About Tilt-Werks®

Tilt-Up Design Systems, LLC -- an innovative company comprised of industry-leading structural engineers -- present Tilt-Werks®, the first collaborative, web-based software application designed specifically for the tilt-up industry.

Tilt-Werks is unique in that it creates engineered design drawings instead of just model renderings. Engineering data and building geometry is input to generate a complete tilt-up design and construction package. Panels are designed after entering wall geometry and design loading requirements. Design incorporates checking service load deflections and bending stresses using the various limitations provided by the user to produce an optimized reinforcement layout. This includes but is not limited to reinforcement bar spacings, size and clearances. Along with the engineering output, complete reinforcing shop drawings with cut lists, panel layout drawings with embeds, reveals and a multitude of other tilt-up features are generated fully dimensioned and ready for use in a CAD package. Material takeoffs for all items required to complete the panels entered is also generated as well in an easy to read report format which can be grouped based on individual panels up to the full building. All of which can be shared with all project team members.

Tilt-Werks organizes pertinent project information from conception to completion. The user-friendly proprietary interface is highly intuitive and easy to learn. As geometric information is entered into this interface a graphical model of the wall is also created in real time. The user can navigate around the using a standard set of zoom functions. It can also be used for select data entry as well. The interface also allows panel costs to be calculated for accurate estimates that take into account the unique requirements of tilt-up projects. This process is easy; users enter their unique material cost data and the application will generate per square foot cost data. This information also can be exported to other estimating software for more extensive cost analysis. Further, Tilt-Werks manages material lists and shares them instantly with suppliers for cost estimates and just-in-time take-off information. Branded product material takeoffs for manufacturers and their distributors, are all generated from the dimension and load data entered at the beginning of the design process.

Tilt-Werks allows project team members to communicate directly with one another, enabling all parties to collaborate throughout each phase of the project to ensure a seamless design and construction process. Automatic generation of documents—from construction drawings to material lists—helps processes like permitting and obtaining quotes from suppliers run smoothly.

Tilt-Werks technology is web-based, and as such real-time project data can be obtained anywhere users have Internet access. In addition to accessing project information, subscribers can get the latest information on innovative tilt-up technology and other industry resources such as white papers, frequently asked questions, user groups, standard details for drawings and design, manufacturers’ forums on the latest technology and more. Project data is hosted on a secure server, and backed up on a daily basis. Subscribers are not required to load software on their computer systems and updates and enhancements are automatic.
System Requirements

To use the Tilt-Werks® online collaborative product the following minimum requirements are suggested:

- Computer: 450 MHz CPU and 128MB RAM
- Operating System: Microsoft Windows 2000 or later
- Internet Browser: Internet Explorer
- Internet Connection: DSL, Cable, T1, Mobile 3G (possible)
- Screen Resolution: 800x600
- Printer: Any printer compatible with OS used
- Adobe Reader 6.0 or higher is required to view any information output to a pdf creator.
- Microsoft .Net 3.5 Framework
- DXF file viewer
- IFC file viewer

On Demand Advantages

Below are just a few of the advantages of Tilt-Werks® being provided as an on demand service:

- Instant and seamless program updates.
  - As features are added to the program they will be made available to users without the need for user interaction (users will be notified prior to update)
  - Building Code changes will be implemented automatically with options for the user to update existing files with the changes
- Access from any internet enable pc.
- Real time update of project information for all contributors to a specific project, reducing the wait time compared to traditional RFI's.
- Initial data entry (wall geometry and project description information) can be entered by any of the stakeholders.
- No software to install.

Program Design Assumptions/Limitations

Below are the various conditions/limitations that are assumed when the program performs the design of tilt-up wall panels:

- Panel design is based on ACI 318-08 chapter 10 using the exact integration method.
- Column strip reinforcing provided is not designed to meet ACI 318-08 10.9.1, it is provided for confinement purposes.
- The maximum building story height that can be designed using the program is 2. (Note:
Buildings with more stories can be design using the program but require advance manipulation of the input:

- Wall panels are assumed to be continuously bearing on the footing. Panels supported each end on pile caps is not designed for.
- Wall panels typically should be entered as viewed from the inside face of panel since this is most likely how they will be laid out in the field.
- Torsion in panels is not currently accounted or designed for.
- Trapezoidal roof loads can not currently be entered.
- Thickness of panel shall be such that slenderness does not exceed 65. (i.e. Panel unbraced length / Panel thickness < 65)
- Panel sections above openings are checked to ensure they meet the temperature and shrinkage reinforcement, wall horizontal and vertical spacing minimums of the ACI code only. These sections should be checked to ensure they meet the necessary requirements of the code for bending, shear and torsion.
- The load factor used on wind load is 1.529411. This is 1.3/0.85 which is allowed since the commentary of ACI 318-08 Section 9.2.1 (R9.2.1(b)) states that the 1.6 factor is actually this value rounded up.
Tilt-Werks® Design Theory

Tilt-Werks is a strain based methodology that uses the Portland Cement Associations' Stress-Strain relationship for concrete. This results in a parabolic stress distribution in the concrete section, which is then used to determine the resisting moments and moment of inertia of the cross section for each particular load case.

\[
\varepsilon = \frac{2(0.85 \xi)}{E_c}
\]

\[
E_c = 57,000 \sqrt{f'_c}
\]

ACI chapter 14 methodology uses the Whitney rectangular stress block, for stress distribution, which for thin sections like tilt-up panels, slightly overestimates the stiffness and moment of inertia of the section. For tall slender elements subject to second order, P-Delta effects this approach will slightly underestimate the actual moments and deflections.
Login and Launching Tilt-Werks:

Once you have received the welcome email confirming your subscription has been activated, you can then login to the subscriber site and access the application.

Click login at the top of the main page www.tilt-werks.com. This will take you to the login page where you can enter the username and password chosen at the time you registered or assigned to you by your account administrator.

Once in the site you have access to all the subscriber features. To launch the program click on the Launch Tilt-Werks®. On first access to the application you will see a notice that the site wants to install an activex add-on.
Click on the install bar and allow the activex control to be installed. This add-on gives you the option to download exported DXF files and other content from the application to your PC. To allow for future updates to the add-on you can select “Always install software from “Tilt-Up Design Systems, LLC”” and you will no longer be prompted when updates to this are available. The add-on can be easily removed if needed by using the Windows Add/Remove program function.

The control is only installed when there are program updates so after the initial install there is no need to allow this action again unless an update occurs. After installation the user will be able to access the program.

**Project Sharing**

Project sharing can be done by selecting that option from the subscriber main landing page. This will take the user to a page with a listing of their current projects and sharing options for those projects. The only information needed is the customer number of the other Tilt-Werks subscriber that the user wishes to share the project with. Permissions can be changed at anytime. Users who projects have been shared with cannot re-share the project with others. The project creator is the main control point.
## Project Sharing

**Select a project to share:**
- Sample Project
- Harmony Electronics
- Technology Annex
- Tilt-Up Technology Warehouse
- Sample 2

**Enter Customer Number to share with:**

**Permissions:**
- **View Only**
  - Engineering Design
  - Engineering Reinforcing Drawings
  - Panel and Wall Drawings
  - Summary Report
  - Cut List and Placing Drawings
- **Engineering Access**
  - Engineering Design
  - Geometry
  - Openings
  - Grid Lines
  - Panel Joints
- **Detailing Access**
  - Geometry
  - Openings
  - Features
  - Embeds
  - Grid Lines
  - Panel Joints

**Share with Tilt-Works Customer Support**

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**Currently Shared Projects**

No Projects Currently Shared
Main Interface

Main Window Menu Bar

New Project - Closes the current project and opens the new project dialogue.
Open Project - Closes the current project and opens an existing project of the users choice.

Save Project - Saves the current project.

Add New Wall - Add a new wall to the current project.

Delete Wall - Deletes the currently selected wall.

Clone Wall - Makes a copy of the currently selected wall.

Wall Display Type - Toggles the display of onscreen dimensions for wall features. (beta)

Zoom Window - Allows for the user to define an a zoom in area.

Reset Drawing - Resets the drawing back to fill the viewing pane.

DXF - Brings up the dxf drawing generation dialog box to allow for drawing file export.

Summary Report - Prints a summary report of the material quantities for the project. Any items which require design must clear the design checks to be included in the report.

Reinforcing Cutlist - Prints a reinforcing cutlist for the project. Panels which have not been designed will not be selectable.

Panel Report - Prints multiple panel reports from one location. Panels which have not been designed will not be selectable.

3D Output - Brings up the 3D drawing generation dialog box to allow for IFC file export.

Program Settings - Brings up the setting dialogue which holds user input items (embed plates, coil inserts etc.) and manufacturer products which can be specified in the project.

Help - Display the program manual.

About - Displays current program version and company information.

Exit - Closes the program. Prompts user to save or discard the changes made since last save or project creation or to cancel the close operation.
1. **Graphical Display Window** - Dynamic display of wall based on user defined values. Displays the wall panel layout graphically as entered by the user. Displays loads, embeds, reveals and openings.

2. **Project List** - Displays projects in the user account. An action menu allows for various options with the projects.

Action Menu in Project List Window:

- **New Project** - Closes the current project and opens a new project with default settings.
- **Open Project** - Closes the current project and opens an existing project of the user's choice.
- **Copy Project** - Copies the current project to a different Project ID.
- **Save Project** - Saves the current project.
- **Delete Project** - Deletes the current project, prompts the user for confirmation of the process.

*Note: Some options may not be displayed based on project status.*
3. Reference - User entered reference number for the project. This cannot be changed once entered when the project is created.

4. Project Name - User entered project name.

5. Project Location - User entered project location.


7. Client Name - User entered client name.

8. Creation Date - Project creation date.

9. Created By - Id of user that created the project.

10. Building Code - List box for selection of building code to be used for design. (Currently only ACI318-08 is available.)

11. Max Roof Load - Maximum load applied to the roof live/snow in \textit{psf}

12. Roof Snow Load - Code or project specified roof snow load in \textit{psf}

13. Floor Live Load - Code or project specified floor live load in \textit{psf}

14. Design Wind Load - Code or project specified component and cladding design wind load (maximum of pressure and suction) in \textit{psf}.

*Note: Load values above are currently used for project record keeping. Future use in determination of applied loading is being developed.

15. Construction Wind Load - Calculated wind load for during the construction period per the applicable code or governing design guide which will be used to check the panels full height unbraced with only roof dead load applied \textit{psf}.

16. Spect. Resp. (Sds) - Five-percent damped design spectral response acceleration at short periods

17. Deflection Limit H/ - Code or project specified panel deflection limit

18. Alt. Serv. Load Comb. - Check box which enables the use of the service load combinations specified in the commentary of ACI318-08 R14.8.4 DL+0.5LL+0.7WL, DL+0.5LL+0.7EQ & footnote f of table 1604.3 in IBC 2006 DL+0.7WL.

19. Deflection Check w/ Roof Live Load – Check box which enables the user to choose whether the Roof live load is considered when deflection checking is performed.

20. Building Code Strength Load Combinations – This section enables the user to choose which load combinations to use for the panel design.

21. Concrete Strength – Wall panel concrete compressive strength in \textit{ksi}.

22. Concrete Density – Density of concrete to be used in wall panel design (normal wt, lightweight, etc.) \textit{pcf}

23. Concrete Cost – Current price of placed concrete for the project per yard\(^3\) of concrete.

24. Steel Yield Strength – Specified yield strength of reinforcement to be used for the project in \textit{ksi}.
25. Steel Cost – Current price of steel reinforcement to be used for the project per pound of steel weight.

26. Horiz. Bar # - User defined minimum and maximum bar size limits to be used in the design of the horizontal reinforcement. (This is currently just temperature & shrinkage reinforcing or code spacing minimums.)

27. Vert. Bar # - User defined minimum and maximum bar size limits to be used in the design of the vertical reinforcement. (This currently holds all strips to the minimum, including the panel section above an opening.)

28. Bar Spacing – User defined minimum and maximum vertical & horizontal bar spacing (inches).

29. Configuration – Reinforcement Configuration. Options are center mat (level) or double mat (each face) layout.

30. Typical Reinf. Layout Cover – Code or project clear cover to reinforcing steel from the inside and outside face of the panel (in.).

31. Column Reinf. Layout Cover – Code or project clear cover to reinforcing tie steel in a column configuration (in.).

32. Max. Stress Ratio – Maximum stress ratio allowed for the tilt-up wall panel design. A lower stress ratio produces a higher factor of safety. (Default 1.0)

33. Joint Width – User defined width of the joint between adjacent panels.

34. Form Board Thickness – User defined thickness for typical form board to be used in panel construction. (Informational only)

35. Shim & Grout Thickness – User defined thickness of the shim and grout to be used. (Displayed on the dimensions of the exported panel shop drawings.

36. Panel Layout Drawing Scale – The drawing scale to be applied to the panel shop drawings when the project is exported to the dxf format.

37. Reinforcing Layout Drawing Scale – The drawing scale to be applied to the reinforcing design or placing drawings when the project is exported to the dxf format.

38. Sheet Size – The sheet size to be used in determination of the break points for the wall panel shop drawing output.

39. Drawing Options – Check boxes to adjust the content that is exported to the dxf file.

40. Feature Selection – The output options for the project. (Note: The show bar lengths option turns the bar lengths on or off for the engineering reinforcing drawings)

41. 3D Wall Layout – Co-ordinates of the walls to be used for the 3D export to an IFC file.

42. Project Layer Settings – Layer definitions for the current project.
1. Wall Data Input Tabs – Data input is separated into categories for ease of entry
2. Wall Name - User entered wall identification.
3. Wall Description - User entered wall description (Ex. North Wall Elevation, Entry Wall, etc.)
4. Wall Grid – The grid line where the wall is located on the plans.
5. Configuration Level – Selection box for general reinforcing layout type to be used for the current wall. Level (single mat) or Face (double mat) reinforcing are the options.
6. Concrete Cover – User defined reinforcement clear cover requirements for the current wall.
7. Grid Line Entry Form – User can enter the grid line I.D.’s and spacings for the wall to be defined.
8. Panels – Panel identification and width are defined in this location. They can either be entered in incremental mode or by giving the distance to the end of the panel starting from the beginning of the wall.
9. Insulation Thickness – For informational purposes. This is the thickness of insulation to be used in an insulated panel.
10. Face Wythe Reinforcing – User defined selection of the reinforcing mesh to be used in the outside face wythe of an insulated panel.
11. Reveal Thickness Allowance – User defined reveal thickness to be used if reveal pattern is unknown. This will adjust the bar location (depth to tension reinforcement) to account for the addition of any reveal pattern with the specified depth.

12. Generate Wall Output – Creates the individual panel data from the user wall input. After generation individual panels can be analyzed and adjusted. The panels are optimized using the limitations set by the user and the building code requirements.

Wall Data Input Tabs Listing – Entry of wall geometry and loads using options as listed below:

**Geometry**

Straight Top – User input of the top of wall. This can vary or slope. Varying heights require multiple entries of the top option. A start and end height is provided along with a width and the required panel thickness.

Bottom – User input of the bottom of wall. This can vary or slope. Varying horizontal dimensions require multiple entries of the bottom option. A start and end dimension is provided along with a width.

If the wall section being entered is insulated then input the thickness of the outside face wythe in this section.

Pilaster – Defines a pilaster element on the wall. The user is prompted to enter the pilaster location and the additional thickness, to be added to the typical panel thickness, that is required to create the pilaster.

Ledger – Defines a ledger element on the wall. The user is prompted to enter the ledger location, height and the additional thickness, to be added to the typical panel thickness, along with the density of the material used to create the ledger that is required to create the pilaster.

**Openings**

Rectangular Opening – User defined opening size and location input. The opening can be classified as current (which means it will be in place at the time of construction) or future (to be installed at a later date).

Round Opening – Defines circular openings for plumbing/electrical conduit, etc.

**Features**

Horizontal Reveal – Defines the architectural reveal pattern extents in the wall.

Vertical Reveal – Defines the architectural reveal pattern extents in the wall.

(Currently only horizontal and vertical reveals can be defined.)

**Supports**

Roof Support – Defines the top support for the current wall, this is the point at which load is transferred to/from the supporting structure (Ex. Joist bearing elevation on sidewall or deck bearing on endwall). User is prompted for start and end
elevations, start and end location of supports and the roof support detail.

Int. Floor Supt - Intermediate floor support point defines the support location for second floor/mezzanine connections to the wall, this is the point at which load is transferred to/from the supporting structure. User is prompted for start and end elevations, also the start and end location of supports.

Floor w/o Sup – Defines an intermediate floor location for the application of floor loads but does not provide a support point for the wall.

Base Support – Defines location of wall panel base support (typically this is the connection to the floor slab or foundation). The user can also enter a 2 or 4 to have the program automatically generate wall ties at a maximum spacing of 2' and 4' respectively.

Pier Support - Defines location of wall panel base support if on pile caps. The user is prompted to enter the bearing width of pile cap measured from the edge of the panel.

(Currently not working)

Out-Of-Plane Loads

Surface Load – Surface load defines the out of plane loads applied to the wall panels. These are the component and cladding wind load and the seismic load. The user enters the load in pounds per ft\(^2\) and the extents of the load application. Multiple loading zones can be defined if necessary. All surface loads are assumed to act on the outside face of the wall panel in suction.

Roof Loads

Uniform Roof Load – Roof load defines the gravity loads applied to the wall panels. Currently DL and LL/SL are entered by the user, along with the eccentricity of the load and it's extents. Multiple loading zones can be defined along with loads at different eccentricities. All gravity loads act on the inside face of the wall panels.

Concentrated Roof Load – Concentrated roof load defines gravity loads applied to the roof as point loads. The user is prompted to enter a DL and LL along with the eccentricity of load. Loads currently can only be entered at grid lines when analyzing an entire wall. When designing individual panels concentrated roof loads can be located anywhere.

In-plane Roof Load – In-plane roof load defines the in-plane load from the roof diaphragm. The user is prompted for wind and seismic in-plane loading and the extents (grid-to-grid) of the loading. This load is used to check panel stability only and is not used to check panel in-plane shear.

Floor Loads

Uniform Floor Load – Floor load defines the gravity load from the floor due to live and dead loads entered by the user. The user is also prompted for the eccentricity and extents of the load.

Concentrated Floor Load – Concentrated floor load defines the dead and live gravity floor loads
to the panel. The user is prompted for the eccentricity and grid location of the load. Loads can currently only be entered at grid lines when analyzing and entire wall. When designing individual panels concentrated floor load can be located anywhere.

In-plane Floor Load – In-plane floor load defines the in-plane load from the floor diaphragm. The user is prompted for wind and seismic in-plane loading and the extents (grid-to-grid) of the loading. This load is used to check panel stability only and is not used to check panel in-plane shear.

Misc. Loads

Misc. Concentrated Load – Miscellaneous Concentrated load is used to define a load at any location on the wall panel without the roof or floor limitation. Users provide the horizontal and vertical distance to the load along with the live and dead gravity load magnitude and the load eccentricity.

Misc. Uniform Load – Miscellaneous Uniform load is used to define a load at any location on the wall panel without the roof or floor limitation. Users provide the horizontal and vertical distance to the load along with the live and dead gravity load magnitude and the load eccentricity. (Not Currently Used)

Embeds

Roof Girder Connection – Roof girder connection locates girder connections to the tilt-up at the user defined locations at the roof elevation. The user is prompted to enter the start and end grid line along with the vertical distance down from the roof elevation to the connection. The connection to be used is selected from the list of connections previously entered by the user.

Floor Girder Connection – Floor girder connection locates girder connections to the tilt-up at the user defined locations at the roof elevation. The user is prompted to enter the start and end grid line along with the vertical distance down from the floor elevation to the connection. The connection to be used is selected from the list of connections previously entered by the user.

Roof Connection - Roof connection defines the joist or deck attachment to the tilt-up wall at the defined roof support location. The user is prompted for the start location of the connections, the spacing and quantity, along with the connection detail type.

Floor Connection - Floor connection defines the floor joist/beam or deck attachment to the tilt-up wall at the specified floor support location. The user is prompted for the start location of the connections, the spacing and quantity, along with the connection detail type.

Misc. Connection - Miscellaneous connection is used to locate embeds/connects which do not occur at the roof or floor location. The user is prompted for the horizontal and vertical location of the insert and the embed call-out.

Corner Connection - Corner connection is used to define the location of panel-to-panel corner
connections. The horizontal and vertical location of the first corner connection is entered by the user, along with the quantity of connections and spacing, plus the embed plate type that is to be used.

Base Connection - Base connection defines the wall panel connection to the slab or footing. The user is prompted for the start horizontal dimension of the connection set. Next, the quantity and spacing of the connections is entered along with the connection detail that is to be used.

**Misc. Items**

Chair Height – Height of chairs used to support reinforcing mats in wall panels. This can be useful when designing a building with varying wall panel thicknesses or reinforcing layouts which would typically call for the use of slightly different chair heights. The program automatically determines the optimal chair to be used on a per panel basis.

**Panel Interface**

![Panel Interface Diagram]
The panel interface is accessed by double clicking the desired panel in the user entered list or in the wall graphical window.

1. Panel - Current panel ID selected to be viewed/modified by the user.

2. Concrete Properties – This section displays the weight and volume of concrete required to form the selected panel. The compressive strength is displayed and can be adjusted per panel.

3. Steel Properties – This section displays steel weight in total pounds and pounds per square foot of panel area. The steel yield is displayed and can be adjusted per panel. Minimum reinforcement for temperature and shrinkage and code specified spacing requirements are also displayed.

4. Slenderness – The ratio of panel unbraced length to thickness. This is provided for informational purposes only and is not used in design.

5. Stability Safety Factor – The ratio of overturning to resisting moment for the selected panel. This is a basic stability check as it only considers panel weight versus in-plane lateral load. (A full stability check including in-plane shear in the panel is currently in development)

6. Center of Gravity – Location of panel center of gravity in relation to bottom left corner of panel selected.

7. Reinforcing Configuration - Reinforcing layout type used for the panel design. This value can be adjusted on a per panel basis.

8. Max. Structural Thickness – The maximum structural thickness of the selected panel. This includes any reveal or recess thicknesses that may be removed.

9. Steel Concrete Cover – Clear cover to reinforcing steel. This value can be adjusted on a per panel basis.

10. Panel Joint Gap - Defines the type of panel edge condition to be applied (Bevel End, Butt Joint, etc.) and the corresponding dimension of the detail (ex. 3/8” or half of a 3/4” joint).

11. Run Panel Engineering – Perform the design/analysis of the selected panel based on the wall defaults or user adjusted values per panel.


13. Strip Data – Displays the results of the design/analysis of the selected panel for each individual strip. Changes can be further made to each strip in this area.

14. Panel Reset – Resets the panel back to the wall default values.
The strip interface is an extension of the panel interface and strip data sheet. It allows for adjustments of some of the strip properties to fine tune the panel design.

**Adjustable Items**

1. Reinforcement Level - Reinforcing layout type used for strip design.
2. Bar Size – Reinforcement bar size to be used for strip design. This value can be set by the user and the program will analyze the strip with that value.
3. Bar Quantity – Number of bars to be used for strip design. This value can be set by the user and the program with analyze the strip with that value.
4. Chair Height - Height of chairs used to support reinforcing mats in strip. This value can be set by the user and the program will analyze the strip with that value. (Note: The concrete clearance has a bearing on the chair height specified)
5. Strip Adjustments:
   1. Check – Used to check current conditions.
   2. Bar quantity – Select the number of bars required based on the size entered by the user.
   3. Optimize – Optimize the strip based on the user entered minimums.
   4. Combined – Combine the current strip with the adjacent strip (on the right) in panel.
   5. Delete – Delete the selected strip from the wall panel.
6. Strip Engineering Results (Not adjustable just presented for information) – Results of design/analysis.

Result Outputs which could be displayed are:

- Deflection Limit Exceeded
- Steel Ratio Exceeded
- Panel Stability Issue
• Panel Overstressed
• Allowable Concrete Strain Exceeded
• Below Cracking Moment

These are used to aid user to determine what adjustments need to be made to the wall/panel to obtain a viable design.

**DXF Interface**

The DXF interface is used to select individual panels or full walls for export to the dxf file format for use or viewing in any applicable CAD program/viewer. Three different types of drawing details are possible:

• Wall/Panel Drawing – Panel shop drawings which include panel geometry, embedded items, reveals and all pertinent information to for the panels.

• Reinforcing Design Drawings – Engineering reinforcing drawings which display the number and size of reinforcing bars to be used in the panel. The bar lengths can be turned on or off for the dxf generation.

• Reinforcing Placing Drawings – These drawings are similar to the engineering drawings with the addition of the bar lengths and a cut list of all the bars to be used for the selected panels.
Program Settings

The program setting interface is used to define custom embed plates and layers for use in all projects. It will also be the location of manufacturers products which can be specified in the project as well. Users define embed plates dimensions and properties and this information is used in the determination of quantities for the summary reports and is also displayed in the panel shop drawing output (if selected). Future use of the data will be to check embed plate capacities based on user or manufacturer specified limitations.

- **Plate Type** – Defines where the plate will be located. Roof connections are referenced from the roof support location, floor connections from the floor support location and base connections from the base support location. Corner and miscellaneous connections can be located at any point on the wall.

- **Plate Mark** – User/manufacturer defined plate mark.

- **Description** – User defined plate description.

- **Graphical X-Dim** – User defined width of the embed plate.

- **Graphical Y-Dim** – User defined height/length of the embed plate.

- **Insertion Point X-Dim** – User defined width, from bottom left corner of embed plate, to the insertion point of the embed.

- **Insertion Point Y-Dim** – User defined height, from bottom left corner of embed plate, to the insertion point of the embed.

  *Note: Insertion point is the location at which the embed is placed on the support line. Therefore if support point and insertion are the same insertion point dimensions will be half of graphical dimensions.*

Users can define custom layers for the various parts of the project that is exported in dxf format. The
layer name, color and linetype can be specified and will be the default used for a future projects. Once assigned to the project the layer properties can be further customized on a per project basis which does not affect the global settings previously entered.

Panel Engineering Report

The panel engineering report displays the results of analysis/design. User entered data and a graphic of the selected panel are displayed as a verification of the entries. Also displayed are the results per structural strip along with any relevant notes. The same information that is shown in the strip interface is presented here. Some of the areas to note are as follows:

- **Strip width(ft)** - Width of the structural strip to be designed.
- **Load width(ft)** - Width of the panel load that the structural strip supports.
- **Structural Thickness(in)** – Thickness used in the design (determination of section properties etc.) of the strip at the analysis point
- **Distance to Analysis Point (ft)** - Distance above the base support point to the point on the panel to be analyzed.
• Unbraced Length-$L_{u1}$ (ft) - The vertical unbraced length of the panel from base support to roof support (1-Story) or from base support to floor support (2-Story).

• Unbraced Length-$L_{u2}$ (ft) - The vertical distance from floor to roof support for 2-Story Panels.

• Dist. To c.g. Of Steel (in) – Minimum distance from the compression face to the center of the reinforcing used to resist tension.

• Strength Reduction ($\phi$) – Factor applied to the nominal moment to obtain the resisting moment

• Controlling Strength Load Combination – The load combination that controlled the strength design of the strip.

• Controlling Service Deflection Load Combination – The load combination that produced the largest deflection in the strip.

• Factored Applied Load – Factored applied axial (gravity) load to the strip based on the controlling load combination.

• Factored Panel Weight – Factored panel dead weight to the strip based on the controlling load combination. This is the weight of the panel above the analysis point.

• Factored Pressure – Factored applied out-of-plane load to the strip based on the controlling load combination.

• Reinforcement Level – Displays the reinforcing layout type

  ○ 3, 1-5 ← Single Mat Reinforcing

  ○ Col ← Column section with ties

  ○ Face ← Double mat reinforcing (1 each face)

• Bar Quantity and Size – The number and size of the reinforcing bars used.

• Chair Height (in.) - Height of reinforcement chairs to be used.

• Bar Spacing (in) – Nominal bar spacing considering edge conditions, rounded to the nearest 1/8 inch.

• Area of Steel Provided (in$^2$/ft) - Calculated area of steel required rounded to the nearest whole reinforcing bar.

• Factored Applied Moment – Factored applied moment using user entered loads to the strip based on controlling load combination.

• Factored Total Moment – Factored total moment to the strip including P-Delta effects based on controlling load combination.

• Resisting Moment – Resisting moment of strip based on reinforcing used.

• Cracking Moment – Cracking moment of strip based on reinforcing used.

• Ultimate Panel Deflection – Panel deflection due to the applied factored load based on the critical load combination. This is calculated in accordance with ACI chapter 14.

• ACI 318-08 Service Deflection – Panel deflection due to the applied service load. This is calculated in accordance with ACI 318-08 chapter 14. The use of the alternate load combinations as specified in the commentary of ACI 318-08 section 14.8.4 is available by
selection of the user but the default calculations do not use these combinations.

- Allowable Service Deflection – Allowable service deflection limit based on user entered/code or engineer of record value.
- Steel Ratio – ratio of nonprestressed tension reinforcement for the strip.
- Allowable Steel Ratio – Code specified limit for ratio of nonprestressed tension reinforcement for the strip
- Concrete Strain – Calculated concrete strain for the applied loads
- Allowable Concrete Strain – Concrete strain limit.
- Steel Strain – Calculated steel strain for the applied loads.
- Allowable Steel Strain – Steel strain limit.
- Cracked Moment of Inertia – The factor to be applied to the Gross Moment of Inertia to produce the cracked moment of inertia of the strip.

Summary Report

<table>
<thead>
<tr>
<th>Project: Sample 1</th>
<th>Design Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: Store</td>
<td></td>
</tr>
<tr>
<td>Created By: TED Admin on 5/23/2011</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Selected Walls</th>
<th>Selected Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>PS1, PS2, PS3, PS4, PS5, PS6, PS7, PS8</td>
</tr>
<tr>
<td>East</td>
<td>PS1, PS2, PS3, PS4, PS5, PS6, PS7, PS8</td>
</tr>
<tr>
<td>West</td>
<td>PS1, PS2, PS3, PS4, PS5, PS6, PS7, PS8</td>
</tr>
</tbody>
</table>

CONCRETE & REINFORCING:

<table>
<thead>
<tr>
<th>Wall Name</th>
<th>Panel</th>
<th>Area [sq. ft.]</th>
<th>Concrete</th>
<th>Steel</th>
<th>Cost $/sq.ft</th>
<th>Total Cost $</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FACTORS FOR CONCRETE & REINFORCING:

<table>
<thead>
<tr>
<th>Wall Name</th>
<th>Thickness</th>
<th>Area [sq. ft.]</th>
<th>Concrete</th>
<th>Steel</th>
<th>Cost $/sq.ft</th>
<th>Total Cost $</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Cost is based on user entered cost of materials and labor.

FORMULA:

<table>
<thead>
<tr>
<th>Wall Name</th>
<th>Thickness</th>
<th>Area [sq. ft.]</th>
<th>Concrete</th>
<th>Steel</th>
<th>Cost $/sq.ft</th>
<th>Total Cost $</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTALS:

LOGIC:

<table>
<thead>
<tr>
<th>Wall Name</th>
<th>Area [sq. ft.]</th>
<th>Concrete</th>
<th>Steel</th>
<th>Cost $/sq.ft</th>
<th>Total Cost $</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FINISH PLATES:

<table>
<thead>
<tr>
<th>Wall Name</th>
<th>BG1</th>
<th>BG2</th>
<th>BE1</th>
<th>BL1</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>East</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>West</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
The summary report provides a listing of the materials required to construct the tilt-up panel. At minimum the report provides concrete, reinforcing (if designed) and forming required to construct the panels. All other values are dependent upon users specific entry. A report can be generated for any combination of an individual panel, group of panels, wall or the full project by making selections from the dialog box.

**Reinforcing Steel Cut List**

The reinforcing steel cut list provides an industry standard listing of the rebar required for construction of the tilt-up panels designed by Tilt-Werks. Like the summary report, users can select any combination of panels and generate a cutlist for the reinforcing steel. The list only displays panel which have been designed and have a status of “OK” to ensure that panels which do not meet design criteria are not accidentally created.
The 3D/BIM output from Tilt-Werks is built from the previously entered user geometric and design data. On the project tab the user has the option to input the start and end co-ordinates of each entered wall and from this information a file in IFC format can be generated for import into any BIM compatible software for viewing of further manipulation. This file will include all the openings, reveals, panel joints, ledgers and pilasters. If a cutlist is selected as an option for the project then the reinforcement is also included.

The co-ordinates should be based on the inside face of the wall and should be to the extreme ends of the panels. Some things to note when entering the co-ordinates are:
• At butt joints if the edge of a wall starts on a grid line so should the co-ordinates. The program automatically includes a gap when a wall starts on a grid so the user does not have to account for this. If this has been accounted for in the user input already (ie. Starting a wall 3/4” from a grid line) then the co-ordinate should start at that point instead.

• At bevel joints the point that should be used is the extreme end of the panel (ie. The tip of the bevel or physical end of the concrete) and the inside face. So as an example for a bevel with a 45 degree angle the imaginary inside corner (if the bevel was not there) is the point that should be used.

• The layout plan above the input can be used to help with verification of the entries.

The layout plan that is generated as a result of the 3D input will be further developed to produce a more complete on-screen layout plan with panel numbers and joints shown.

Once the entry is complete the user selects the 3D output option and is presented with a dialog box to select which walls are to be exported and where the file will be stored. This also initiates a check of the wall length against the co-ordinates to verify the length of wall entered can be obtained by the co-ordinates used.

The resulting output when imported into BIM compatible software is as follows:
Example – 1: Wall Entry and Design

A design of the wall shown in figure 1 is required. Final output should include a panel layout elevation (as shown in figure 1), panel reinforcing shop drawings, panel reinforcing design calculations and a summary of the materials required to construct the wall.

Design Data:
Typical Concrete Concrete Compressive Strength ($f'_c$) = 4,000 psi
Normal Weight Concrete Density ($\rho_c$) = 150 pcf
Reinforcing Steel Yield Strength ($f_y$) = 60 ksi
Reinforcing Steel Modulus of Elasticity ($E_s$) = 29,000 ksi
Wall Thickness = 7.25 in
Uniform Load Eccentricity ($e$) = 5 in
Concentrated (Girder) Load Eccentricity ($e$) = 1.625 in
Uniform Roof Dead Load = 26.15 plf (based on 10 psf roof dead load – excludes joist and girder wt.)
Uniform Roof Live Load = 52.30 plf (based on 20 psf roof live load)
Concentrated Roof Dead Load = 10.76 kips
Concentrated Roof Live Load = 14.35 kips
Construction Wind Load = 15 psf
Out of Plane Wind Load = 20 psf
In Plane Roof Wind Load = 300 plf
Service Load Deflection Limit = H/150 (ACI 318-08 14.8.4)
Reveal Depth = 0.75 in
**General Project Data Entry**

After starting a new project and assigning the job description parameters the basic material properties, load data, load combinations and drawing output scales are entered.

Construction wind load and the deflection limit are entered in the locations shown under the *Project Load Data* section. Next the Load Combinations to be used for panel design are chosen. The check box for the Alternate Service Load Combinations is used to choose between the standard set of combinations:

- DL
- DL+LL
- DL+0.75LL+0.75WL*
- DL+0.75LL+(0.75)(0.7)EQ*
- DL+WL*
- DL+0.7EQ

and the alternate set suggested for use based on the commentary in ACI 318-08 R14.8.4 and footnote f of table 1604.3 in IBC 2006 which allows for the use of a 0.7 factor on wind loads when checking deflection:

- DL
- DL+LL
The strength load combinations choices are as follows:

1.4DL

1.2DL+1.6LLr+0.5(LLr or SL or RL)\(^1\)

1.2DL+1.6(LLr or SL or RL)\(^1\)+1.0LLr

1.2DL+1.6(LLr or SL or RL)\(^1\)+0.8WL

1.2DL+1.6WL+1.0LLr+0.5(LLr or SL or RL)\(^1\)

(1.2+0.2Sds)DL+1.0EQ+1.0LLr+0.2SL

0.9DL+1.6WL

(0.9+0.2Sds)DL+1.0EQ

\(^1\)Note: The maximum load of this set entered is used in design. If the user wishes a specific load to be used the others in the set should be set to 0.

For this example no seismic load was specified so those load combinations will not be selected. Conservatively the alternate service load combinations will not be used.

The next entry are the Material Properties, these include the minimum and maximum bar sizes and spacings to be used along with the reinforcing configuration (single (level) or double (face) mat) and clearances.

The minimums specified in ACI 318-08 7.7 shall be used. Depending on how the tilt-up project in classified by the engineer performing the design the minimum clearance for this example is either 1in or 3/4in. 1 in will be used.

The maximum stress ratio for this project shall be 1.0.

Finally panel joint width and dxf drawing scale output are specified 3/4in and 3/16in respectively.
After clicking on the “New Wall” button the Wall Name location will be the first entry.

Input **Wall 1** as the wall identifier, this will also be the label for the wall tab.

The wall description shall be entered as **East Wall**

Next enter the grid line on which the wall occurs **Line 1**

The reinforcing configuration can be changed on a per wall or per panel basis, for this wall single mat (**Level**) reinforcing was specified.

The cover can be changed on a per wall and panel basis as well.

Now the Grid identifiers and location/spacings shall be entered, chose incremental mode (right click on the incremental column heading and select it from the action menu) and enter the spacing between grid lines as follows:

<table>
<thead>
<tr>
<th>Id</th>
<th>X-dist</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0'-0”</td>
</tr>
<tr>
<td>B</td>
<td>50'-0”</td>
</tr>
<tr>
<td>C</td>
<td>50'-0”</td>
</tr>
<tr>
<td>D</td>
<td>50'-0”</td>
</tr>
</tbody>
</table>

*Note: Entries for distance can be entered in a variety of ways 50-0, 50'-0”, 600 or 600”. Additional options and entry types will continue to be added.*
Wall Geometry

The wall geometry can now be entered, note that all vertical dimensions are taken from the project finish floor elevation which is assumed to be the zero point. Horizontal dimensions are taken relative to the point 0,0. Walls typically should be entered as viewed from the inside face.

Top Elevation of 25'-2 1/2" above finish floor for a width of 149'-10" from grid line A with a wall thickness of 7.25".

First Bottom Elevation of 4'-10 1/2" below finish floor for a width of 75'-0" from grid line A with no wall thickness since this is not an insulated panel and that field defines the face wythe thickness.

Second Bottom Elevation starting 75'-0" (note this value is automatically filled in by default) from grid line A 0'-10 1/2" below finish floor for a width of 74'-10" with no wall thickness.

With the overall wall geometry entered the openings are next. Enter the first rectangular opening as follows:

Horizontal distance to bottom left corner from Grid Line A (X) = 2'-0"
Vertical distance to bottom left corner from finish floor (Y) = -1'-0"
Width of rough opening = 9'-0"
Height of rough opening = 10'-0"
Will opening be a future opening = No

Enter the remaining openings as follows:

<table>
<thead>
<tr>
<th>Opening #</th>
<th>X dimension from 0,0 point(ft)</th>
<th>Y (ft)</th>
<th>W(ft)</th>
<th>H(ft)</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>14'-0&quot;</td>
<td>-1'-0&quot;</td>
<td>9'-0&quot;</td>
<td>10'-0&quot;</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>27'-0&quot;</td>
<td>-1'-0&quot;</td>
<td>9'-0&quot;</td>
<td>10'-0&quot;</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>39'-0&quot;</td>
<td>-1'-0&quot;</td>
<td>9'-0&quot;</td>
<td>10'-0&quot;</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>52'-0&quot;</td>
<td>-1'-0&quot;</td>
<td>9'-0&quot;</td>
<td>10'-0&quot;</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>64'-0&quot;</td>
<td>-1'-0&quot;</td>
<td>9'-0&quot;</td>
<td>10'-0&quot;</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>77'-0&quot;</td>
<td>-0'-10 1/2&quot;</td>
<td>10'-0&quot;</td>
<td>12'-10 1/2&quot;</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>89'-2&quot;</td>
<td>-0'-10 1/2&quot;</td>
<td>3'-4&quot;</td>
<td>8'-0 1/2&quot;</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>108'-0&quot;</td>
<td>3'-2&quot;</td>
<td>4'-0&quot;</td>
<td>4'-0&quot;</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>122'-0&quot;</td>
<td>3'-2&quot;</td>
<td>4'-0&quot;</td>
<td>4'-0&quot;</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>135'-0&quot;</td>
<td>-0'-10 1/2&quot;</td>
<td>12'-0&quot;</td>
<td>10'-10 1/2&quot;</td>
<td>No</td>
</tr>
</tbody>
</table>

*Note: Array input for openings is also an option. Additional information is sued to help user with opening placements and scheduling.
Enter wall reveals as follows:

<table>
<thead>
<tr>
<th>Start Distance</th>
<th>Vertical distance above finish floor</th>
<th>Width(ft)</th>
<th>Height(ft)</th>
<th>Depth(in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'-0&quot;</td>
<td>2'-10&quot;</td>
<td>149'-10&quot;</td>
<td>0'-2&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>0'-0&quot;</td>
<td>12'-9&quot;</td>
<td>149'-10&quot;</td>
<td>0'-6&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>0'-0&quot;</td>
<td>17'-9&quot;</td>
<td>149'-10&quot;</td>
<td>0'-6&quot;</td>
<td>3/4&quot;</td>
</tr>
</tbody>
</table>

### Wall Support

With all the architectural features now entered the wall panel support locations and loading is now entered. The wall shown is a deck and girder bearing wall (endwall) with the roof support located at the deck elevation. The building roof is a single slope with a 1/4" in 12" slope. The roof support is entered as follows:

<table>
<thead>
<tr>
<th>Start Distance</th>
<th>Elevation from finish floor(ft)</th>
<th>Support Width</th>
<th>Elevation from finish floor(ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'-0&quot;</td>
<td>21'-0 1/4&quot;</td>
<td>149'-10&quot;</td>
<td>24'-1 3/4&quot;</td>
</tr>
</tbody>
</table>

The base support consists of wall ties connected to the floor slab at a location 2” below finish floor. The entry is the same as that for the roof support:

<table>
<thead>
<tr>
<th>Start Distance</th>
<th>Elevation from finish floor(ft)</th>
<th>Support Width</th>
<th>Elevation from finish floor(ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'-0&quot;</td>
<td>-0'-2&quot;</td>
<td>149'-10&quot;</td>
<td>-0'-2&quot;</td>
</tr>
</tbody>
</table>
**Wall Loading**

With the support locations now defined, the loading can be applied. The surface load is applied to the wall assuming a simple span condition from the base support to the roof support. Edge zones can be entered if required by defining those regions separately. For this example no edge zone wind is assumed:

<table>
<thead>
<tr>
<th>Start Distance</th>
<th>Load Width</th>
<th>Wind load (psf)</th>
<th>Seismic load (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'-0”</td>
<td>149'-10”</td>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>

Roof loads are entered in a similar manner:

<table>
<thead>
<tr>
<th>Start Distance</th>
<th>Load Width</th>
<th>Eccentricity (in)</th>
<th>Dead load (klf)</th>
<th>Live load (klf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'-0”</td>
<td>149'-10”</td>
<td>5</td>
<td>.02615</td>
<td>.0523</td>
</tr>
</tbody>
</table>

Concentrated loads will be entered individual:

<table>
<thead>
<tr>
<th>Dist to Load</th>
<th>Eccentricity (in)</th>
<th>Dead load (kip)</th>
<th>Live load (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50'-0”</td>
<td>1 5/8</td>
<td>10.76</td>
<td>14.35</td>
</tr>
<tr>
<td>100'-0”</td>
<td>1 5/8</td>
<td>10.76</td>
<td>14.35</td>
</tr>
</tbody>
</table>

Horizontal roof loads are entered as shown:

<table>
<thead>
<tr>
<th>Start Distance</th>
<th>Load Width</th>
<th>Wind load (klf)</th>
<th>Seismic load (klf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0'-0”</td>
<td>149-10”</td>
<td>.300</td>
<td>0</td>
</tr>
</tbody>
</table>

At this point all the necessary information has been added to proceed with setting panel joints and obtaining a design for the wall. Additional information entry for weld plates and other embedded items can be performed but this will be addressed later in the example when covering output for dxf drawings.
Panel Joint Layout

Panel joint input is similar to that of grid lines. The distance from the selected grid line can be entered or, incremental mode can be enabled which will allow for the entry of nominal panel widths as shown on a typical layout plan.

Enter the panel layout as shown below with incremental mode enabled:

<table>
<thead>
<tr>
<th>Panel Id</th>
<th>X-dist*</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>12'-6&quot;</td>
</tr>
<tr>
<td>P2</td>
<td>25'-0&quot;</td>
</tr>
<tr>
<td>P3</td>
<td>25'-0&quot;</td>
</tr>
<tr>
<td>P4</td>
<td>12'-6&quot;</td>
</tr>
<tr>
<td>P5</td>
<td>20'-0&quot;</td>
</tr>
<tr>
<td>P6</td>
<td>19'-0&quot;</td>
</tr>
<tr>
<td>P7</td>
<td>18'-9&quot;</td>
</tr>
<tr>
<td>P8</td>
<td>17'-1&quot;</td>
</tr>
</tbody>
</table>

*Note when in incremental mode the current grid selected does not affect the panel widths entered.

Wall Panel Design

With all the information entered it is now time to generate the design and determine if any panels require additional input. Select Generate Wall Output from the wall details tab.

This action has now divided the wall into individual panels and performed a design of each panel providing reinforcing required, reinforcing shop drawings, panel layout shop drawings and a material summary outlying the quantities of the various products required to construct the wall.

Single panels can now be accessed by the user by double clicking on the panel in the list or on the panel in the graphical window. Any panels for which a suitable design could not be achieved are highlighted by the program for investigation by the user.
The program will provide reinforcing that meets the conditions set earlier in the project. If a solution using those parameters cannot be obtained, an error message will be shown in the strip status row which will help the user to narrow down the possible design issues. The messages are as follows

- Deflection Limit Exceeded
- Steel Ratio Exceeded
- Panel Stability Issue
- Panel Overstressed
- Allowable Concrete Strain Exceeded
- Below Cracking Moment

At this point panel engineering reports can be generated if the panel status is listed as ok.

**Drawing Output**

User specified or all panels can be exported. If an entire project is exported the program determines like panels and only outputs one panel of each type for reinforcing drawings. For panel layout drawings there are a few options with the first being the program separating walls into segmented runs which will fit onto the specified architectural sheet size at the drawing scale specified. The other options are individual panel views or a full wall view based on the specified scale.
This step could be completed before design but since embed information is sometimes not known until later in the project development we chose to enter them last. Embeds can either be preloaded by manufacturer or entered by the user and stored for future use. Embeds are grouped by use which determines where they will be placed on the wall, this is done in the program settings.

For this example roof and roof girder connections are required. RC2's will be used for roof deck and RG1's will be used for girder attachment to the tilt-up wall. They shall be entered as shown in the figure above.

Once entered the embeds can now be used in the current and any subsequent project. Now the embeds shall be added to the wall by entering the information on the wall data screen as follows:

**Roof Connection:**

- **Embed Mark = RC2**
- **Start Distance = 0'-0”**
- **Distance to 1st embed from Start Location = 2'-0”**
- **Number of Spaces = 36**
- **Typical Spacing of Embeds = 4'-0”**

Connection runs can be segmented if needed to avoid interferences with panel joints or if specific
placements are required.
Roof girder connections are entered similar to the manner in which concentrated loads are.
Distance to Connection = 50'-0"
Dimension to roof support at connection location = 22'-0"
Vertical distance below roof support to Girder connection = -1'-0"
Embed Mark = RG1
Distance to Connection = 100'-0"
Dimension to roof support at connection location = 23'-0 1/2"
End Grid Line = 100'-0"
Vertical distance below roof support to Girder connection = -1'-0"
Embed Mark = RG1

Regenerate the wall and now when the panel layout drawing is exported the embeds will be included.
Panel Report
Summary Report

<table>
<thead>
<tr>
<th>Wall Name</th>
<th>Area (sq ft)</th>
<th>Concrete</th>
<th>Steel #/sq ft</th>
<th>Cost</th>
<th>Cost $/sq ft</th>
<th># of</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Thickness</td>
<td>Gross</td>
<td>Net in lbs.</td>
<td>Gross Dollars</td>
<td>Gross</td>
<td>Net Dollars</td>
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<td>4,160</td>
<td>1,181</td>
<td>14.04</td>
<td>10,622</td>
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**NOTE:**
Cost is based on user entered cost of materials and labor.

**TURNING (in. ft.):**

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<th>Wall Name</th>
<th>Top</th>
<th>Bottom</th>
<th>Edge</th>
<th>Joint</th>
<th>Opening</th>
<th>Bound</th>
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<th>Pilaster</th>
<th>Ledger</th>
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**DETAILS (in. ft):**

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<th>0'-1/8&quot;</th>
<th>0'-2/8&quot;</th>
<th>0'-3/8&quot;</th>
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**TOTALS:**

|            | 150    | 150    | 61     | 153    |

**THREE PLATES:**

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<th>COL</th>
<th>RCS</th>
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|            | 28      | 2    | 8    | 27   |
Reinforcing Steel Cut List

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<th>END</th>
<th>BENDING DIMENSIONS</th>
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</tbody>
</table>

Completed Building 3D Export

(see manual for 3D output generation)

TOTAL STEEL WEIGHT (pounds): 9,926