RAM® Concept

Reinforced and Post-tensioned Concrete Design

RAM Concept is the ultimate structural designer's solution for post-tensioned and conventionally reinforced slabs, mats, and rafts. RAM Concept empowers structural engineers to design floor systems much more cost effectively than with other applications, and with exceptional visibility into the compliance, efficiency, and practicality of the design. RAM Concept interoperates with a number of engineering applications and formats, allowing the work done by an engineer to extend to other purposes during a project including building information modeling, documentation, and collaboration with other structural designers.

The CONNECT Edition

The SELECT® CONNECT Edition includes SELECT CONNECT*services*, new Azure-based services that provide comprehensive **learning, mobility,** and **collaboration** benefits to every Bentley application subscriber. *Adaptive Learning Services* helps users master use of Bentley applications through CONNECT Advisor, a new in-application service that provides contextual and personalized learning. *Personal Mobility Services* provides unlimited access to Bentley apps, ensuring users have access to the right project information when and where they need it. *ProjectWise® Connection Services* allow users to securely share application and project information, to manage and resolve issues, and to create, send, and receive transmittals, submittals, and RFIs.

> *"The project we were working on was a 32-story condominium with post-tensioned flat slabs in Miami, Florida, and with the improved link between RAM® Structural System and RAM Concept we were able to do in one day what previously took us 10 days. Our firm has found many benefits to using RAM Structural System and RAM Concept together."*
>
> — *Alex Salmin, P.E.*

Slab Design for the Practicing Engineer

Bentley developed RAM Concept with the practicing structural designer in mind. Several key features automate the time-consuming tasks engineers spend much of their day performing. RAM Concept offers capabilities that automate the layout of tendons, design spans, and column and middle strips. Modeling commands allow for fast rework of floors when geometric revisions are necessary. You can easily
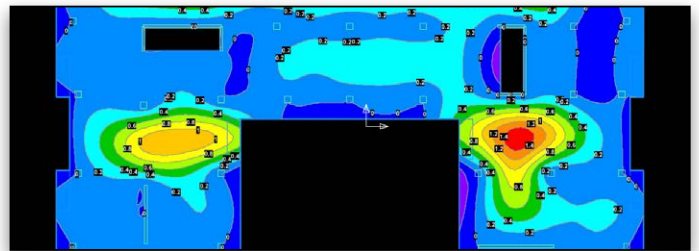
Predict accurate long-term deflections considering cracking, creep, and shrinkage.

access a wealth of information and results using a well-organized, layer-themed interface. Both auto-design and specify-check methods are available to the user with the ability to override any program-selected design entities.

The cloud-based post-tensioned slab optimization feature helps reduce total tendon, reinforcement, and studded shear reinforcement costs for the entire floor and eliminates the need for tedious manual iteration.

Realistic Tendon Modeling

RAM Concept allows tendons to be modeled in their true three-dimensional positions. Banded, distributed, or arbitrary tendons with virtually any profile can be easily modeled. RAM Concept tendon loading analyses consider full 3D hyperstatic (secondary) effects, including restraint from shear walls and stiff columns. These features facilitate a better understanding of the effects of tendons on the slab.

Accurate Punching Shear Analysis and Design Software

RAM Concept can check punching shear capacity for any irregular slab geometry. It automatically designs studded shear reinforcement (studrails) as required, eliminating the time needed to simplify real punching geometry into standard interior, edge, and corner conditions. Punching shear can be checked and reinforcement designed at columns below slabs and at transfer columns on floors and mats/rafts. These capabilities can save a day of design time on every slab.

Accurate Analysis of Long-term Slab Deflections

RAM Concept features load history analysis, a method for calculating deflections with accurate consideration of time-dependent material behavior, cracking, and load history. These results consider the effects of cracking, creep, shrinkage, tension stiffening, and load sequence. The load history feature provides the precision needed to assess long-term deflections accurately while keeping run time and processing demand within reason.

RAM Concept At-A-Glance

Flexible Structural Modeling
- Elevated floors, mats, and rafts
- One-way and two-way slabs, pan joists, waffle slabs, beams, and girders
- Orthotropic or isotropic slab properties
- Drop caps, drop panels, and random thickenings of any shape at any location
- Openings of any shape at any location
- Wall, column, point spring, and line spring supports
- Zero-tension area springs to model soil
- Accurate modeling of irregular structures
- Imported CAD drawing as snapping background
- Automated meshing

Tendon Modeling and Design
- Banded, distributed, and arbitrary tendons with virtually any profile
- Capabilities for automating tendon layouts over large areas
- Specify explicit tendon properties and quantities or a desired effective tendon force
- Automatic calculation of tendon profile based on desired balance load
- Friction losses including consideration of horizontal curves
- Analysis includes 3D hyperstatic (secondary) effects
- Post-tensioned slab optimization feature that reduces total tendon, reinforcement, and studded shear reinforcement costs over entire floor

Loading Analysis
- Fx, Fy, and Fz point, line, and area force loads
- Mx and My point, line, and area moment loads
- Self-weight and tendon loadings calculated automatically
- Self-equilibrium loadings available for integrating floor-system analysis with building frame analysis
- Temperature and Shrinkage Loadings
- Loads can be filtered through arbitrary-shaped patterns with on-pattern and off-pattern factors
- Pattern loading effects automatically enveloped together
- Live load reduction in accordance with ASCE 7, AS/NZS 1170.1, BS 6399-1, IBC, IS 875, UBC, or EC1
- Tributary/influence areas may be specified or calculated by the program
- Automatically generated load combinations for each design code
- Optional user-specified load combinations (no limit)
- Two load factors per loading, allowing easy enveloping of maximum and minimum forces
- Zero-tension area spring results for mat/raft foundations

Analysis Methods
- Determine response of floor to walking-induced vibrations
- Specify walking excitation areas
- Solve for modes of vibration and peak accelerations and velocities

- Long-term deflections considering cracking, creep, and shrinkage
- Specify any number of steps in load history

Steel Reinforcement Modeling and Design
- Auto-selection of reinforcement by program or design-check of specified reinforcement
- Specify a uniform mesh of reinforcing over an area, with only additional required reinforcing designed
- Automatic calculation and consideration of development lengths and hooks
- Enforce custom detailing preferences
- True 3D representation and display of tendons, reinforcing bars, and shear reinforcement
- Export reinforcement to Revit through Bentley's Integrated Structural Modeling (ISM) format

Span and Cross Section Design
- Automated layout of design spans for entire floor, with the ability to manually revise
- Post-tensioned, reinforced, and hybrid concrete design
- Considers minimum, strength, initial service (transfer of pre-stress), service, and ductility design
- Cracked section analysis using appropriate material stress-strain curves for each component
- Retrieve an exhaustive design echo for each cross section using the auditor tool
- Tools that simplify the process of identifying, locating, and fixing design errors
- ACI 318, AS 3600, BS 8110, IS 456, EC2

Punching Shear Design
- Automated generation of critical sections considering actual (not simplified) geometries
- Design for columns above or below the slab
- Considers biaxial moments
- Design of studded shear reinforcement (SSR)

Report Generation
- Fully customizable professional reports
- Reports are complete ready-to-submit calculations
- Reports can be printed to any page size or orientation
- Results tables can be output to spreadsheet format

Integration and Interoperability
- Fully compatible with Bentley's Integrated Structural Modeling (ISM) format
- Integration with Bentley Cloud Services enabling access to a wealth of software services
- Run as an integrated module within RAM Structural System
- Import/export of floor levels from/to RAM Structural System
- Import of structure and loadings from STAAD®
- Import and export of CAD drawings

Need a more comprehensive structural portfolio of trusted analysis and design applications?
Check out Structural Enterprise. Design in any infrastructure sector, with multiple materials, using any analysis method that is appropriate for the job. Learn more by visiting, **www.bentley.com/StructuralEnterprise**
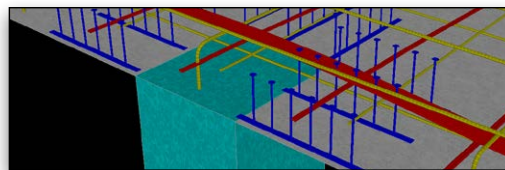
Generate realistic tendon and reinforcement layouts,
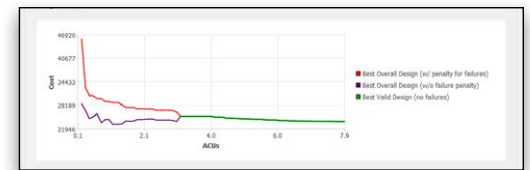
Reduce post-tensioning and reinforcement costs using cloud-based optimization and save engineering time.

Bentley®
Advancing Infrastructure