NAC **Executive Insights**

Safety Insight: Design Related Failures

Key Points

- Design-related failures often originate upstream—before construction begins—and are rarely caught without independent review or robust quality control.
- These failures include calculation errors, overlooked load paths, inadequate detailing, and missed inspection triggers.
- When peer review is absent or superficial, latent design flaws can propagate into field execution, leading to collapse or structural compromise.
- Governance interventions—such as mandatory peer review, QC documentation protocols, and stop-work triggers tied to design anomalies—are essential.
- This insight outlines the operational signature, governance triggers, and training priorities needed to address this failure mode.

When the Blueprint Becomes the Weak Point

Construction failures are often blamed on field execution. But in many cases, the root cause lies upstream—in the design itself. A miscalculated load, an overlooked connection, a missing detail in a structural node—these are not field errors. They are design deficiencies that embed risk into the project from the start.

What makes these failures especially dangerous is their latency. A flawed design may pass through multiple stages—planning, procurement, mobilization—without detection. It's only when the structure is loaded, stressed, or exposed to environmental forces that the flaw reveals itself. And by then, it's often too late.

Design-related failures are not limited to complex structures. They occur in pedestrian bridges, billboard frames, concrete pours, and steel connections. What they share is a breakdown in quality control and peer review—two governance mechanisms that are often underutilized or bypassed entirely.

Representative Case: Pedestrian Bridge Collapse

A pedestrian bridge designed with an unconventional truss configuration collapsed during post-tensioning. The design had passed internal review but lacked independent peer validation. The node

that failed had been flagged in earlier drafts but was never reanalyzed. QC documentation was incomplete, and field crews were unaware of the design's sensitivity to load sequencing.

The collapse killed multiple people and triggered national scrutiny. Investigators cited calculation errors, inadequate detailing, and lack of peer review. The incident wasn't just a design failure—it was a governance failure. The systems meant to catch the flaw had been sidelined.

Why This Failure Mode Persists

Design deficiencies are often invisible until they manifest. Several systemic factors contribute to their persistence:

- **Peer Review Gaps:** Many projects skip independent review, relying on internal checks that may lack rigor or objectivity.
- **QC Documentation Shortfalls:** Quality control is often informal, undocumented, or disconnected from field execution.
- **Schedule Pressure:** Design teams may rush deliverables, deferring detailed analysis or relying on assumptions.
- **Field Disconnect:** Crews may not be briefed on design sensitivities, leading to misaligned execution.
- **Inspection Blind Spots:** Critical nodes may not be flagged for enhanced inspection, especially if design anomalies are undocumented.

These failures are not just technical—they are procedural. They reflect a lack of governance discipline in how designs are reviewed, documented, and communicated.

Governance Triggers and Operational Controls

To prevent design-related failures, governance must intervene early and reinforce traceability throughout the project lifecycle. Recommended controls include:

- **Mandatory Peer Review:** All critical structural designs must undergo independent peer review, with documented findings and resolution tracking.
- **QC Documentation Protocols:** Quality control must be formalized, traceable, and tied to specific design elements and field actions.
- **Design Briefings for Field Crews:** Crews must be briefed on design sensitivities, load paths, and sequencing requirements.
- **Stop-Work Triggers:** If design anomalies are discovered during execution, crews must have the authority to halt work pending review.
- **Inspection Mapping:** Critical nodes must be flagged for enhanced inspection, with checklists tied to design assumptions.

These controls ensure that design flaws are caught before they become structural failures—and that field execution is aligned with design intent.

Training Priorities and Cultural Shifts

Design governance requires both technical training and cultural reinforcement. Recommended modules include:

- **Design Verification Literacy**: Engineers and reviewers must be trained to spot calculation errors, load path gaps, and detailing omissions.

- **QC Documentation Discipline**: Teams must learn how to document, trace, and communicate quality control findings.

- **Field–Design Integration**: Training should bridge the gap between design teams and field crews, emphasizing shared understanding.

- **Regulatory Compliance**: Codes such as ANSI/AISC, ACI, and OSHA 1926.703 must be embedded in both design and execution workflows.

- **Case History Briefings**: Real-world design failures should be studied to reinforce the consequences of governance gaps.

- **Safety Culture Activation**: A mature safety culture ensures that design risks are not just identified—they are actively mitigated through shared values, daily behaviors, and leadership commitment. Toolbox talks, Accident Hazard Analyses, and pre-task planning must embed design-related hazards into routine dialogue, empowering crews to challenge assumptions and uphold life-safety standards.

This training must be paired with a cultural shift: design is not just a technical deliverable. It is a safety-critical artifact that must be reviewed, documented, and enforced—within an organizational culture that treats every design decision as a potential life-safety impact.

Why This Insight Matters

Design deficiencies are among the most preventable failure modes in construction. They occur upstream, before materials are ordered or crews mobilize. But without peer review, QC discipline, and field alignment, these flaws can propagate silently—until they cause collapse.

This Executive Insight provides a roadmap for prevention. It shows where governance must assert control, where documentation must be enforced, and where training must evolve. It's a call to treat design not just as a blueprint, but as a safety-critical system with traceable accountability.

About the Author

Bob Prieto was elected to the National Academy of Construction in 2011. He is a senior executive who is effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering, and construction industries. Bob received the 2024 ASCE OPAL Award (Outstanding Projects and Leaders) for his Outstanding Lifetime Achievement in Management.