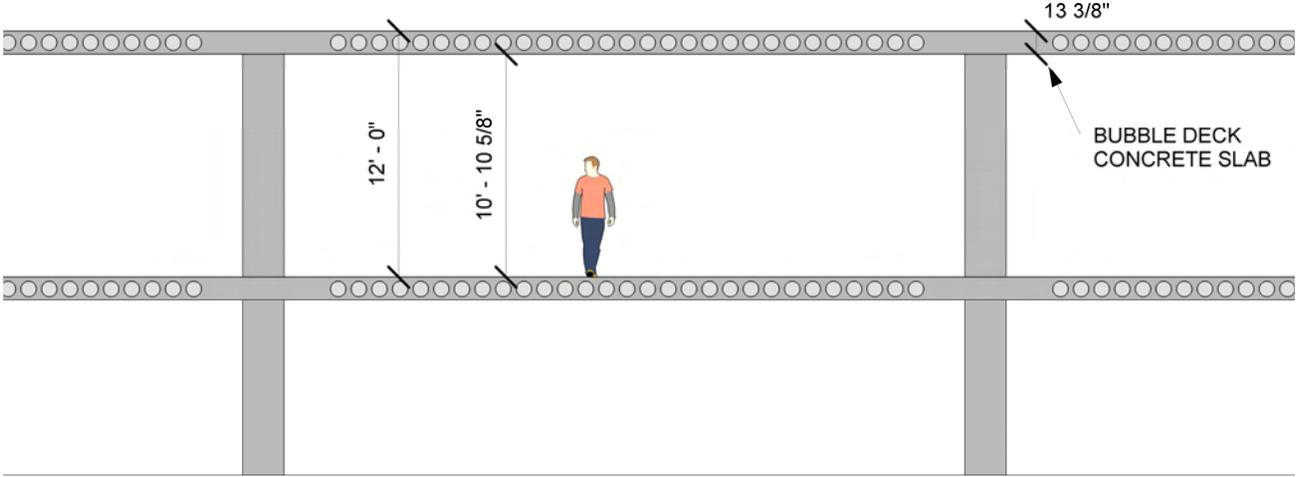


Two-Way Mild Reinforced Concrete Slab System (Self Weight = 173 psf)					
Material	Quantity	Unit Cost	Field Labor Hours/ 100 Sq. Ft.	Cost/Sq. Ft.	
Concrete (4 ksi)	492 cu. yds.	\$139.50/cu. yd.	1.47	\$5.78	
Mild Steel	32.9 tons	\$1,875.00/ton	3.06	\$5.19	
Shear Stud Rails (1/2")	96 studs	\$2.12 ea.	0.01	\$0.02	
Formwork & Shoring	Slab	10185 sq. ft.	\$8.40/sq. ft.	8.06	\$7.20
	Drop Panels	2243 sq. ft.	\$8.40/sq. ft.	1.77	\$1.59
Total:			14.37 hours	\$19.77	

12" Concrete Slab 10" Drop Panels



13³/₈" BubbleDeck Concrete Slab



Summary

This floor comparison was developed to compare hard physical quantities and costs. All costs were quoted from the 2008 estimating book "R.S. Means". Other advantages to be considered when using the BubbleDeck system are as follows:

- The time cycle from floor to floor can increase dramatically since the activity of form work is eliminated. The forming and subsequent stripping of the form work. Wider shoring Bays.
- The finished underside of a BBD panel can be left exposed. Some systems that require fireproofing must have drop ceilings to hide aesthetics.
- When using composite slab systems you lose ceiling height inside the building and/or overall building height is substantially taller requiring more finishes i.e. more ext glazing etc.
- Crane time logged is reduced from less lifts which gives a bigger window since crane lifts can be affected by the weather/wind.
- Less labor onsite which can result in improved safety.
- Schedule impacts due to bad weather is minimized because floor plates built inside controlled factory setting.
- Less onsite concrete to pour, quicker pour time. Core drilling is possible and also faster.
- Trades work more efficient due to 100% flat ceiling.
- Clash detection simpler in BIM projects because of no drop beams and column capitals.
- More efficient use of building space because of larger spans.
- Overhangs and cantilevers easily achieved without additional structural supports.
- Freedom of design - any shape building will work with BBD technology, curves and irregular shapes for exterior and interior.
- Building has a smaller carbon footprint and works well with achieving LEED credits.
- Getting BubbleDeck engineers involved in the early stages can help reduce column and footing schedules which can equate to additional savings.

