

DBM VIRCON

Case Study

Digital Delivery in Extreme Terrain: The Pretty Rocks Slide Bridge

The Pretty Rocks Bridge project in Denali National Park is a flagship example of how **Integrated Design and Detailing (IDD) can compress schedule, de-risk construction and raise the quality bar on a complex steel truss bridge fabrication and erection.**

For DBM Vircon, it was the ultimate test of its integrated digital engineering capability: taking a 475-foot single-span weathering steel Warren truss, to be launched over an actively moving rock glacier in remote Alaska, from concept to fully detailed, fabrication-ready model in just five months.

Project Overview

Denali National Park and Preserve is accessed by a single 92-mile long gravel road cut into steep, permafrost-affected terrain. Halfway along the only road that accesses the third largest national park in the US along with the largest mountain in North America, the Pretty Rocks landslide, essentially an ice-rich rock glacier, has been slowly deforming the escarpment for decades. Movement increased from inches per year prior to 2004 to inches per month by 2017, and ultimately to more than five feet per month in 2021, as warming temperatures accelerated permafrost thaw.

By late summer 2021, the Denali Park Road could no longer be safely maintained, and access beyond the Polychrome region was lost to the more than 600,000 tourists per year visiting the park from all over the world. The alignment sagged and dropped out from under maintenance crews, resulting in a loss of access that cost the local Alaska economy an estimated $1.79 billion per year.

The Federal Highway Administration and the National Park Service ultimately selected the “Polychrome Area Improvements” concept: a new 475-ft-long, 50-ft-tall, 26-ft-wide steel truss bridge spanning over the Pretty Rocks landslide, combined with additional slope stabilization and road realignments nearby.

The project was delivered under a General Contractor-Construction Manager model, with Jacobs as lead designer, BGC Engineering as geotechnical engineer, Granite Construction as general contractor, KWH Constructors and Somerset Engineering as the steel erector and erection engineer, and DBM Vircon as the IDD partner and steel bridge detailer.



Key Challenges

1. A LIVE, CLIMATE-DRIVEN LANDSLIDE

Pretty Rocks is not a static slope failure but a rock glacier: a mass of debris and ice with movement occurring both along a basal shear plane and internally through creep. Borings identified ice-rich permafrost with ice seams up to 15 feet thick beneath the existing road and a thick, unstable clay unit dipping steeply toward the valley, making conventional cut-and-fill reconstruction impossible. Movement accelerated from minor cracking to more than 12 inches per day in 2021. Any solution had to bypass the moving mass entirely and be tolerant of long-term permafrost degradation.

2. EXTREMELY CONSTRAINED SITE AND LIMITED SEASON

The bridge sits on a narrow mountain bench above a 600-foot drop, with virtually no level ground available for staging and an active slide beneath the entire span. Access is via a single-lane gravel road with strict environmental, wildlife, and operating restrictions inside Denali National Park. Construction is limited to roughly May to September each year due to snow, cold, and darkness.

3. COMPRESSED SCHEDULE AND HIGH STAKEHOLDER RISK

The initial procurement contemplated a pre-engineered truss with substantial completion by late 2023, but this risk profile was unacceptable to industry. The Federal Highway Administration and the National Park Service targeted reopening as quickly as possible, which meant pushing design, detailing, steel procurement, and temporary works design in parallel rather than sequentially. The team needed to advance the bridge from 30% concept design to 100% Issued for Construction (IFC) in five months while also finalizing the erection strategy.

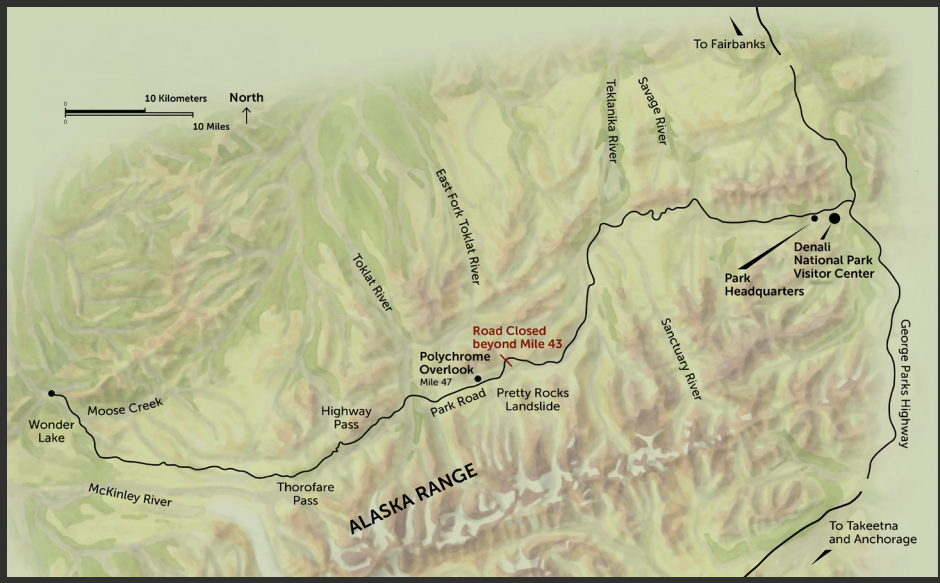
4. COMPLEX FOUNDATIONS AND PERMAFROST MANAGEMENT

Both abutments sit as close as possible to the slide margins on relatively competent rock, but investigations revealed fractured rock, clay seams, and permafrost with significant ice content. The foundation solution combines precast modular abutment blocks, ground anchors, battered micropiles, soil nails, rock dowels, and a field-installed array of 23 thermosiphons to maintain frozen conditions beneath the east abutment for the long term.

5. LAUNCH-CONTROLLED STRUCTURAL BEHAVIOR

Given the moving ground beneath and the inability to use falsework in the landslide zone, the team selected an incremental launch scheme: building the permanent truss on the east side with a temporary “launching truss within the truss” and then pushing the entire 475-foot span across to a receiving tower on the west abutment before jacking it down into final bearing.

This meant many members and connections had to be designed for both cantilever “diving board” and final simple-span states, with full stress reversal in some diagonals and chords. Launch engineering and permanent design were tightly coupled, and the model had to reflect both states.







Engineering Solution

BRIDGE AND SUBSTRUCTURE

The adopted solution is a single-span weathering steel Warren truss, 475 feet long and 50 feet deep, carrying an 18-foot single lane roadway on a 24-foot wide deck. Primary members are welded box-section chords and end posts, welded H-section diagonals, and welded I-section floorbeams, with remaining framing in rolled wide-flange, channel, and angle sections. Many gusset plates use higher-strength ASTM A709 Grade 70W to minimize weight.

The deck is a steel Sandwich Plate System (SPS) with a urethane core, chosen for its light weight, its stiffness, and its ability to be installed in small, modular panels compatible with the remote site and limited crane capacity.

Each abutment is formed from thirteen 4 ft × 4.5 ft × 15 ft precast reinforced concrete blocks, each weighing approximately 40,000 lbs, post-tensioned together on site and anchored into the rock with vertical ground anchors and subhorizontal micropiles extending roughly 40 feet into the formation.

On the east side, a soil nail wall with wire mesh facing stabilizes the fractured rhyolite above the abutment, while on the west side a pattern of rock dowels reinforces the basaltic rock cut. An array of CO_2-charged thermosiphons, modeled against climate projections through 2100, keeps a critical ice lens beneath the east abutment in a frozen state despite ongoing warming.

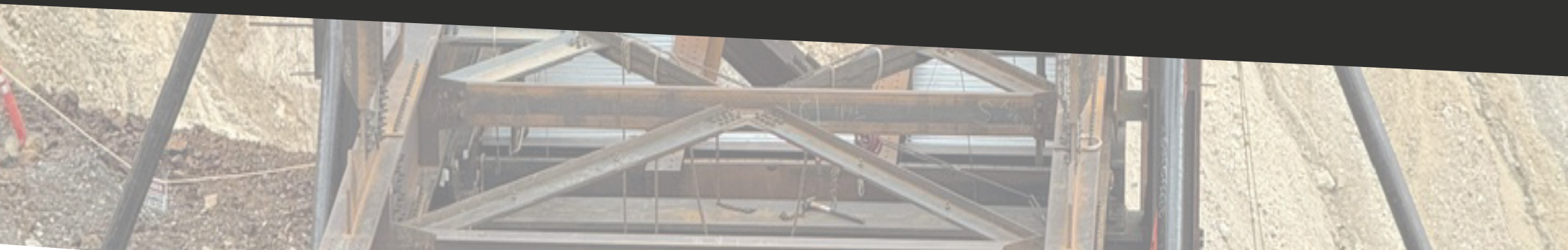
Isolation bearings at each abutment accommodate differential movements and limit seismic demand on both the foundations and truss, with fused bolt connections designed to resist extreme wind but shed excessive transverse seismic forces.

CONSTRUCTION AND LAUNCH

Approximately 1.6 million pounds of permanent truss steel and a similar quantity of temporary steel were CNC-fabricated at a facility in Portland, Oregon, where KWH conducted a full trial assembly before components were shipped by truck, barge, and rail to Alaska and then trucked through the park in tightly controlled night-time convoys just in time due to extremely limited site laydown.

On site, the team assembled the permanent truss on the east abutment, with a nested launching truss and nose providing stiffness and support during the incremental launch over the void. Once the nose reached the receiving tower on the west abutment, the truss was jacked down approximately 14 feet into its final support position.

All of this depended on extraordinary digital precision. That is where DBM Vircon's Integrated Design and Detailing services became the backbone of the project.





DBM Vircon's Scope of Work: Integrated Design and Detailing

1. BRINGING BRIM AND IDD TO A REMOTE TRUSS BRIDGE

DBM Vircon is a long-standing specialist in 3D bridge information modeling, with more than 400 bridge projects delivered, multiple National Steel Bridge Alliance Bridge of the Year awards, and over 15 years of customizing Tekla Structures specifically for complex steel bridges.

For Pretty Rocks, DBM Vircon was engaged from day one as part of the IDD task force; not as a downstream detailer, but as a core design-assist partner. DBM Vircon's mandate was to:

- Develop the 3D bridge model and erection geometry in parallel with the design engineer.
- Generate fabrication-ready, LOD 400-level models for all truss steel, deck steelwork, and abutment steel interfaces.
- Support rapid Advanced Bill of Materials (ABM) creation so the steel mill order could be placed before final IFC plans were sealed.
- Enable Virtual Model Approval (VMA) workflows so that the digital model, not a stack of 2D drawings, became the single source of truth.

2. GEOMETRY-DRIVEN DESIGN: FROM 30% TO 100% IN FIVE MONTHS

The IDD team (which included Jacobs, KWH, Granite and DBM Vircon) met up to three times per week. Within this environment DBM Vircon first built a 3D wireframe geometry of the bridge and launch system, iterating it continuously with Jacobs as the main member sizes and launch strategy were refined.

Crucially, design and detailing occurred concurrently. As Jacobs advanced analysis and member design, DBM Vircon modeled those members at full fabrication detail, including plate thicknesses, cope details, cut lengths and camber, hole patterns, and weld preparations.

These constructible models drove ABMs and CNC data that enabled the project to place the steel mill order before the plans were fully stamped and sealed. This was a first for many on the team and only achievable because the model had effectively reached fabrication level of definition ahead of traditional documentation.

Over roughly five months (February to June 2023), the project moved from 30% to 100% design, releasing two to three design sheets per week while the fabrication model was being completed in parallel.

Granite estimates that this IDD approach cut around seven months from the conventional detailing schedule.



3. VIRTUAL MODEL APPROVAL IN TRIMBLE CONNECT

DBM Vircon exported the Tekla production model to Trimble Connect, where it became the shared coordination space for designers, fabricator, erector, contractor, and owner. Key practices included:

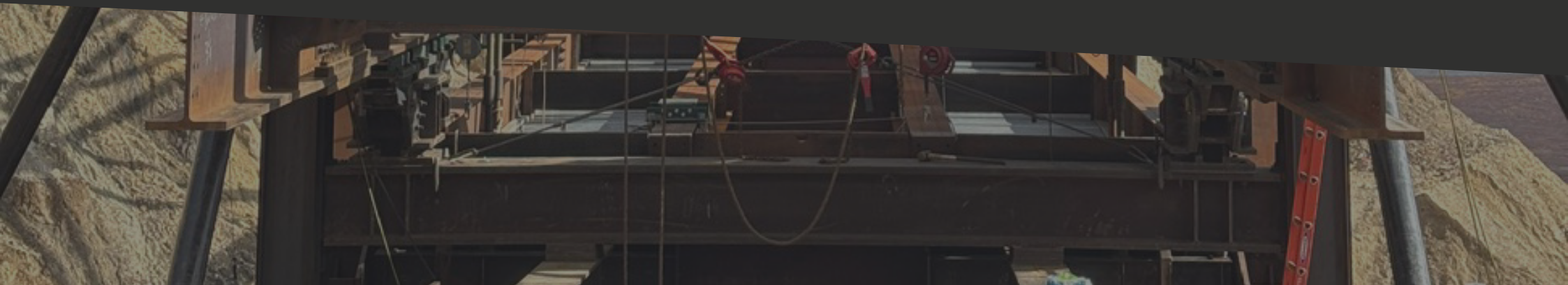
- Model-based review: Curated viewpoints of critical joints (such as bottom chord connection at L5), each overlaid with 2D drawings in Trimble Connect so reviewers could see dimensions, bolt edge distances, weld sizes, and material grades directly against the 3D context.
- Clash detection and constructibility checks: DBM Vircon used the 3D environment to test clearances for tooling, hand access, crane envelopes, and temporary launch frames; this was especially important for the proprietary one-sided LeJeune bolts, where wrench swing and access were tight inside box sections.
- Multi-phase model overlays: Different IFCs for design phases and temporary works could be viewed simultaneously (such as cambered truss geometry vs. launched geometry vs. final in-service shape), helping launch engineers and designers visualize stress-reversal states.
- Because approvals occurred in the model rather than solely on drawings, RFIs were resolved in real-time. Discussions that would typically span multiple RFI cycles were instead handled in IDD work sessions, with DBM Vircon updating the model live and immediately exposing the changes to all participants.

4. FABRICATION DETAILING AND CNC DATA

From the fully detailed Tekla model, DBM Vircon generated:

- Complete connection design and detailing for chords, diagonals, floorbeams, bracing, and deck support steel, with bolt patterns optimized for one-sided installation and exterior-facing nuts to improve worker safety during erection.
- CNC data files (CNC-drill and cut) for all main plates and rolled sections, enabling the fabrication facility to drill every bolt hole and cut every plate to size prior to any trial assembly.
- Piece marks, shipping groupings, and even truck-loading views used by Granite and KWH to plan staging, transport, and on-site assembly sequences.

The payoff was exceptional dimensional control. Out of approximately 20,000 modeled bolts, field crews reported only a single bolt that did not fit, and zero reamed holes on a 475-foot truss launched in one piece in an Alaskan wilderness.



5. SUPPORTING CONSTRUCTION AND LAUNCH ENGINEERING

Because DBM Vircon's model captured both permanent and temporary works, it became a live construction planning tool:

- Launch truss geometry, nose configuration, jack locations, and temporary tower interfaces were all modeled and visualized, allowing Somerset and Jacobs to validate launch stresses and deflections against the structural analysis.
- Access openings, panel boundaries, and bracing sequences were adjusted in the model to give ironworkers safe working space and logical "triangle-per-week" erection sequences during build-out on the east abutment.
- Trimble Connect was widely used in the field; foremen carried tablets and could interrogate the 3D model directly for bolt lists, part locations, and sequencing rather than deciphering complex 2D connection drawings in isolation.

This tight feedback loop between digital model and field conditions is at the heart of DBM Vircon's IDD service offering.



Outcomes and Future Impact

As of late 2025, the Pretty Rocks truss has been successfully launched from the east abutment, landed on the west receiving tower and jacked into its final position, with deck installation and approach works scheduled for completion in 2026 and full public access to Denali's interior expected in 2027.

From DBM Vircon's perspective, the project has delivered several clear outcomes:

- **Schedule compression with no compromise in quality.** IDD and Virtual Model Approval enabled the team to move from 30% to 100% design while simultaneously producing fabrication-grade models, bringing steel procurement forward and shaving months off the critical path.
- **Exceptionally accurate steelwork.** Model-driven CNC drilling and assembly allowed a 475-foot truss to be assembled, trial-fit, shipped, re-assembled, and launched with virtually no field rework. This is an outcome that would be remarkable on any project, let alone one in the middle of an active landslide in rural Alaska.
- **A proven template for climate-resilient infrastructure.** Pretty Rocks is one of more than 140 unstable slopes along the Denali road. The combined geotechnical, structural, and digital strategies used here (including bridging over active movement, leveraging thermosiphons, and using IDD for rapid, high-confidence project delivery) now form a reference model for future climate-adaptation projects in permafrost and landslide-prone environments.

For DBM Vircon, Pretty Rocks demonstrates that for the next generation of complex, high-risk steel bridge projects, Integrated Design and Detailing is not a "nice-to-have" but the critical delivery mechanism. By embedding BrIM experts directly into the design and construction team, and by elevating the 3D model to the central contractual and technical reference, DBM Vircon helped turn an almost unbuildable project into a constructible, climate-resilient bridge that will reconnect visitors to the heart of Denali for decades to come.

