Session 2A

BIM in Total Precast Construction

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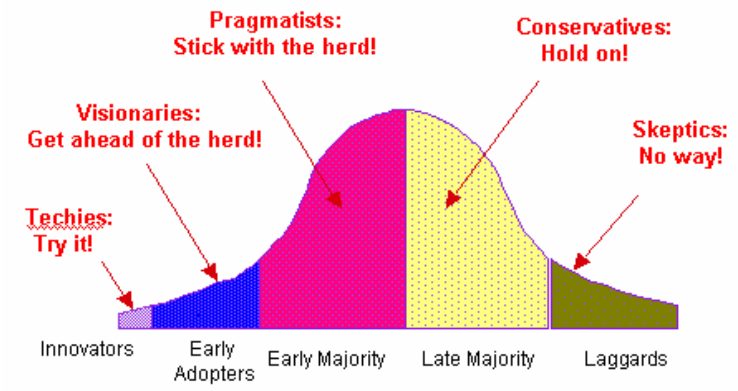
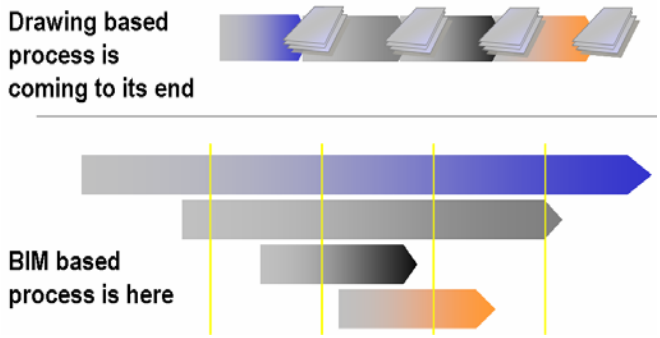
BIM - A New Era For Precast Concrete

Two-dimensional drawing has been the default method of the construction and architectural industry, dating as far back as 2500 BC. Several sectors – mechanical engineering, fabrication, steel detailing - have been early adopters and understood the significant advances of the new 3D software technology.



Precast concrete is significantly more complex than other materials. Perhaps this is the reason the most of the precast industry has not fully progressed beyond the 2D realm.

Understanding that the innovative architecture of today cannot be possible without 3D capabilities, in April 2001 frontline North American precast concrete detailers and fabricators came together to form the Precast Concrete Software Consortium (PSCS). Their objective was to identify or develop for the precast industry advanced 3D modeling capabilities and support its integration in all of their operations.

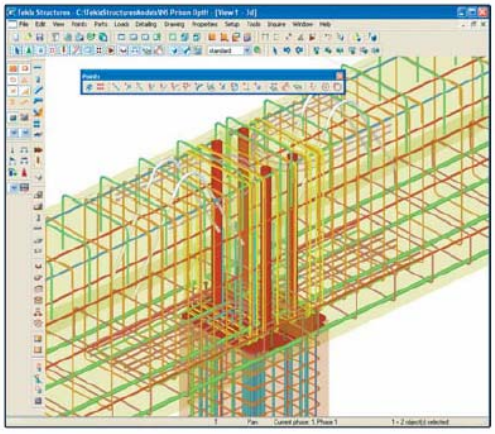


The consortium hired Dr. Chuck Eastman and his team from Georgia Tech, including Dr. Rafael Sacks and Dr. Ghang Lee, to evaluate 3D top-down parametric modeling applications. Tekla Corporation was selected from amongst software providers such as Autodesk, Bentley, Intergraph, Nemetschek and Solidworks to refine Tekla's 3D steel BIM market leader – Xsteel – to address the precast concrete requirements. Joint work between Tekla and PCSC began on a 3D beta development model that included architectural and structural finishes.

In September 2005, Tekla Structures Precast became a production software, expending Tekla's already impressive steel BIM capabilities with the ability to serve the precast industry.

Making 3D BIM A Standard For Precasters

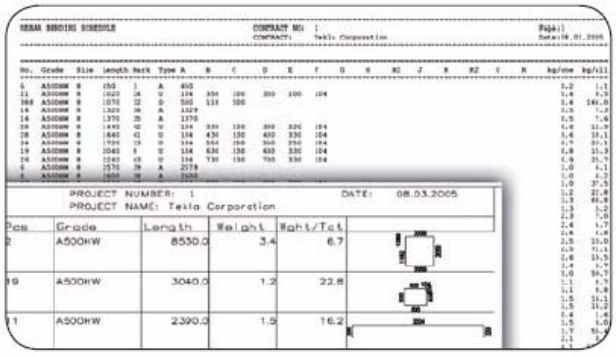
Precast concrete is an extremely attractive material to construct with. The material is low cost, and produced with consistent quality every time. There is an intrinsic advantage in terms of cost when compared to steel or other materials. It can be finished to provide an amazing range of appearances.



Easier than 2D drafting
– you can start modeling quickly.
Get immediate results while generating sound return on your investment. Over time, your efficiency and productivity will exponentially augment the benefits of modeling in Tekla Structures.

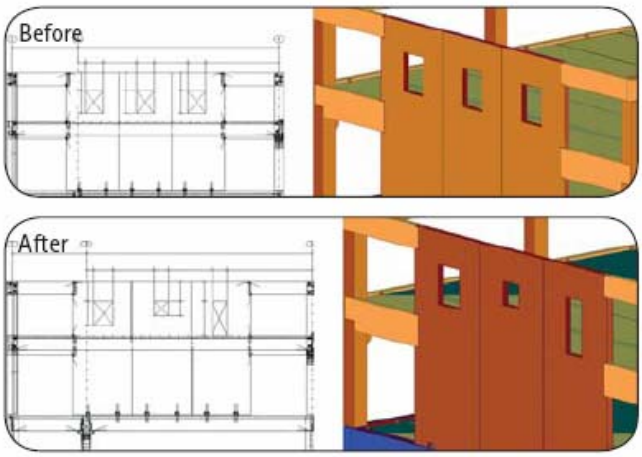
In order to fulfill the needs of the precast industry, a 3D BIM precast concrete solution must address not only the modeling of curved and complex surfaces but also the challenge that a designer has to consider the behavior of precast elements in two conditions: as manufactured, and as erected.

Tekla Corporation, with its Tekla Structures Building Information Modeling (BIM) software, has been working for many years to provide the most productive platform for precast concrete.



Automate your routine tasks, focus on design
Fully associative drawings and documents (e.g. bill of materials, BOM and bending schedules) are extracted from the model whenever needed.

In Tekla Structures Precast, all project information for estimating, manufacturing, erecting and finishing components are stored in a centralized 3D model. The all-in-one model makes Tekla Structures a unique modeling and detailing solution that integrates the entire structural workflow from sales and conceptual design to manufacture and erection. Structural drawings are fully integrated into the model, and are nothing else but another report. Contract drawings and reports can be automatically generated at any time throughout the process, and all drawings are fully associative with the model. A change in the model automatically updates the drawings.



Make late changes with ease
When changes occur, Tekla Structures' intelligence automatically keeps the model and drawings consistent.

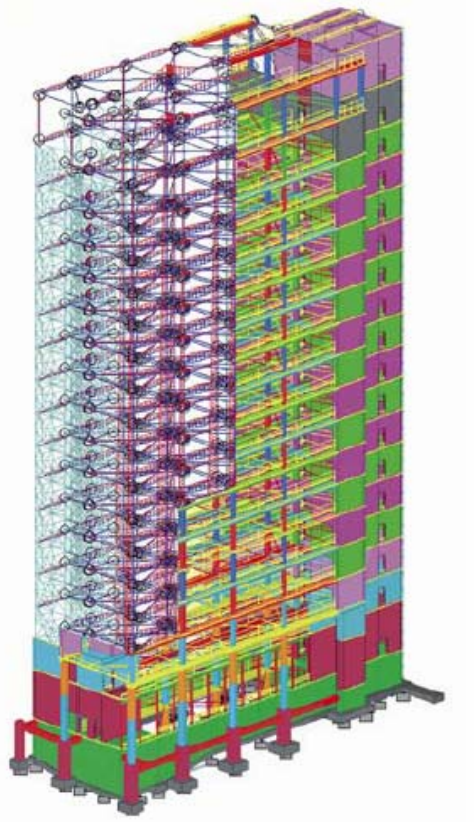
Change management is automated, resolving spatial conflicts in design coordination. Using such a 3D model alleviates most consistency issues.

The advantages of 3D product modeling are largely seen during the design phase. Using a common platform enables the same 3D model to be utilized for producing analysis

and design results, drawings and reports.

When changes do occur, the built-in intelligence automatically stores the modified information. This work process minimizes overlapping work phases and errors, which translates into shorter project lead times, significant cost savings and overall better building quality.

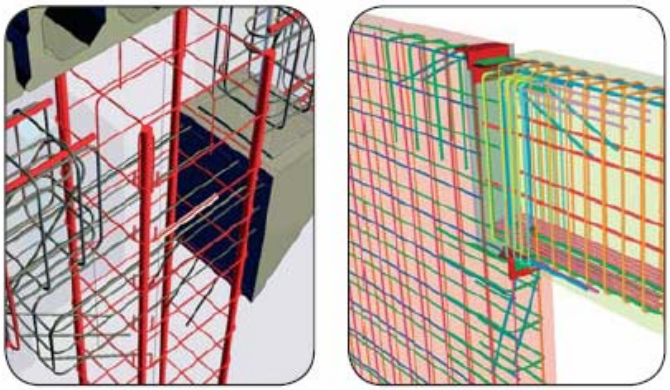
Specifically for precast projects, it is important to view the model and see which precast pieces have been approved, which pieces have been issued for approval and which pieces have been fabricated, shipped or erected. The data can then be presented as textual reports and drawings, and in 3D color view. Schedule data can be animated so that problem areas are easily spotted.



When it comes to analysis and design, the ability to create a single physical and analysis model in one integrated, easy-to-use interface – no in-between work phases – is extremely important in obtaining reliable results. Essentially, when you create the physical model you are actually creating the basis of the analytical model.

In practice, all engineers need to do is to define in the 3D model the member analysis conditions (i.e. fixed or pinned), add loads, create load combinations, etc. and "extract" the analytical model based on the finite element modeling solution they prefer, and analyze it. The results of the structural analysis can be transferred back to Tekla Structures and automatically incorporated into the model. This two-way transfer is seamless and lossless, which significantly shortens project lead time and allows users to use their favorite analysis and design tools in a tight integration with Tekla's 3D modeling environment.

Using a 3D BIM you can manage more than just the structural process: an information management interface supports project management matters as well. This capability enables efficient throughput and fluent collaboration with other parties involved.



Adaptive reinforcements and connections
Automatically attach to parts and follow all changes made to the part whenever it is revised.

All members of a project team can enjoy the advantages of real-time 3D model sharing. Multiple users can work simultaneously with the same model, regardless of location or industry. Once information is entered, it can be shared

throughout the process and is always up to date.

This capability allows users to track and view the status of projects, plan future actions, assign tasks, follow project progress and send/receive requests. The intelligent model stores numerous sources of information and then connects the design process to the corresponding project process. This makes it an ideal tool to address the needs of project managers, project designers and consulting engineers.

The data exchange can be accomplished using multiple data formats, including the open-format Industry Foundation Classes (IFC) standard that enables communication between different software and disciplines in the building industry and Open API (Application Programming Interface) to enable a wide range of third-party applications to integrate their functionality and/or communicate with the 3D modeling environment. Applications such as databases, MS Access, Excel, Word, or Mathcad, as well as commercial MIS and ERP software, can receive data from the Tekla Structures model, run calculations, and then return results back into the model.

The open API also makes it possible for users and 3rd party vendors to develop plug-in applications and additional functionality on the Tekla Structures modeling platform.

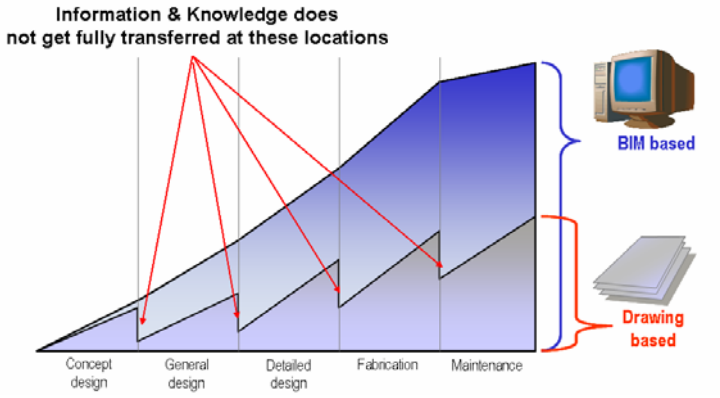
Tekla has acknowledged the importance of data exchange, and has worked within the International Alliance for Interoperability (IAI) to develop IFC. The latest milestone in the support for open data exchange mechanisms in building information modeling is the IFC 2x3 certification. Tekla Structures has received the IFC 2x3 1st Step Certification as part of the buildingSMART initiative of the IAI.

Using this ability, architectural, structural, mechanical, and electrical models can have open data exchange between them. Open data exchange provides the freedom to select the best application at hand without loosing connectivity to other disciplines, thus improving productivity across the industry.

True Productivity Benefits

Upon implementation of Tekla's BIM by precast producers and engineers, Dr. Rafael Sacks assessed the actual tangible benefits the Tekla application provides precast concrete users.

Based on a comparison between current modes of operation using 2D drafting with Tekla BIM software, Dr. Sacks and the Georgia Tech team found that by using the Tekla BIM solution there was an 80-84% reduction in drafting costs, a 35-51% reduction in engineering costs and the elimination of most design-related errors.



Moving from 2D drafting towards 3D BIM could potentially save a company up to 5.5% of total project costs. Off the top, users can save up

to 2% in errors. In short, using Tekla Structure's 3D modeling considerably improved accuracy and productivity in addition to reducing project lead-time.

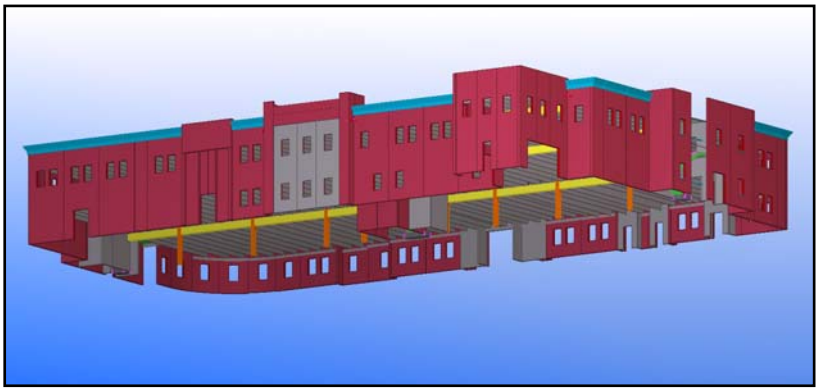
The Future

When asked about the long-term prognosis for the precast industry, Dr. Chuck Eastman chuckles clarifying that he is not a psychic. "We will see a big transformation in all precast vertical markets. 3D is a way for precast as a whole to compete and become more productive. Building Information Modeling (BIM) will be part of that growth. There is enough cultural and social awareness about BIM that it will eventually become part of our daily work process. Tekla has been BIM even before the name was created. And with its sound position in the automation back-end of the construction process, Tekla is on the leading edge of innovation."

Case Study: Frederick County Public Safety Building

In January 2006, the Shockey Precast Group (SPG), Howard Shockey & Sons (HSS), and Hayes, Seay, Mattern & Mattern, Inc. (HSMM) met to review the preliminary building sketches and overall building appearance for the Frederick County Public Safety Building. HSMM's project called for a tight schedule: from Notice to Proceed to Project Turnover, the project schedule was 17 months.

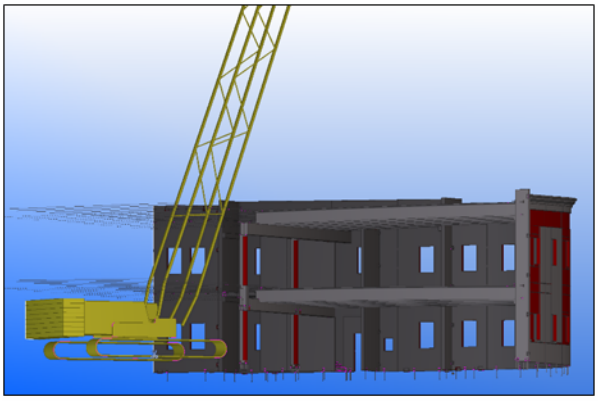
Upon review, SPG proposed to HSMM to use a total precast system rather than a steel and masonry system. HSMM accepted the proposal, and SPG decided to use the Tekla Structures Precast, 3D BIM capabilities on the project, and created an initial 3D model for HSMM's review. The use of Tekla Structure's visualization tools facilitated early MEP design decisions, and provided an easy ability to address architectural changes as the building concept continued to evolve.



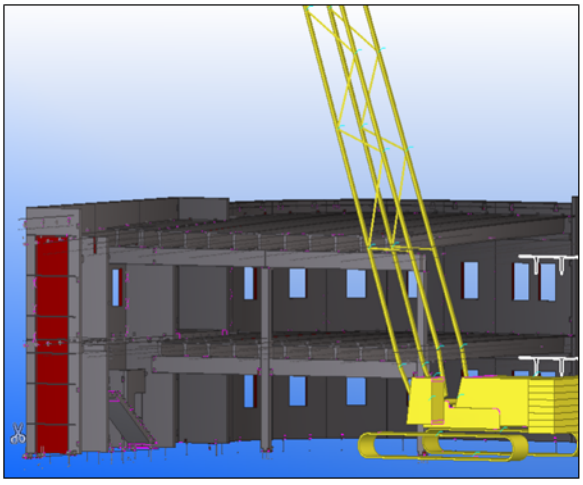
Following several meetings to review building panelization and precast color samples, it became apparent that the original anticipated start erection date of June 1 would be difficult to meet, and would require the majority of SPG engineering resources to meet the production/erection schedule.

By May 2006, SPG began production of the double-tee precast concrete pieces, and it became apparent that engineering was unable to supply information to the plant quickly enough to maintain constant flow of production. Upon discussions with HSS a revised erection start date of July 17, 2006 was established. By July 12th, SPG provided sealed 95% drawings and specifications to HSS, allowing HSMM to issue 95% construction drawings.

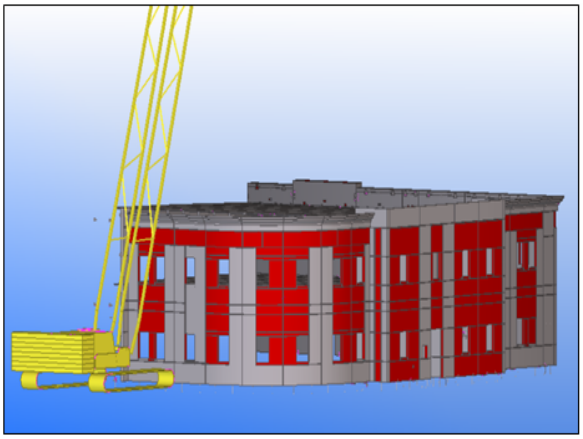
On July 17th Phase 1 erection began as planned, and continued until July 26th.



On July 26th the crane is moved and begins Phase 2 erection.

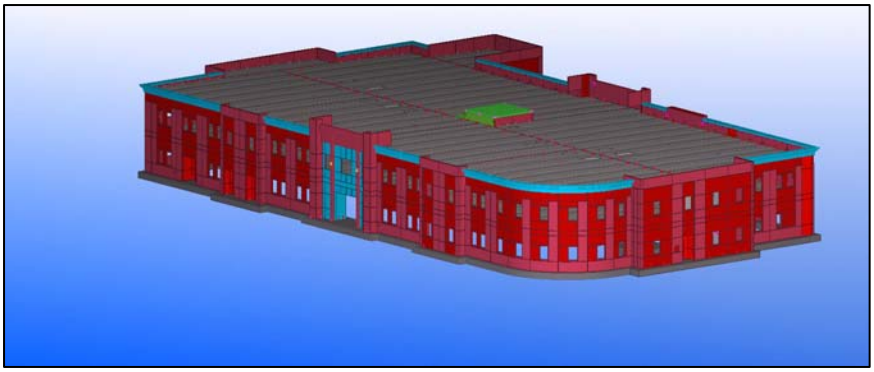


Erection continues according to schedule, and on August 1st Phase 3 begins.



By August 14th plumbing and electric follow-on trades begin work inside the building footprint. The crane moved on August 18th to begin Phase 5 of erection.

The erection is completed on August 22nd, 2006, three days ahead of schedule.



Key Benefits of Utilizing Total Precast System vs. Conventional Construction:

- The use of TEKLA's visualization tools on the Frederick County Public Safety Building facilitated early MEP design decisions.
- Reduced erection time – The Frederick County Public Safety building was erected in 5 weeks. The use of a total precast system resulted in a savings of 5 months to the overall schedule, as compared to a masonry/steel building.
- General Contractor's management costs (General Conditions) were reduced by $300,000 (out of a $16M project cost).
- Speed to market – From Notice to Proceed to Project Turnover, the original project schedule was 17 months. By incorporating a total precast system and utilizing Tekla modeling, the actual project schedule was reduced to 14 months.
- Increased safety – The decision to use a total precast system rather than steel and masonry meant a reduction of man hours in the field, and an increase of man hours in a controlled manufacturing environment. Lower man hours in the field translated to a decrease in the risk of injuries and lost time on the project.
- Sole source responsibility -- By putting responsibility for the "superstructure" in the hands of a single precaster, the need for coordination of submittals between several trades was eliminated.
- Speed to follow-on trades – The rapid erection time associated with total precast systems meant that the Frederick County Public Safety Building was a totally enclosed structure ready for doors and windows, and follow on trades, in just 5 weeks.