



Project Summary

Organization:
Flad Architects

Solution:
Buildings

Location:
Northwest United States

Project Objective:

- Relocate to mitigate seismic risk
- Design and build new facility in 24 months
- Take occupancy in 2008
- Be operationally qualified by 2010

Products Used:
RAM Connection V8i,
RAM Foundation V8i,
RAM Frame V8i, RAM Steel V8i,
RAM Structural System V8i, and
Revit Structure Link

Fast Facts

- Facility covers 300,000 square feet over 5 buildings
- Designed to International Building Code (IBC) Occupancy Category IV (Essential Facility)
- Designed to American Society of Civil Engineers (ASCE) 7 seismic importance factor of 1.50
- Completed engineering of buildings in 7.9 months
- Delivered design faster than 99.99 percent of projects

Bentley's RAM Structural System V8i Speeds Design of Biotechnology Fill-Finish Facility

Flad Architects Stays Ahead of Highly Aggressive 24-Month Design-Build Schedule Using 3D Models to Test Unconventional Solutions

Six weeks into the fast-track design of a \$450 million, 300,000-square-foot manufacturing facility, the structural design team had to determine billet quantities for procurement. Bentley RAM Structural System V8i enabled the team to estimate tonnage and produce material takeoff lists for five separate buildings. With the steel fabricator, erector, and detailer already on board, placing the order early gave the mill enough lead time to produce the rolled steel required to start construction on schedule.

This was just one of the challenges Flad Architects faced as project architect for a biotechnology fill-finish facility being relocated from a high-risk seismic zone to a lower-risk region in the northwestern United States. Once the location was finalized, the client's timeline was tight: Kickoff design in late 2006, take occupancy in 2008, and be fully operational by 2010 after a rigorous production system validation process. Operating under U.S. Food and Drug Administration (FDA) guidelines, the facility would have to achieve current Good Manufacturing Practices (cGMP).



Flad Fill-Finish South Facade

"The engineering of the buildings was completed in 7.9 months. According to industry standard information from Independent Project Analysis Inc., that is faster than 99.99 percent of projects delivered," said Bill McWilliams, FLAD senior structural engineer. "Considering that this cGMP fill-and-finish facility is such a highly complex building, this was a remarkable feat."

In addition to meeting an aggressive schedule, the project team was charged with designing the facility to withstand a seismic load well above the current code's minimum requirements. With a seismic importance factor of 1.50, the facility will withstand a 50 percent greater seismic load than a building designed to the base design load. That puts the plant in the Occupancy Category IV level, which represents essential facilities intended to remain operational during an extreme event. This is the same category that hospitals, fire and rescue stations, and emergency shelters fall.

One reason this manufacturing facility was given such importance is the potentially life-saving aspect of its products. The company creates medicines that improve patient quality of life and, in many cases, save lives. Lost production time in the event of an earthquake or other natural disaster could mean lost lives. This was a tremendous motivator for the 250+ design-build professionals and 500+ construction trades committed to the project.

Unconventional Solutions

The new fill-finish facility needed to meet current operational demands, accommodate future projected production, and serve as a backup for the client's partner company. Structural engineering began before many design parameters were known. "The ability to constantly update and reanalyze the design as previous assumptions became known was essential for the successful completion of the facility," said Craig Weisensel, Flad structural engineer.

Flad implemented RAM early on for the initial material take-offs, then used the models to refine the structural design and test seismic loads. The seismic system had to be readily available to fabricate and erect, but also perform to seismic design requirements. "When we did seismic design in RAM, we were designing above the code minimum. RAM determined that conventional steel braces wouldn't work," Weisensel said. "We looked for an unconventional solution, which was a concrete-filled tubular brace system. At that time, these weren't in the code. They were mentioned in a

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— Craig Weisensel,
Flad Structural Engineer.

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reference section commentary. There were other products we could have used, but we didn't have the time to get them made. We needed to fabricate and detail quickly. RAM allowed us to make the concrete fill work. We were able to check each brace on an individual and schematic basis."

Another major challenge was estimating the loads before receiving specifications for the equipment that would be in each area. "We knew what the building sizes and shapes would be, but not what was going into them," McWilliams said. "We had a pretty good idea of what equipment would be where. As information came in, we took out the good guesses about the loads and put the real loads in the models."

In one building, a 90,000-pound piece of equipment would be suspended from three-stories above. The team determined the movement of an object roughly the size of a railroad car during different seismic events and designed a support system that would keep it from ripping apart. "This was a special piece of equipment designed for this project," McWilliams said. "We had the dimensions and laid it out in RAM, then the size changed. We readjusted the dimensions in RAM, which was really quick, then redesigned the area with reinforcing steel plates." It took a few more design iterations to finish the area, as details about adjacent equipment and access platforms became available.

Least Cost Scope

Progressing the design with so many unknowns could have resulted in escalating costs, as the design team rushed to find solutions that could be accomplished within the time constraints. Using RAM to quickly model alternative approaches not only saved time but also avoided overly conservative solutions.

"Architecturally, we were working under a tight guaranteed maximum price in the design-build contract," McWilliams said. "We had to do a least cost scope—move fast, don't overdesign, and don't be redundant. Be economical and smart."

The connection check feature in RAM Steel V8i helped speed up the fabrication process and enabled the team to stay ahead of the construction schedule. The fabricator sent a list of preferred connections, and the engineers incorporated the connections into the design using the connection check feature. The fabricator was able to choose the connections that could be fabricated most efficiently.

Coordinating with the other disciplines also helped prevent field changes and control costs. On three occasions, the client convened a conference of professionals representing mechanical, electrical, plumbing, process, civil, lighting, instrumentation, and automation to report progress, troubleshoot, and plan ahead. Weekly Building Information Modeling (BIM) coordination meetings held online for participants throughout the United States and in Europe kept the project on schedule and resolved any conflicts.

The project was fully coordinated in BIM including all deliverables and project content from all architecture and engineering disciplines, as well as manufacturing process and equipment vendors. This BIM model facilitated routine clash detection reviews and design coordination. The structural design team provided up-to-date RAM models to Revit and AutoCAD 3D, saving a tremendous amount of time. It took just a few minor adjustments to ensure the accuracy of the final 3D BIM.

If Flad Architects had not been using 3D modeling tools, designing this facility would have taken five to 10 times longer. "It's so much faster with RAM. The output is clear and we can review it easily," Weisensel said. "We revisited the model over and over again and redid things. That would have been unheard of in the past."

McWilliams added, "The client had to be moved into the facility on a timeline to get the manufacturing process validated and up and running. We could not have met that timeline without a system that could go through design and redesign repeatedly at the speed that RAM does."



Flad Fill-Finish East Facade