

Tekla Structures 2009
North American User Meeting

Customer Showcase

Central Park Tower 385 Interlocken Broomfield, CO

August 14, 2009



Central Park Tower



Central Park Tower rendering Gensler

Image courtesy Gensler, project architect



Team Members

Developer:	Prime West Development, Inc.	Denver, CO
Architect:	Gensler	Denver, CO
MP Engineer:	Swanson Rink	Denver, CO
Electrical Engineer:	JBA Consulting Engineers	Denver, CO
Structural Engineer of Record:	Richard Weingardt Consultants	Denver, CO
General Contractor:	The Weitz Company	Denver, CO
Design / Build Structural Contractor:	Construction Products Distributors, LLC <i>a Weitz Company</i>	Des Moines, IA
IPD Structural Engineer:	Structural Consultants Inc.	Denver, CO
GFRP Panel Fabricator:	Metro Cast Corp.	Westland, MI
Steel Detailer:	Axis Steel Detailing Inc.	Orem, UT
Rebar Detailer:	Martino & Luth Inc.	Denver, CO
Steel Fabricator:	CMC / Banner	Denver, CO
Steel Erector:	JD Steel	Denver, CO



Project Statistics

- Location – Broomfield, Colorado
- Area – 305,331 square feet
- Pursuing LEED Gold Certification
- Height – 11 stories with 1 level below grade
- Below Grade Parking Level – Precast double-tees supported on precast inverted tee beams spanning to cast-in-place concrete pilasters
- Above Grade – Structural steel frame with cast-in-place concrete foundation and core walls
- Quantities
 - 2,849 cy concrete
 - 358 tons reinforcing steel
 - 1,400 tons structural steel
 - 2,470 shop drawing sheets, 47 erection
 - 150,000 sf exterior wall panels



Presenters

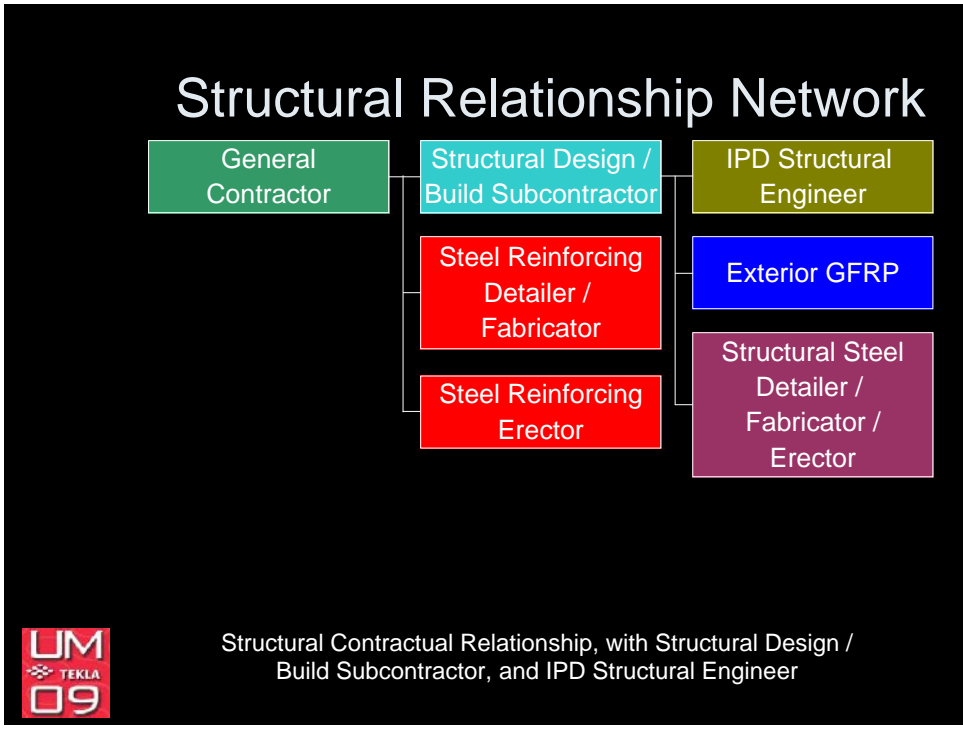
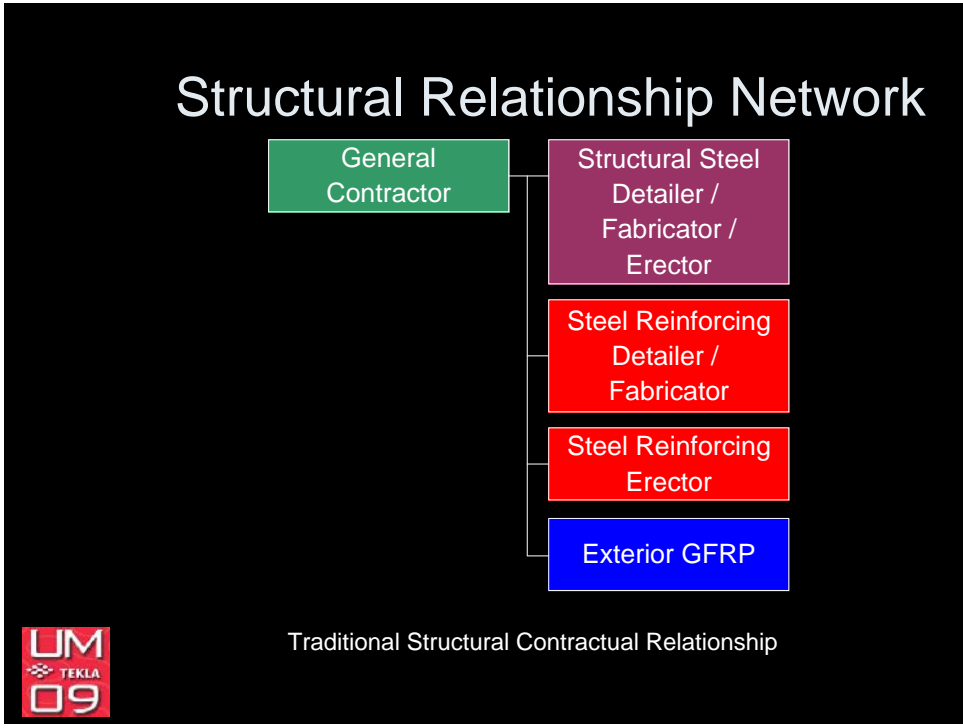
- R. Wayne Muir, P.E.
Structural Consultants Inc.
- Chris Allen, LEED AP
The Weitz Company
- Rob Schoen
Axis Steel Detailing, Inc.
- Russ Martino, P.E.
Martino & Luth, Inc.

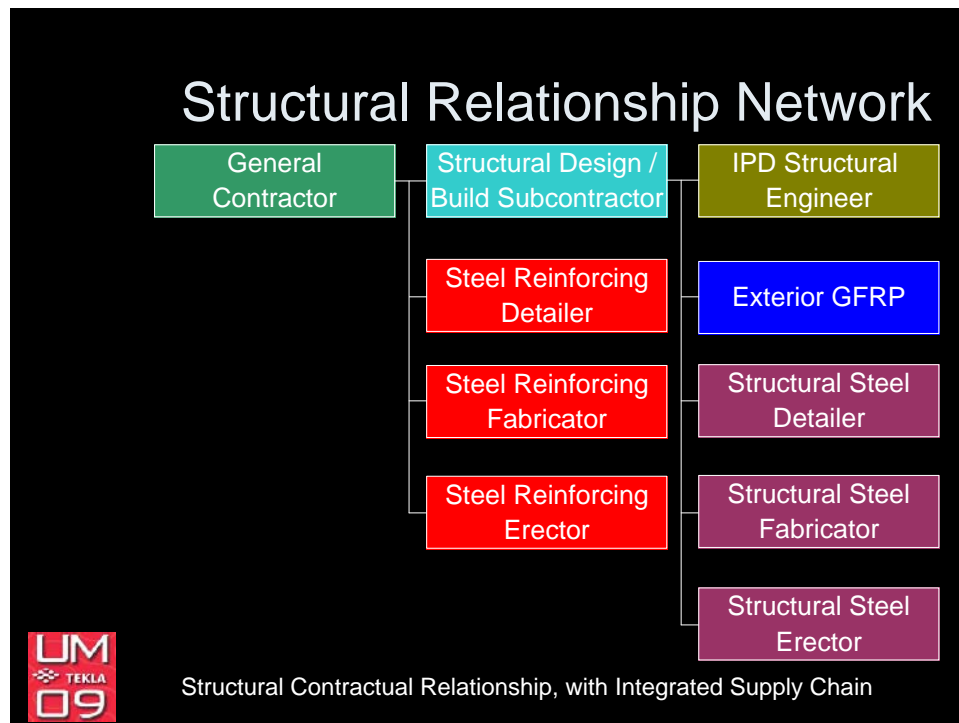


Virtual Design & Construction Process

- Project benefited from VDC through...
 - Earlier involvement in project – commitments made at Schematic Design phase
 - Overlapping of design and construction activities
 - Accurate Tekla structural model maintained throughout design/construction phases
 - Extracted supplementary structural drawings from Tekla structural model







Life Cycle of Tekla through Design and Construction of Project

- Design
- Coordination
- Detailing
- Fabrication
- Erection/Place Work



Model Platforms Used on Project

- IPD Structural Engineer Tekla
- MEP Engineer AutoCAD MEP
- General Contractor Tekla, Vico
- Design / Build Tekla Const Mgr
- Structural Contractor
- MEPF Contractor AutoCAD MEP
- Precaster StructureWorks
- Steel Detailer Tekla
- Rebar Detailer Tekla



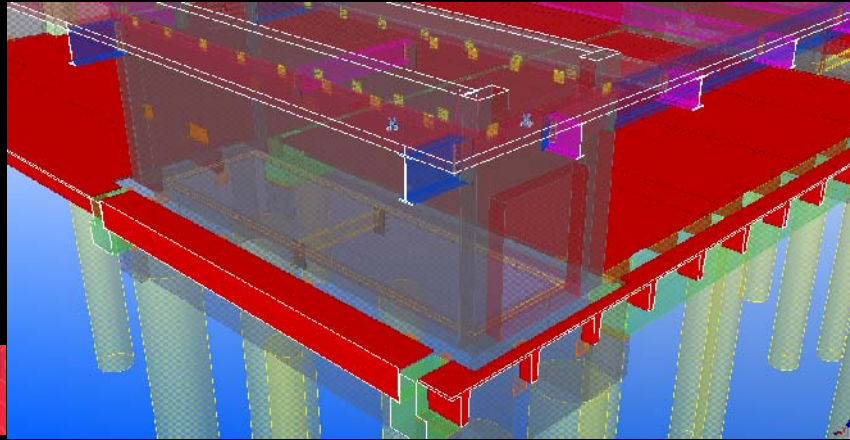
Structural Systems

- Cast in place concrete foundations and core walls
- Structural and miscellaneous steel
- Glass fiber reinforced polymer (GFRP) exterior panels



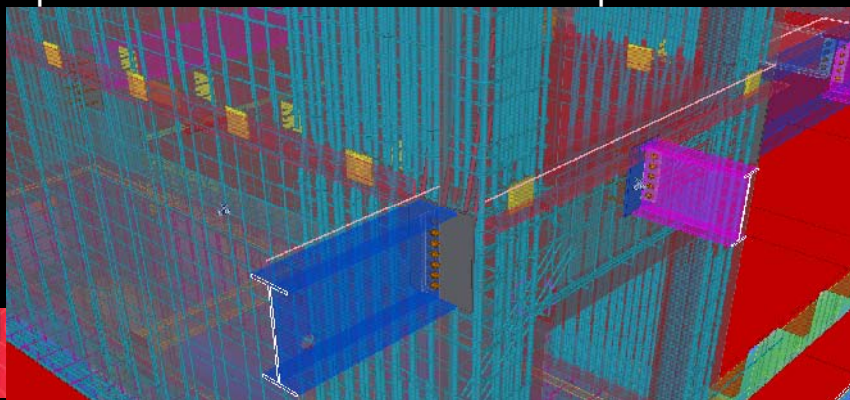
Cast in Place Concrete

- Design
 - Modeled all CIP concrete



Cast in Place Concrete

- Design
 - Designed and modeled all concrete embed plates for attachment of steel and precast



Cast in Place Concrete

- Design
 - Modeled all openings and blockouts
 - Imported into Tekla structural model
 - Embed plates for deck support and miscellaneous steel modeled by Axis in Tekla
 - Embed plates for precast connections modeled by precaster in StructureWorks



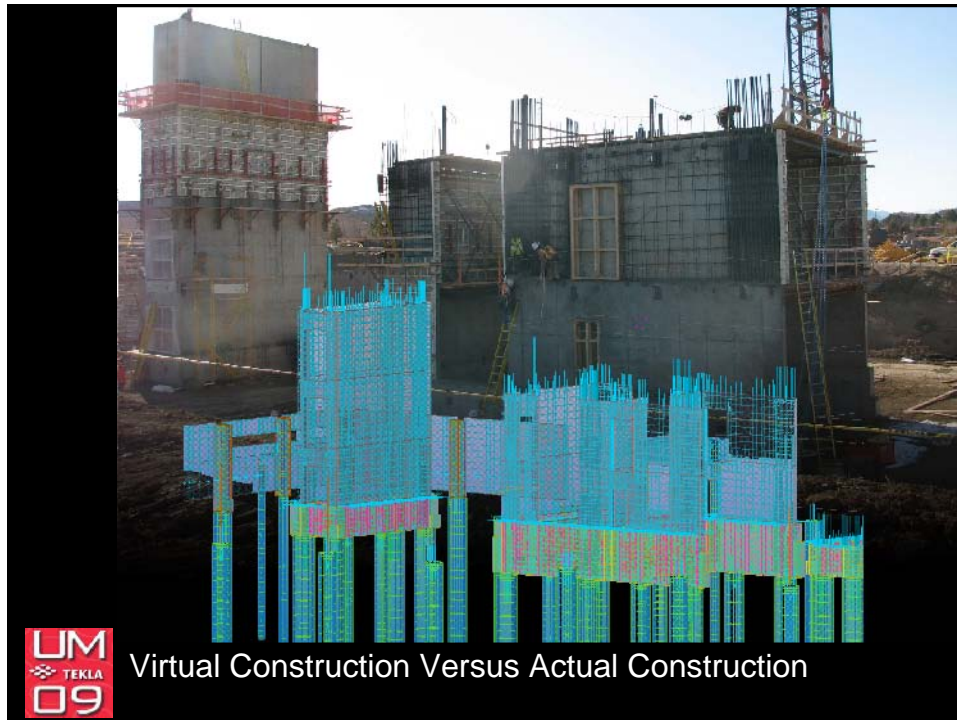
Cast in Place Concrete

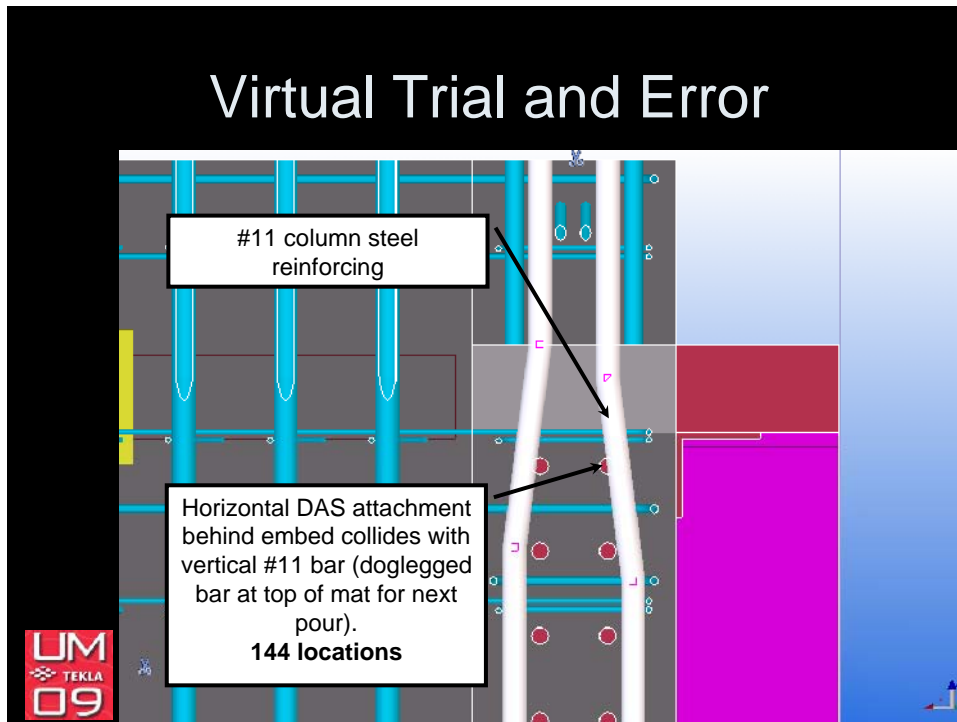
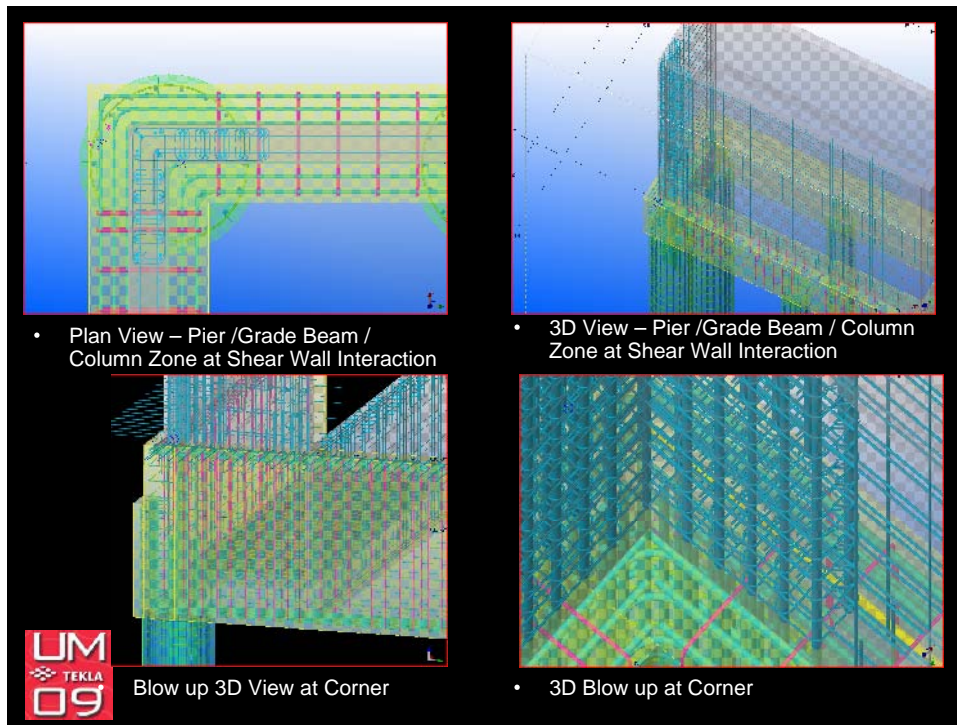
- Concrete Rebar Coordination
 - Coordination of Virtual Construction with Actual Construction
 - Erectability of Rebar and Congestion
 - Sequencing and Panelizing of Bar
 - Pour Joint Locations
 - Dowels vs epoxy vs form savers
 - Erection Bars not shown on Structural drawings
 - Coordination of Rebar Placement versus Embeds Installation.
 - Move Embed or Move Rebar
 - “Field Dap”



Cast in Place Concrete

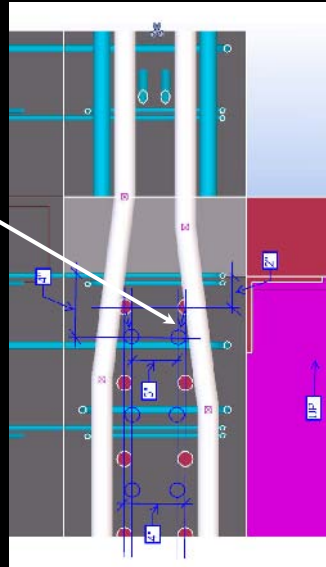
- Coordination
 - Imported Tekla rebar model into structural model
 - Coordinated core wall rebar with embed plate anchorages, penetrations, and blockouts





Virtual Trial and Error

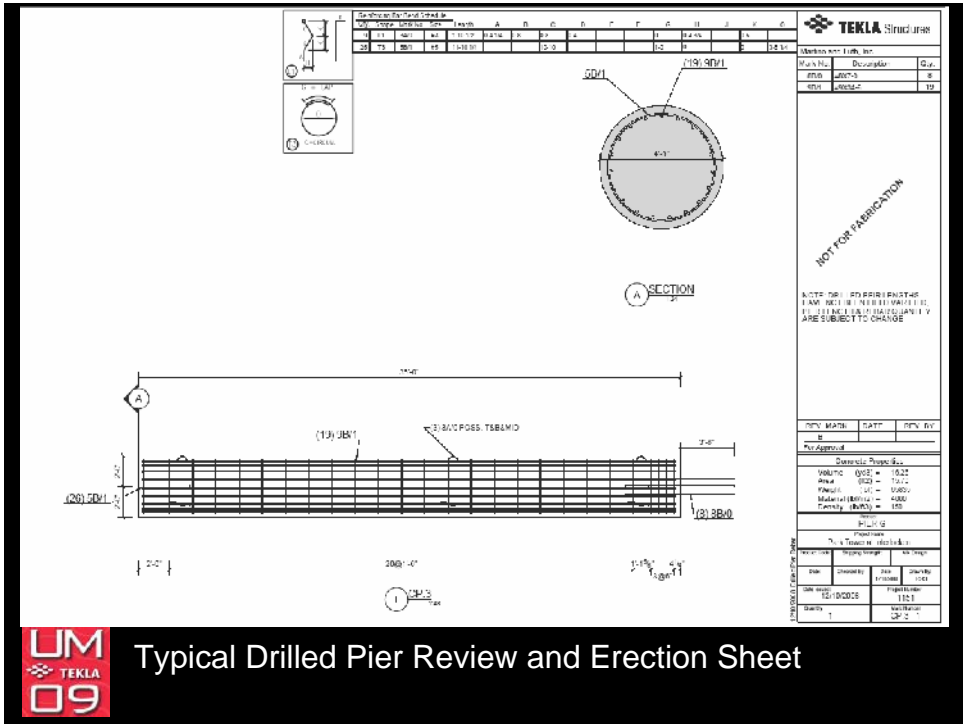
Solution!
Reconfigure DAS embed
pattern to clear #11 column
steel reinforcing



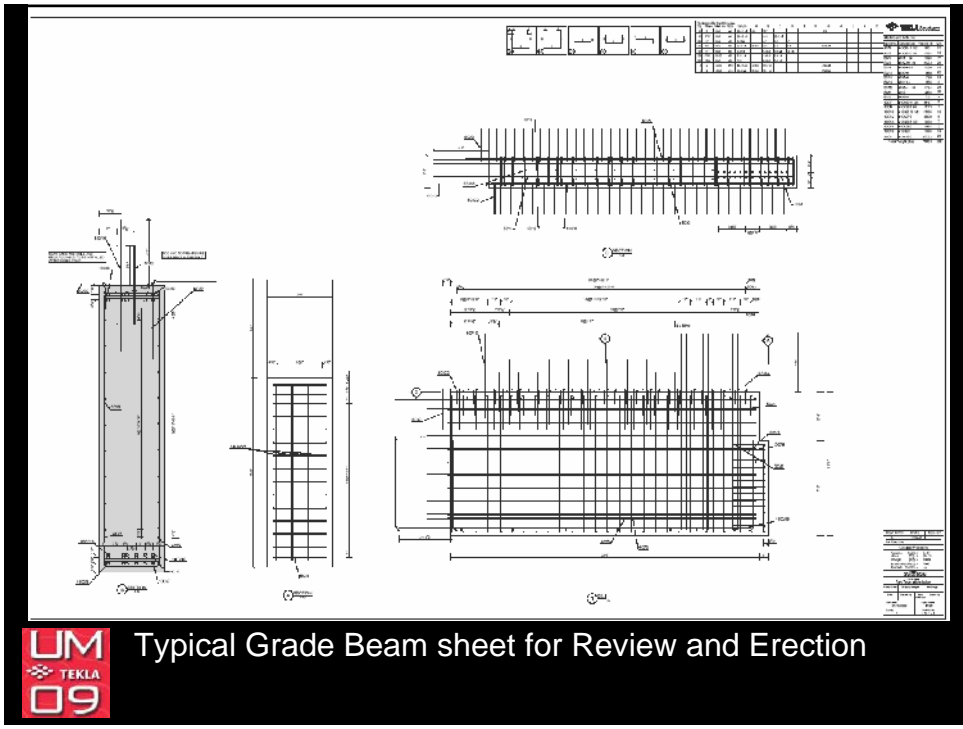
Cast in Place Concrete

- Detailing
 - Create drawings from Tekla
 - Cast In Place Unit
 - Modify Rebar to fit project
 - Bend diagram Pictures created in CAD
 - Create Sheets with Unit , Bend Diagram, and Bar List

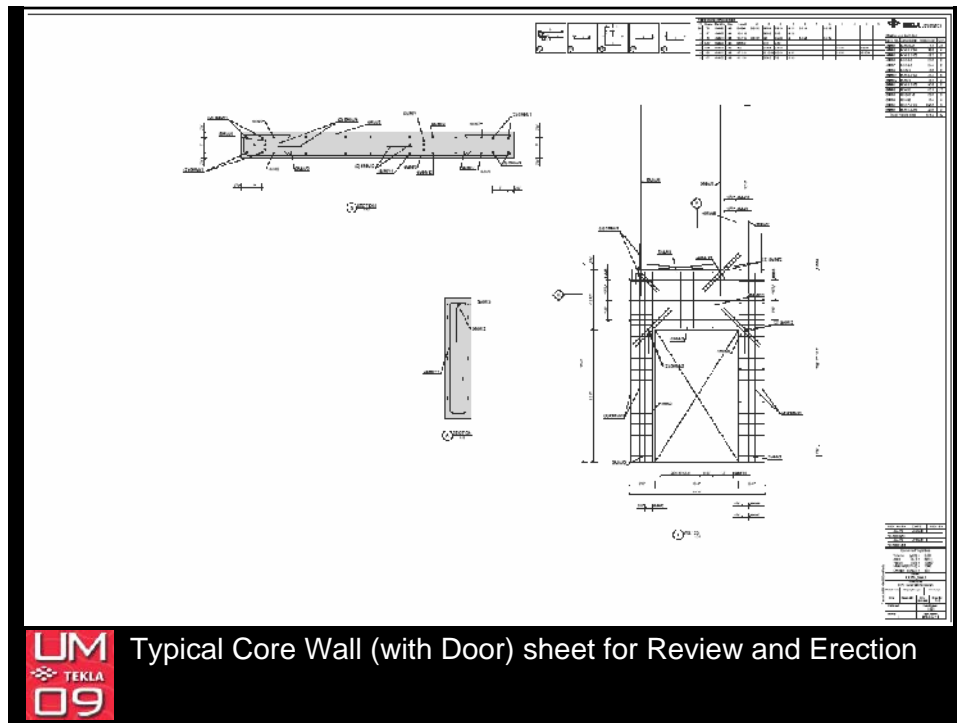




Typical Drilled Pier Review and Erection Sheet



Typical Grade Beam sheet for Review and Erection



Cast in Place Concrete

- Fabrication
 - Create Information to send to Fabricator
 - Create Bar List and Send to Fabricator to be entered by hand (room for improvement)
 - Mapping standard bends in Tekla



**RECOMMENDED INDUSTRY PRACTICE
FOR DETAILING REINFORCING MATERIALS**

FIGURE 6-2—TYPICAL BAR BENDS

**ENLARGED VIEW SHOWING
BAR BENDING DETAILS**

**RECOMMENDED INDUSTRY PRACTICE
FOR DETAILING REINFORCING MATERIALS**

FIGURE 6-2 TYPICAL BAR BENDS (CONT)

Source: CRSI Manual

Example, Standard Rebar Bends

NO.	MARK	SIZE	LENGTH	TYPE	A	D	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	WEIGHT (LBS)																								
01	33/2	43	5 7 3/4	06	0 3 1/2	1 13 3/4	0 0 1/4	1 13 3/4	0 0 1/4																							216.70																							
02	33/2	43	5 2 3/4	06	0 2 1/2	2 9 1/2	2 9 1/2	0 0 1/4	0 0 1/4																							60.24																							
03	33/2	43	1 3 1/2	06	0 3 1/4	0 5 1/2	0 5 1/2	0 0 1/4	0 0 1/4																							60.10																							
04	33/2	43	0 2 1/2	06	0 0 1/2	0 0	0 2 1/2	0 0	0 2 1/2																							27.21																							
05	33/2	43	1 3 1/2	06	0 3 1/2	0 3 1/2	0 3 1/2	0 0 1/4	0 0 1/4																							116.23																							
06	43/5	44	7 3 1/2	12	3 3 1/2	0 13	3 3 1/2	0 1/4	0 1/4																							55.80																							
07	33/2	43	2 0 5	06	0 2 0 5																											292.28																							
08	33/2	43	1 3 1/2	06	0 3 1/2	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																							50.53																							
09	43/5	44	1 3 1/2	12	0 13 3/4	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																							67.61																							
10	33/2	43	5 1 1/2	06	0 5 1 1/2	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																							77.82																							
11	43/5	44	6 1 1/2	12	0 6 1 1/2	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																							54.68																							
12	33/2	43	2 1 1/2	06	0 2 1 1/2	0 0	0 0	0 0 1/4	0 0 1/4																							54.43																							
13	33/2	43	1 3 1/2	06	0 3 1/2	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																							234.33																							
14	33/2	43	1 3 1/2	06	0 3 1/2	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																							245.63																							
15	33/2	43	0 6	06	0 0 6	0 0 6	0 0 6	0 0 1/4	0 0 1/4																							65.10																							
16	33/2	43	0 4 1/2	06	0 4 1/2	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																								53.17																						
17	33/2	43	1 4 3 1/2	06	0 14 3 1/2	0 14 3 1/2	0 14 3 1/2	0 0 1/4	0 0 1/4																							45.47																							
18	33/2	43	0 6	06	0 0 6	0 0 6	0 0 6	0 0 1/4	0 0 1/4																							112.51																							
19	33/2	43	1 1 3/4	06	0 1 3/4	0 17	0 17	0 0 1/4	0 0 1/4																								33.40																						
20	33/2	43	2 0 5 1/2	06	0 2 0 5 1/2	0 13 3/4	0 13 3/4	0 0 1/4	0 0 1/4																								292.57																						
21	43/5	44	1 4 3	12	0 14 3	0 14 3	0 14 3	0 0 1/4	0 0 1/4																							535.4																							
BPC TOTAL WEIGHT																																																							4407.85

Typical Bar List sent To Fabricator

Martino & Luth, Inc.						PROJECT NO:				
Phase:Phase H-N - South Core Rebar - Lifts 7-BH						PROJECT NAME				
No.	Mark	Size	Length	Type	A	B	C	D		
102	3J/1	#3	5-7 3/4	T6	0-3 1/2	1-10 3/4	0-9 1/4	1-1		
34	3J/2	#3	5 4 3/4	T6	0 3 1/2	1 9 1/4	0 9 1/4	1 9		
136	3J/3	#3	1-3 1/2	T9	0-3 1/4	0-9 1/2				
5	4J/1	#4	8-2 1/2	T6	0-4 1/2	0-8	3-2 3/4	0-8		
60	4J/2	#4	7 5 1/2	17		3 5	0 10	3 5		
6	4J/3	#4	7-2 1/2	17		3-3 1/2	0-10	3-3		

UM
TEKLA
09

Typical Bar List sent To Fabricator

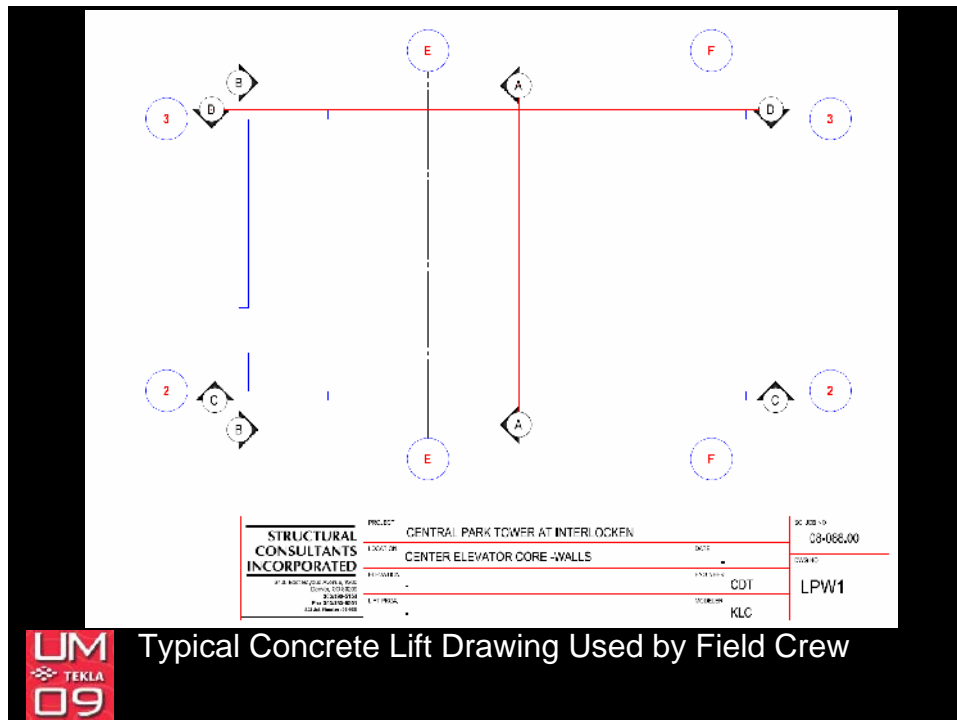
Cast in Place Concrete

- Fabrication
 - General Contractor coordinated fabrication, loading and delivery sequence with fabricator
 - Pre-sorted
 - Organized deliveries by pour type and location
 - Reduced short-trucks...fabricator happy 😊

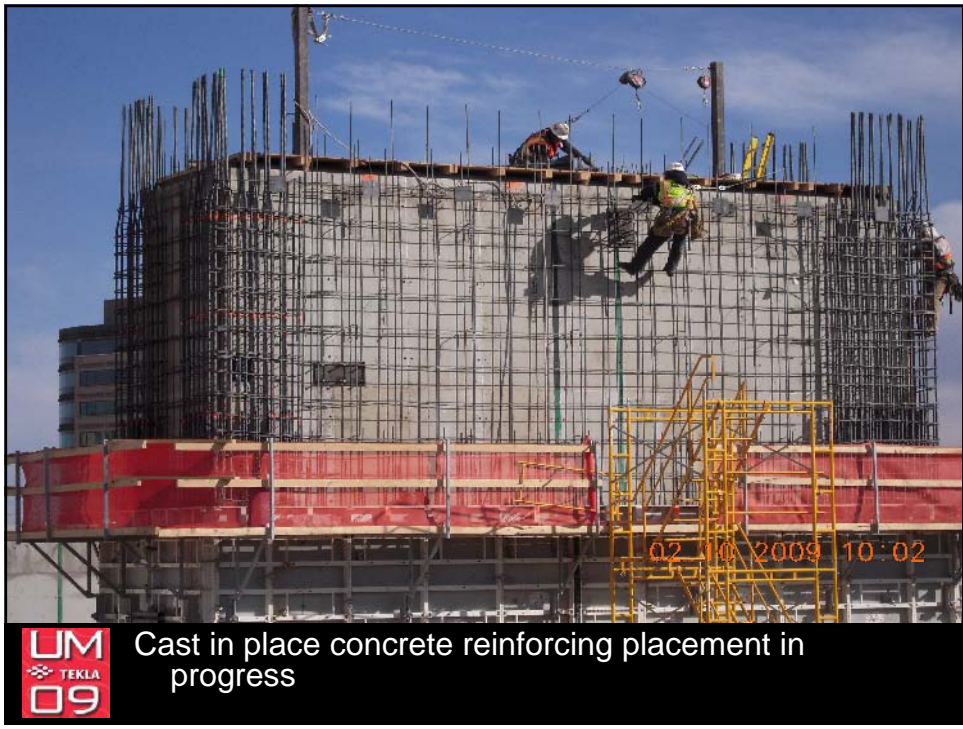
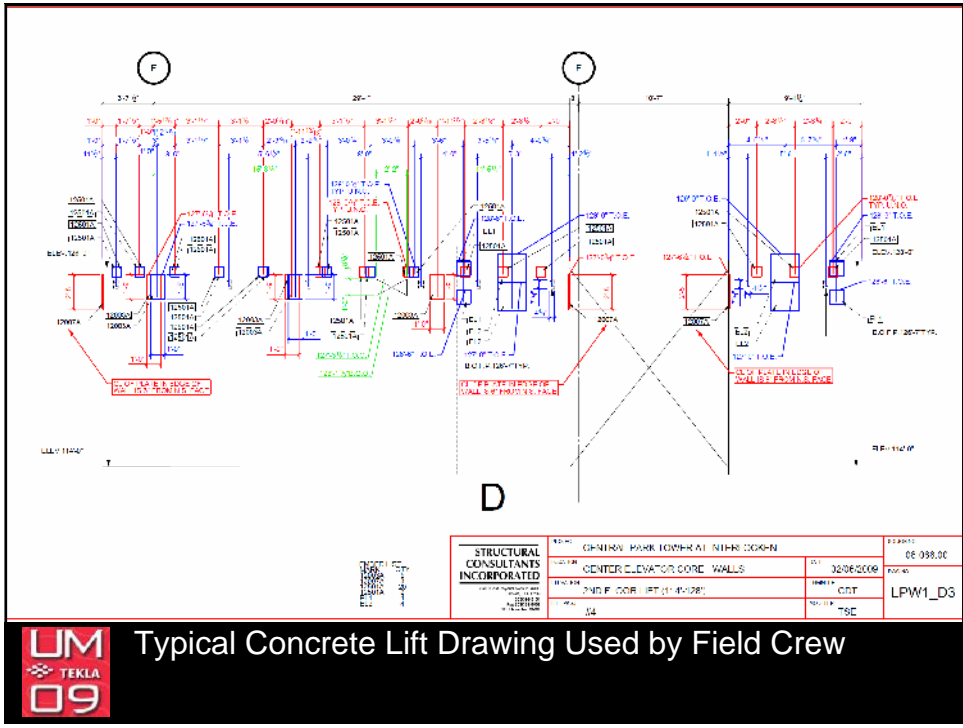


Cast in Place Concrete

- Erection/Place Work
 - Comprehensive lift drawings important to quality CIP concrete job
 - Major improvement over fragmented sources:
 - Reinforcing
 - Precast embeds
 - Structural steel embeds
 - Miscellaneous steel embeds (elevators, stairs)
 - Blockouts / penetrations

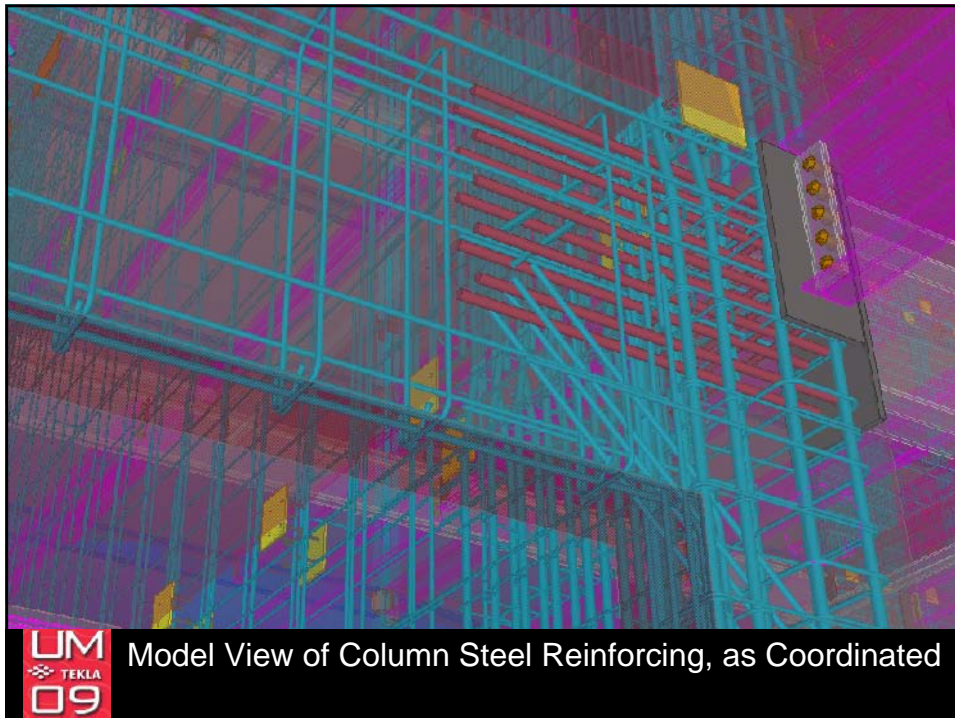


Typical Concrete Lift Drawing Used by Field Crew



Cast in Place Concrete

- Erection/Place Work
 - One lift, one lift drawing
 - Color-coded dimensions from grid
 - List relevant lift data
 - Embed list (type and qty)
 - Concrete yardage
 - Adapt program to fit user needs





Cast in Place Concrete

- Benefits
 - Design
 - Development of base model to input and add various structural elements
 - IPD Structural Engineer given responsibility to design and coordinate **all** structural elements
 - Means to provide added value to GC and Owner



Cast in Place Concrete

- Benefits
 - Construction
 - Zero RFIs
 - Minimal review comments from EOR
 - Reduced construction schedule two weeks
 - 21.6% less reinforcing materials actual vs budget (had three lump sump reinforcing bids)
 - Estimated less than 0.07% waste in reinforcing material

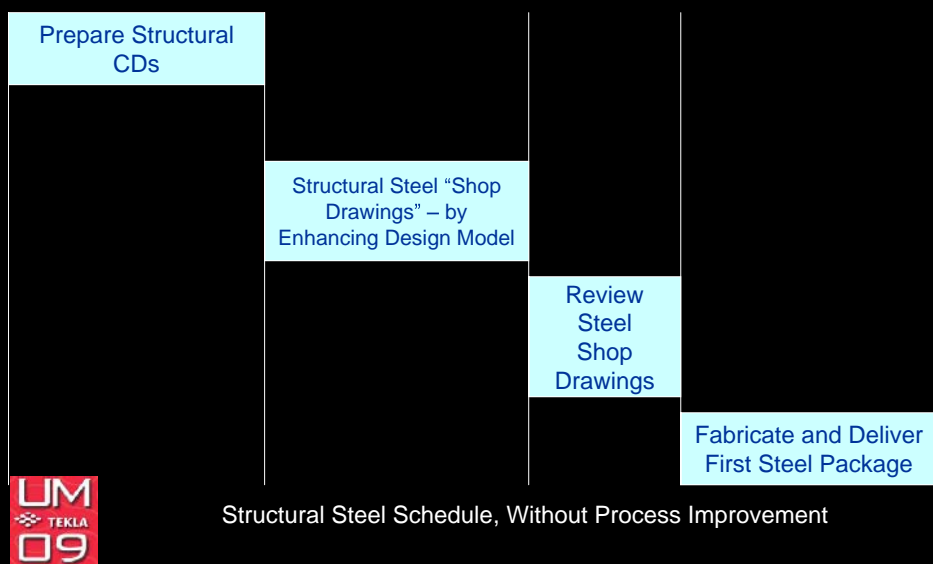


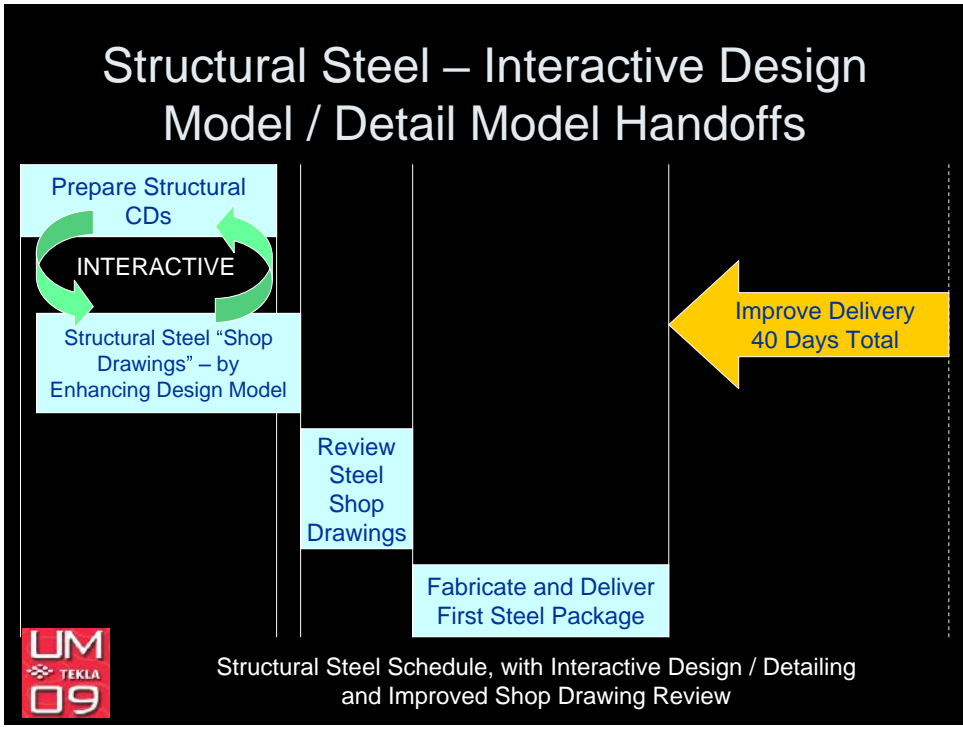
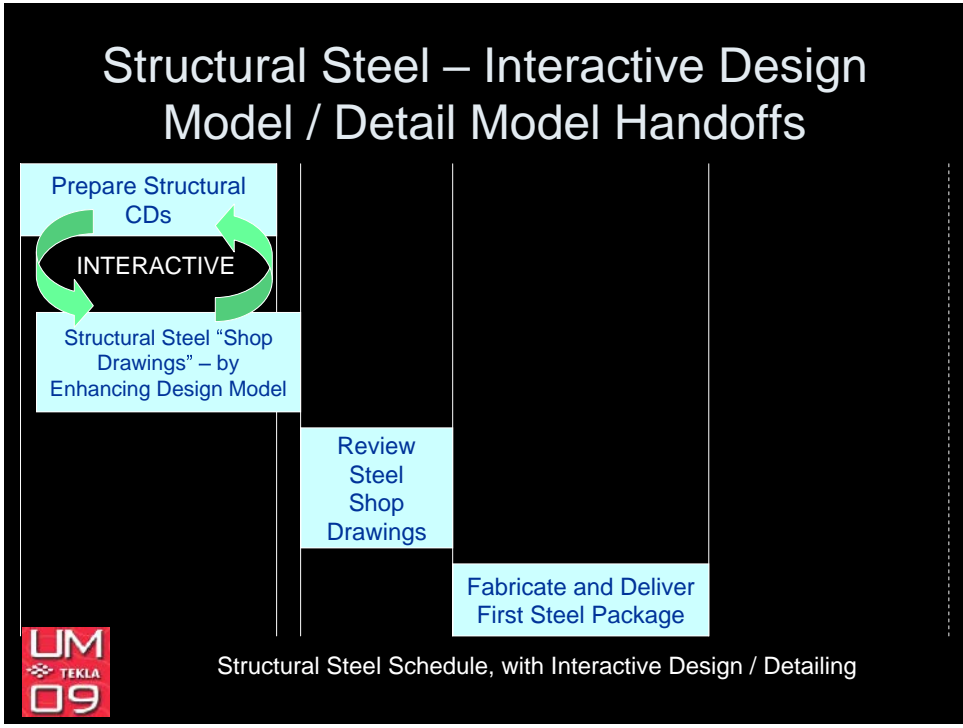
Structural and Miscellaneous Steel

- Design
 - RAM analytical model to start Tekla structural model
 - SCI responsible for design and detailing of structural steel superstructure
 - Participated in design team meetings starting at SD
 - Extracted from model
 - Supplementary contract documents
 - Calculation package (similar to precast package)
 - Designed for constructability
 - Designed for GFRP panel compatibility



Structural Steel – Interactive Design Model / Detail Model Handoffs





Structural and Miscellaneous Steel

- Coordination
 - Continuous coordination of steel, CIP concrete, precast and GFRP panels
 - Structural and Mechanical/Plumbing models coordinated at end of Design Development
 - Continuous coordination of MEPF and structural models, occurred bi-weekly



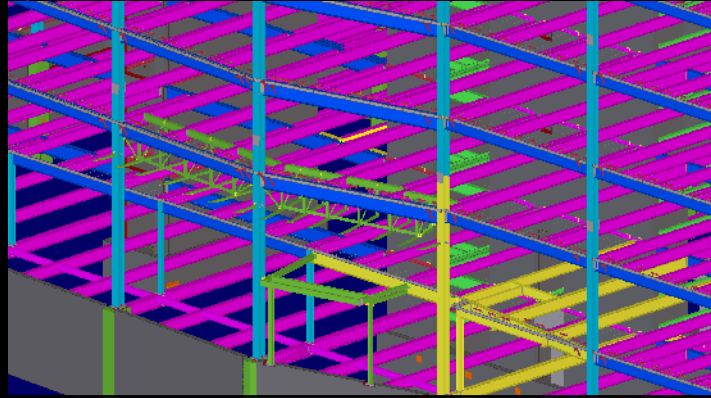
Structural and Miscellaneous Steel

- Coordination
 - Passing of structural and detailing Tekla model during completion of CD's and start of steel detailing
 - Coordination during construction:
 - SCI and Axis with independent Tekla models
 - Structural changes during detailing phase delivered to Axis via Tekla structural model for use in detailing modifications



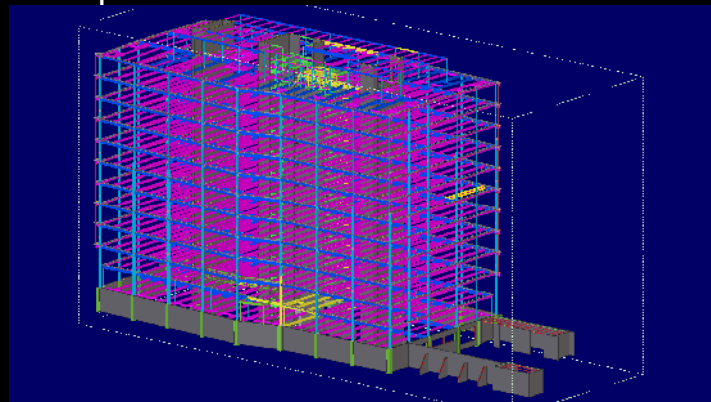
Structural and Miscellaneous Steel

- Detailing
 - Biggest challenge and payoff - upfront planning



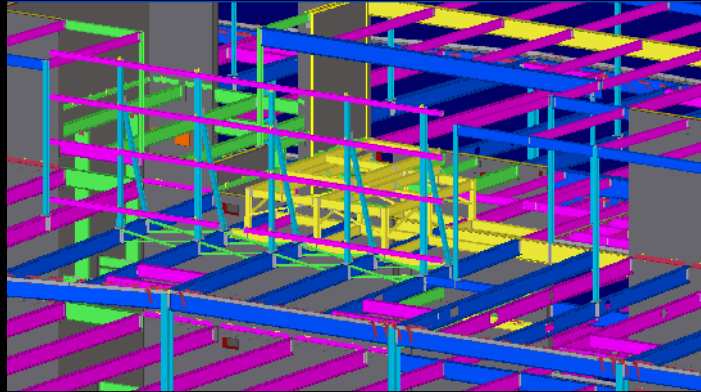
Structural and Miscellaneous Steel

- Detailing
 - Axis worked with SCI on initial set up of custom components



Structural and Miscellaneous Steel

- Detailing
 - Stayed ahead, easy to roll with changes as they came in



Structural and Miscellaneous Steel

- Detailing
 - Reduction in detailing hours
 - 1,600 traditional – as originally planned
 - 1,050 hours actual
 - Attribute to correcting model at the correct stage



Structural and Miscellaneous Steel

- Fabrication
 - Iterative, concurrent design / detailing processes
 - Expedited fabrication start following CDs – reduced by 56% (5 weeks)
 - Reduced initial steel delivery time following CDs by 50% (8 weeks)



Structural and Miscellaneous Steel

- Erection/Place Work
 - Where preceding work in design, detailing and fabrication bears fruit
 - Only two RFIs to date
 - Zero change orders in erection cost



Structural and Miscellaneous Steel

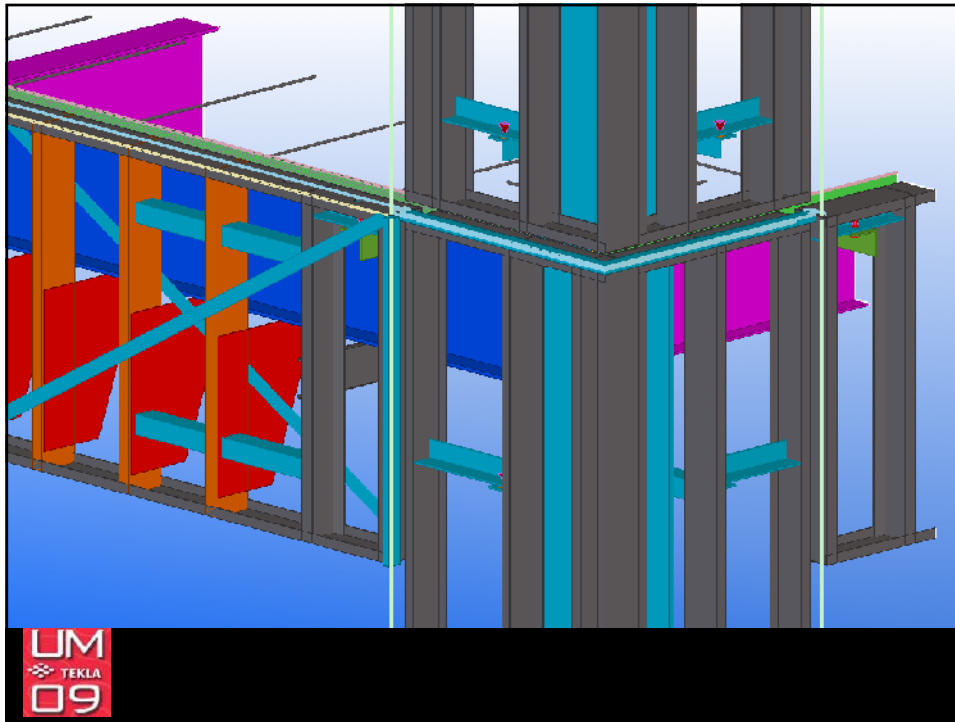
- Benefits
 - Design
 - Facilitated shop drawing review process – few review comments from all of design team
 - Very efficient structural system 8.6# / sf
 - Construction
 - 39% savings in detailing cost
 - \$250k mill order savings to owner
 - Reduced (nearly eliminated) RFIs



GFRP Exterior Panels

- Design, Coordination, Detailing, Fabrication
 - Designed GFRP panels for fabricator
 - Modeled outline of GFRP panels for coordination with structural frame
 - Many conflicts were found during coordination prior to fabrication of GFRP panels





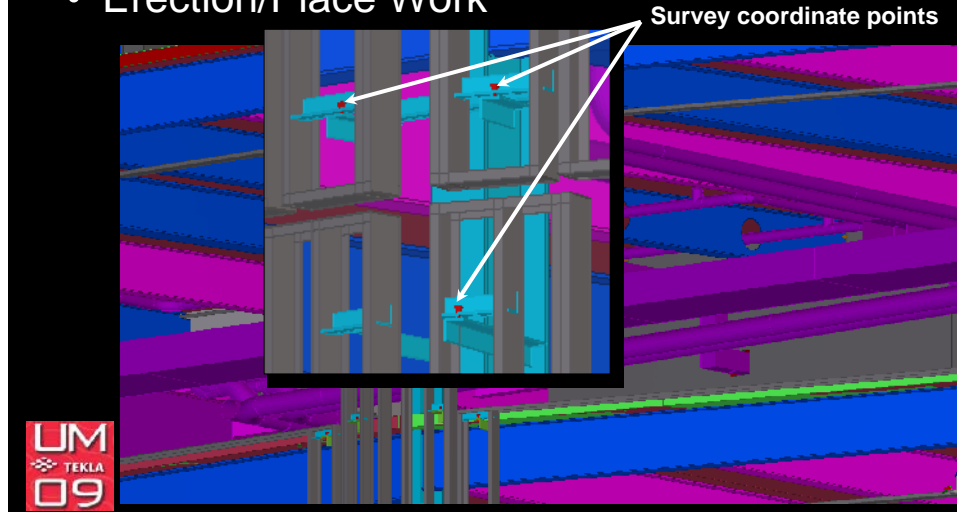
GFRP Exterior Panels

- Design, Coordination, Detailing, Fabrication
 - Extracted erection drawings and survey data for use with total station
 - Modeled x,y,z target coordinates for bracket locations of GFRP panel connections to structure



GFRP Exterior Panels

- Erection/Place Work



Exterior GFRP Panel

- Approach results in risk mitigation of using a new cost effective quality product.
- Team designed and modeled the panels and coordinated them into the project.
- The connection details of the panels were generated from the steel BIM Model.



Overall Results & Benefits

- Certainty from relying on model
 - Structural design is to fabrication tolerances
 - Multiple use cases for structural model on project
 - CIP
 - Coordination
 - Review and placement drawings
 - Bar bend schedules – procurement from model
 - Lift drawings



Overall Results & Benefits

- Certainty from relying on model
 - Multiple use cases for structural model on project (continued)
 - Structural & Misc Steel
 - Coordination
 - Sequence organization
 - Fabrication and review drawings
 - Fabrication model
 - Erection planning
 - GFRP
 - Design coordination (connections w/ steel frame)
 - Erection control



Overall Results & Benefits

- Owner Savings Summary
 - Reduced Direct Cost
 - \$113,000 CIP concrete reinforcing material
 - \$299,000 structural steel package
 - CIP work complete ahead of schedule



Where do we go next?

- Design Professionals of Record will expand their services to provide all needed deliverables and experience in a true Design/Build contractual relationship
- Re-instate craftsmanship within the Design office
- Clash Prevention vs. Clash Detection



Where do we go next?

- Define “Design / Build”
- Number of IPD projects is increasing, though still not majority of contracts
- Steps can be taken today on your traditional contract delivery methods to get benefit of IPD results



Where do we go next?

- Push model data into field survey equipment
- Use models for fabrication of new systems such as GFRP panels – erection drawings, fabrication drawings and/or data extracted, erection data, etc.
- Formation of design/construction teams very early in project maximizing efficiencies and maximizing value to all.



Life Cycle of Tekla through Design and Construction of Project

- Design
- Coordination
- Detailing
- Fabrication
- Erection/Place Work



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