ConX® Modular Pipe Rack System

FASTER

BETTER

SAFER
A System Comprised of Standard Connections and Details

The ConX® Chassis Based Modular™ Pipe Rack System is an ideal solution for the efficient design, fabrication and construction of pipe rack and processing structures. ConXtech® and its growing network of certified fabricators leverage ConXtech’s standardized connectors and employ automated manufacturing technologies to deliver modular and typically brace-free structures. This technology assisted approach accelerates design through construction allowing industrial facilities to come on-line months or years earlier vs. more conventional structural options.

Standardization around a simple common connection in a structure enables unprecedented efficiencies while significantly reducing risk, complexity and cost. The design of a ConX structure is dramatically simplified by using a small set of ConX details instead of the hundreds or thousands of unique, custom designed and hand crafted details used in conventionally designed structures. This system is what ConXtech calls Chassis Based Modular™.

Robust ConX connections are at the heart of the system. They are unique in the fact that no field welding is required. They are comprised of a set of four mating steel connectors that are factory welded onto wide flange beam ends and square columns (HSS or box). Beams are lowered and locked around the four sides of a square column resulting in a robust bi-axial moment “collar”. This modular rack comprised of ConX columns and beams is easily transported and safely and rapidly assembled in the mod-yard (modules) or field (stick-built).

The ConX connections provide an inherently seismic, blast and progressive collapse resistant structural chassis. Standardization streamlines structural design and analysis and enables material optimization. ConX is intuitive to assemble and ideal especially where there is a shortage of qualified and skilled labor.

Since it is based around a bolted connection, the system allows for future expansion and reconfiguration. Structural members and optional accessories can safely and easily be attached or removed as required. ConXtech has also developed foundation systems, layout tools and templates which ensure unprecedented accuracy and predictability in the field.
ConX® Systems Sized Right for Different Structural Applications

**ConXL™ System**

Field Assembly Rate: Typically 5 MH/Ton

- **ConXL™ 300**
  - HSS or BOX Column Size: Nominal 300mm (12” square)
  - Variable Beam Depth*: 14” to 24”
  - Variable Beam Spans**: 12’ to 30’

- **ConXL™ 400**
  - HSS or BOX Column Size: Nominal 400mm (16” square)
  - Variable Beam Depth*: 18” to 44”
  - Variable Beam Spans**: 18’ to 65’

* Allowable beam depth can be greater than or less than this range, dependent upon structural performance criteria.

** Allowable spans may vary from those shown above, dependent on beam tributary area and floor loading.

**ConXR™ System**

Field Assembly Rate: Typically 5 MH/Ton

- **ConXR™ 100**
  - HSS Column Size: Nominal 100mm (4” square)
  - Fixed Beam Depth: 6” (W 6X9)
  - Variable Beam Spans**: 4’ to 10’

- **ConXR™ 200**
  - HSS Column Size: Nominal 200mm (8” square)
  - Fixed Beam Depth: 12”(variable weight)
  - Variable Beam Spans**: 8’ to 24’

** Allowable spans may vary from those shown above, dependent on beam tributary area and floor loading.

**ConX® Gravity Connection (Pinned)**

Used in conjunction with all ConX Moment Connection Systems

- **ConX® Gravity Connection (Beam to Beam)**
- **ConX® Gravity Connection (Beam to Column)**
How the Collar Connectors Work

The Connection Technology

ConX® is the only connection in the world where all six degrees of restraint (X, Y, Z, Mz, My & T) are achieved when the gravity seated tapered interface is Lowered & Locked™ into place.

The connection capacity is then “Fixed” by installation of collar bolts which provide the full capacity of the attached members on all axes in a fully rigid connection.

ConX® Columns

Square columns serve as the vertical structural members of ConX structures. These columns are manufactured in a controlled factory environment by welding four tapered mating collars to the column at the specified elevation. Columns are later filled with concrete to mitigate corrosion and potential trapped gases as well as optimize column steel thickness.

With ConXR, the mating collars are welded to the face of an 8”x8” HSS column.

ConXL uses a slightly different connection design with connectors welded to the corners of 16”x16” HSS or box columns.

ConX® Beams

ConX beam assemblies have moment connector plates factory welded to both ends of wide flange beams (moment/moment ConX beams), or two plasma cut gravity connectors on both ends of the beam (gravity/gravity ConX beams). ConX beams can also have a gravity connector on one end, and a moment connector factory welded to the other (gravity/moment ConX beams).

ConXR uses a 12” deep machined connector plate with a tapered dovetail design.

ConXL uses a tapered upper and lower flange plate configuration which is adaptable to different beam depths.

ConX® Collars

During the field assembly process, ConX beams are Lowered & Locked™ into place between ConX columns from the top down. The connectors immediately and easily lock into place resulting in an instantly stable connection. Mitered vertical edges of the connectors allow four identical plates to surround a column and form a ConX collar.
Safety - Built into Every Connection
Gravity stabilized Lower & Locking™ connections bring immediate stability to structure without adding bolts.

- No field welding mitigates risk:
  - Eliminates “heat” on structure
  - Mitigates need for walking steel

- Fewer man hours = lower risk

- Assembly typically performed from man lifts

- Integrated modular components enhance safety:
  - Self Aligning Stacking/Lifting Lug (SLLUGTM) for rigging, hoisting and stacking modules
  - Reusable Modular Access Platforms
  - ConX Module Assembly Stand

- Lower & Locking™ connections provide opportunity for safe disassembly and reassembly
Getting Started with ConX®

ConXtech® begins working with owners and their design teams early in the process. Most often this is during the site evaluation and feasibility study period.

**Conceptual Design**

Once the program goals are defined, ConXtech’s integration experts collaborate with the team to understand application, loading and other project specific requirements and then quickly identify the optimal ConX System for the particular project and propose an appropriate framing plan to generate a 3D model. At this stage ConXtech and/or our certified fabricators can provide budgetary numbers and an estimated fabrication and field assembly schedule.

**Design Development**

ConXtech has developed ConXCAD digital toolkits to combine the design, fabrication and field assembly processes into an integrated software solution. A virtual ConX Modular Pipe Rack (Digital Chassis) is quickly configured during the earliest design phase of the project. This automated and systemic approach, with a finite number of structural elements, enables a revised structural budget to be quickly generated as plans evolve.

**Construction Documentation**

Creating the documentation required to design, structurally evaluate, and fabricate a steel superstructure conventionally is a time-consuming and fragmented process. The ConX Digital Chassis provides the basis for the final structural analysis, detailing, as well as all of the data that drives the automated manufacture of ConX assemblies.
Digital Design Workflow in a 3D modeling environment

A predictable ConX® Modular Pipe Rack steel frame (Digital Chassis) is quickly configured at the earliest design phases of the project. The ConX steel frame can be initially modeled in plant design software like PDMS and SmartPlant 3D or ConXtech can rapidly define the ConX frame in the steel design and detailing software Tekla Structures. In either workflow, the 3D model can be electronically exchanged using industry standard file formats such as SDNF (Steel Detailing Neutral File) and CIS2 (CIM Steel).

As the piping design progresses, there may be a change in the number of pipe support and anchor load support beams required on the structure. Using Navisworks, ConXtech and the piping designers store saved locations and redline changes directly in the 3D model. Clashes can also be automatically found and then resolved between the piping and structural steel.
The digital ConX® Modular Pipe Rack in Tekla Structures includes an “as built” level of detail all the way down to every nut and bolt that will be used in the field. By having this high level of detail, ConXtech electronically extracts all of the Bill of Materials, shop, and erection drawings directly from the 3D model. This rapid extraction of data from a single database helps compress the project schedule and increase the volume of manufacturing production that can be processed. ConXtech also automatically extracts CNC information that drives cut and drill machines in the shop to help insure fabrication quality and field fit-up.

The 3D model contains all of the profile, weight, piece mark, as well as grid and top of steel information. This allows ConXtech’s field superintendents and project managers to easily plan shipping truck loads and the erection sequence of steel by simply picking the pieces in the 3D model. Isometric erection drawings and sorted erection order reports are then automatically generated from the 3D model.
ConX® Modular Chassis Components

1. Pipe Support Beam Moment (BMM)
2. Pipe Support Beam Gravity (BGG)
3. Anchor Support Beam
4. Column (CM - HSS) (CB - Box)
5. Added Upper Level with Moment Connection
6. Added Upper Level with Gravity Connection
7. T-Support Assembly
8. Trapeze Assembly
9. Cantilever Outrigger

Stick Built Footing shown
For Module Assembly Components
See Page 11

Copyright © 2000-2015 ConXtech, Inc. All rights reserved.
Optional ConX® Accessories

5. Column Extension with Moment Connection
6. Column Extension with Gravity Connection

7. T-Support Assembly
8. Trapeze Assembly

9. Cantilever Outrigger - Moment Connection (BMC)
9. Cantilever Outrigger - Gravity Connection (BGC)

Large Diameter Pipe Shoe with Universal Anchors
Large Diameter Pipe Shoe with Universal Guides
Small Diameter Pipe Shoe with Universal Anchors
Small Diameter Pipe Shoe with Universal Guides
ConX® Module Assembly System Components

- Quick Lift Module™ (QLM™)
- Ground Assembly Stand
- Stacking Lifting Lug™ (SLLUG™)

Copyright © 2000-2015 ConXtech, Inc. All rights reserved. Regarding information presented on this page, please refer to the patent notice which appears on the back cover of this document.
ConX® Modular Access System - Interer Module Make up Platform

Inter Module Make up Platform Truss
Modular Walk Surface
Modular Access Platform
Cantilever Outrigger - Gravity Connection (BGC)
Modular Railing
Modular Toe Kick
Modular Ladder
ConX® Modular Access System - Modular Access Platform / Cable Tray Catwalk

Cable Tray Catwalk

Modular Access Platform

Cable Tray Support Outrigger

Modular Railing

Cantilever Outrigger - Gravity Connection (BGC)

Modular Toe Kick

Modular Ladder
Field Assembly Overview

ConX® structures are designed and detailed considering construction sequence. The use of 3D modeling provides exact grid locations, weights, center of gravity, and dimensional information which are all critical to the field in planning the erection phase of the project. Each piece is then manufactured, marked and shipped with respect to the erection sequence enabling maximum productivity.
Assembly Sequence – Stick Built

1. Site preparation
2. Foundation installation
3. Frame assembly
4. Pipe installation
5. Testing and adjustment
6. Completion
Assembly Sequence – Mod Yard Assembly
Assembly Sequence – Module on a Stick Base

1. Initial setup of modules on stick base.
2. Module placement sequence.
3. Module placement progression.
4. Completed module sequence.
5. Final assembly state.

Regarding information presented on this page, please refer to the patent notice which appears on the back cover of this document.
Example ConXR™ Modular Pipe Rack 2 Level-Fixed Base (20’ X 20’ Grid)

*NOTE: For projects with loads that exceed the standard capacities defined below, please contact ConXtech directly at info@conxtech.com for additional ConX solutions.

ESTIMATED LATERAL LOAD RANGE FOR THIS STANDARD RACK CONFIGURATION*

- Wind = 150 MPH
- Seismic: Cs ≤ 0.43
- ConXR Connection Moment Capacity = 1,870 k-in
- ConXR Connection Shear Capacity = 134 kips
- Pipe Rack Longitudinal Span = 20’
- Moment Beams @ 15’ Height Supporting Pipes @ 40 psf.
- Moment Beams @ 21’ Height Supporting Cable Trays @ 20 psf.
- Response Modification Coefficient \( R = 3.5 \) (OMF)
- Overstrength Factor \( \Omega_s = 3.0 \) (OMF)
- Deflection Amplification Factor \( C_d = 3.0 \) (OMF)
- Importance Factor \( I = 1.25 \)
- Soil Site Class = D
Example ConXR™ Modular Pipe Rack 3 Level-Fixed Base (20’ X 20’ Grid)

*NOTE: For projects with loads that exceed the standard capacities defined below, please contact ConXtech directly at info@conxtech.com for additional ConX solutions.

### ESTIMATED LATERAL LOAD RANGE FOR THIS STANDARD RACK CONFIGURATION*

- Wind = 150 MPH
- Seismic: Cs ≤ 0.35
- ConXR Connection Moment Capacity = 1,870 k-in
- ConXR Connection Shear Capacity = 134 kips
- Pipe Rack Longitudinal Span = 20’
- Moment Beams @ 15’ Height Supporting Pipes @ 40 psf.
- Gravity Beams @ 21’ Height Supporting Pipes @ 40 psf.
- Moment Beams @ 27’ Height Supporting Cable Tray @ 20 psf.
- Response Modification Coefficient R = 3.5 (OMF)
- Overstrength Factor Ωp = 3.0 (OMF)
- Deflection Amplification Factor Cd = 3.0 (OMF)
- Importance Factor I = 1.25
- Soil Site Class = D
Example ConXR™ Modular Pipe Rack 4 Level-Fixed Base (20’ X 20’ Grid)

*NOTE: For projects with loads that exceed the standard capacities defined below, please contact ConXtech directly at info@conxtech.com for additional ConX solutions.

ESTIMATED LATERAL LOAD RANGE FOR THIS STANDARD RACK CONFIGURATION*

- Wind = 110 MPH
- Seismic: Cs ≤ 0.27
- ConXR Connection Moment Capacity = 1,870 k-in
- ConXR Connection Shear Capacity = 134 kips
- Pipe Rack Longitudinal Span = 20’
- Moment Beams @ 15’ Height Supporting Pipes @ 40 psf.
- Gravity Beams @ 21’ Height Supporting Pipes @ 40 psf.
- Moment Beams @ 27’ Height Supporting Cable Tray @ 20 psf.
- Gravity Beams @ 33’ Height Supporting Cable Tray @ 20 psf.
- Response Modification Coefficient $R = 3.5$ (OMF)
- Overstrength Factor $\Omega_0 = 3.0$ (OMF)
- Deflection Amplification Factor $Cd = 3.0$ (OMF)
- Importance Factor $I = 1.25$
- Soil Site Class = D
## ConX® Benefits at Every Stage of a Project

### Safety
1. **Robust Structure**
   - Premium
   - Pre-fabricated off site
   - No field welding
2. **Reduced Risk**
   - Fewer personnel required
   - Lower & Locking™ connection
   - Gravity stabilized without bolts
   - No “spud” required to align
3. **Standardized Construction Site Advantages**
   - Efficient, consistent work planning & flow
   - Clean / uncluttered site
4. **Easy to “top load” pipe**
5. **Standard repeatable work**
   - Simplified safety training

### Modularization
1. No added braces for transport loads
2. Built in stability without base connection
3. No diagonals to interfere with pipe or equipment
4. Precise dimensions
5. Top load pipe in partially complete structure
6. Expandable horizontally
7. Expandable vertically
8. **Innovative ConX SLLUG™**
   - A multi-function Stacking Lifting Lug
   - The ConX Way for safe lifting, aligning, stacking and transporting industrial modules

### Design
1. **Robust & Brace Free Structure**
   - Allows ultimate pipe routing options
   - Simplifies equipment placement
   - Design flexibility - same frame for various loads
   - Reduces dependency on information flow between trades
2. **Components Accelerate Design**
   - Pre-designed, standardized connections
   - Fewer variations in beam sizes
   - More standardization of beams with same erection marks
   - Modular, adjustable "pipe guides" and supports
   - Modular equipment
   - Modular platforms
   - Modular scaffolding
3. **Standardized**

### Operational
1. **No diagonals to interfere with maintenance access**
2. **No diagonals to interfere with equipment removal or replacement**
3. **No diagonals to interfere with piping modifications**
4. **Expandable horizontally**
5. **Expandable vertically**
6. **Safer work environment**

### Fabrication
1. **Shorter lead times**
2. **Robotics and specialized fixturing in ConX Factory easily scale to meet demanding schedules for multiple projects with minimal labor**
3. **Standardized work**
   - Higher throughput with existing facility
   - Higher throughput with existing workforce
   - Reduced layout and fit up
   - Process oriented workflow
   - Specialized jigs and fixturing delivers precision
   - Reduces RFIs
   - Reduces errors and re-work
   - Simplifies entire fabrication process
   - Scalable process

### Life Cycle and Sustainability
1. **Interchangeability of “standard” modular components extends life cycle**
2. **Easily expandable**
3. **Relocatable**
4. **Potential for disassembly, reconfiguration and re-use**
   - Lower & Locking™ bolted assemblies can be easily unbolted and disassembled for future use
5. **Safe to disassemble**
### Procurement

1. Fewer variables in member sizes and SKU’s
   - Volume purchasing power & cost control
   - Availability
   - Predictability in quality and sourcing
   - Simplified inventory
2. Common components
   - Mass-customization
   - Production off-site ensures quality
   - Interchangeability of parts
   - Opportunity to stock common items
3. Early release
4. Shorter lead times
5. Robotics and specialized fixturing in ConX Factory easily scale to meet demanding schedules for multiple projects with minimal labor

### Logistics

1. Factory manufactured “kit of parts”
   - Significantly simplifies logistics
   - Reduces manpower required
   - Reduces cost of onsite support for workforce
   - Ensures quality and accurate fit up
2. Easier logistics and workflow
   - Lowers total freight cost
   - Reduces risk
3. Minimize or eliminate lay down
   - Just in time delivery
   - Minimal sorting required
   - Erect directly from truck

### Detailing

1. Simple digital model creation
   - Limited variables
   - Standard detail libraries
   - No braces simplifies integration of non-structural elements
2. Digital concept model rapidly evolves into final model
   - Early dimensionally accurate BIM is a clash prevention tool

### Piping Process & Design

1. No diagonal braces
   - Increases pipe rack capacity
   - Greatly reduces pipe coordination
   - Greatly reduces equipment coordination
2. Modular chassis
   - Anatomically correct at concept
   - Expandable horizontally
   - Expandable vertically

### Qualifications

1. Extensively tested in full scale
2. Proven with 7+M sf deployed to date
3. Only connection tested 100% on both axes
4. Meets all special high seismic detailing requirements

### Assembly

1. Faster
   - 2x to 5x faster
2. Safer
   - Lower and Locking™ connection
   - Simplified process driven erection
   - Smaller workforce in field
3. Factory built kit-of-parts
   - Interchangeable parts
   - Factory fabricated full-length columns & beams
   - No "cut and fit" on site
   - Reduces plumbing and squaring
   - No scoring or galvanizing for slip critical joints (U.S.)
4. Factory welded components
   - Robotically welded standardized connections
     - Ensures quality
     - Eliminates field weld inspection
5. Simplified Bolting
   - Reduced quantity of standardized bolts - prepackaged with DTI washers
   - Ensures bolting materials are there and ready
   - Accelerates bolt-up process
   - Reduces handling and make-up of bolts
   - Simplifies and accelerates QC by enabling visual field inspection
   - Eliminates possibility of using wrong bolts
6. Intuitive Lower & Locking™ connections speeds assembly and ROI
   - Allow for safer erection
   - Fewer number of pieces to erect
   - Reduces risk in schedule
   - Eliminates errors and re-work
7. Standardized process-driven construction
   - Simplified layout with omni-directional columns
   - Efficient and consistent work planning
   - Consistencies among multiple projects
   - Faster site prep: simplified foundations
   - Fewer manpower-related logistics
   - System reduces learning curve
8. Install work platforms and catwalks as primary structure is erected
Structures, methodologies, concepts, descriptions thereof, trademarks, logos of ConXtech® shown, illustrated and described in this document are covered by various forms of intellectual property protections considered by ConXtech to be of great value. These protections include, but are not limited to, copyrights, and the following U.S. and Foreign Patents which variously cover ConXtech’s ConX® structures and methodologies:

US and Foreign Patents: U.S. P.N. 6,837,016; U.S. P.N. 7,021,020; U.S. P.N. 7,051,918; China P.N. 2,458,706; Japan P.N. 4166640; Mexico P.N. 262,499; U.S. P.N. 6,802,169 B2; U.S. P.N. 8,011,150; Australia P.N. 2004283131; Canada P.N. 2,153,038; Mexico P.N. 2008260527; Canada P.N. 2,578,959; Australia P.N. 2005283131; Canada P.N. 2,685,181; U.S. P.N. 8,011,150; U.S. P.N. 7,051,918; U.S. P.N. 7,837,084; Australia P.N. 2008260527; Canada P.N. 2,685,181; Other U.S. and Foreign Patent Protection Pending.

Copyright © 2000-2014 ConXtech, Inc. All rights reserved. www.ConXtech.com