15. PLS-CADD/ LITE

PLS-CADD/ LITE is a limited version of **PLS-CADD** restricted to calculations of sags, tensions, loading trees, clearances between wires, stringing tables and conductor current vs. temperature relationships for the wires radiating from a single structure. Its capabilities are also available in the full version of **PLS-CADD**. The structure attachment points can be designated points in space or attachment points of a structure model developed in the **TOWER** or **PLS-POLE** program. With **PLS-CADD/ LITE** one is able to rapidly create a model without having to manage the full terrain information of **PLS-CADD**.

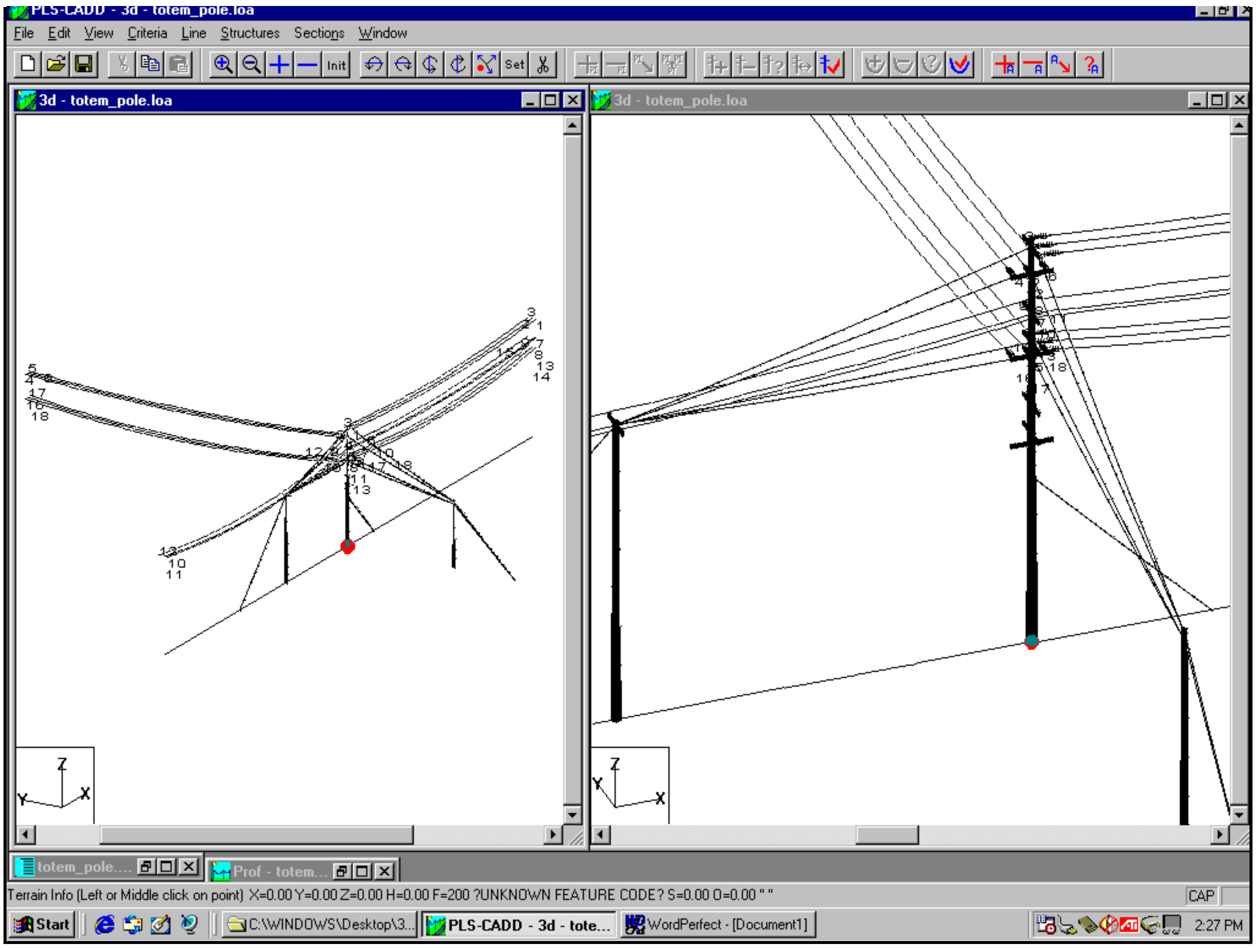

Fig. 15-1 Wood pole strung in PLS-CADD/ LITE

If a structure model has been developed in the **TOWER** or **PLS-POLE** program, that model can quickly be strung with wires in any direction by entering data in a single table (see Fig. 15-2). Then the corresponding loading tree can be calculated for that structure and the structure checked at the click of the mouse. The structure shown in Fig. 15-1 actually consists of a wood pole guyed in several directions through stub poles and span guys. The pole, cross arms, insulators, associated stub poles and all guys are part of a single **PLS-POLE** model.

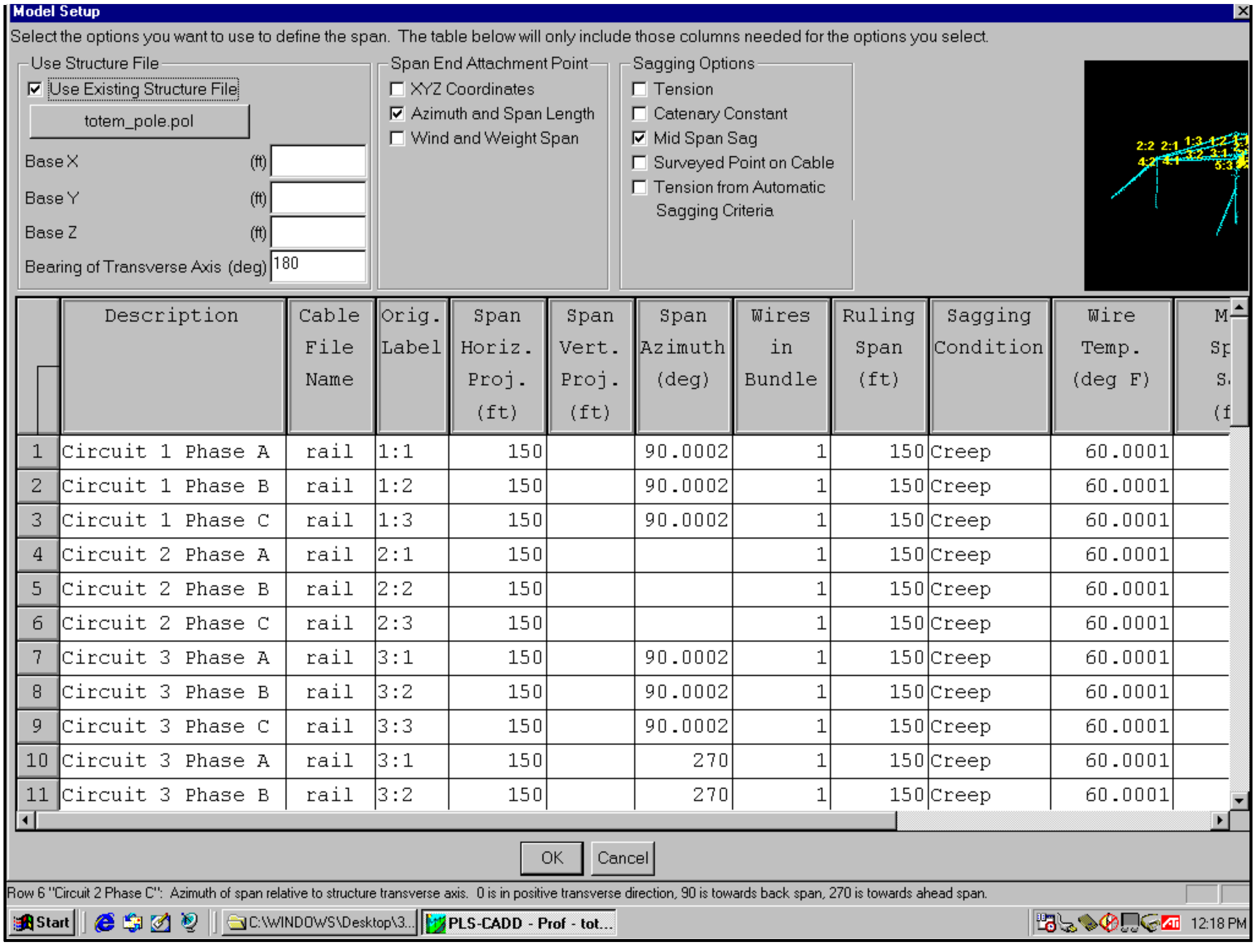

Fig. 15-2 One possible configuration of the Model Setup dialog box

While **PLS-POLE** and **PLS-CADD/ LITE** working together form the ideal combination for conducting joint-use studies of existing wood or other poles, either one of these programs can be used by itself in stand-alone mode.

A project developed by **PLS-CADD/ LITE** is saved in a file named *Project.loa*. The *".loa"* extension is required to distinguish **PLS-CADD/ LITE** files from regular **PLS-CADD** files which have the *".xyz"* or *".pfl"* extension. Therefore, it is essential when you create a new **PLS-CADD/ LITE** project to name the project file with the *".loa"* extension, as this is the only piece of information that lets **PLS-CADD** know that it should run in **PLS-CADD/ LITE** mode.

In order to use **PLS-CADD/ LITE** you need first to develop design criteria in the **Criteria** menus (this was described in Section 7) and you need to have the appropriate ground wire and conductor models (these models were described in Section 9). Then you will install and sag the wires that radiate from your structure as described below. When you start a new project you can set up your work quickly as described in Section 15.1.5.

15.1 Installing and sagging wires

In **PLS-CADD/ LITE,** there is no concept of cable sets and phases. All you need to do is describe how individual wires radiate from attachment points on your structure. While we say that the wires radiate from the structure, it is not necessary that they all terminate on the same vertical axis. Actually, one of the powerful features of **PLS-CADD/ LITE** is that the various wire attachment points on the structure may have arbitrary offsets from whatever vertical reference axis is associated with the structure. In the right pane of Fig. 15-1 you can see wires with different offsets radiating from cross arms perpendicular to each other. Ignoring offsets, as is commonly done by other loading programs, can result in serious errors in the calculation of design loads, especially with short spans.

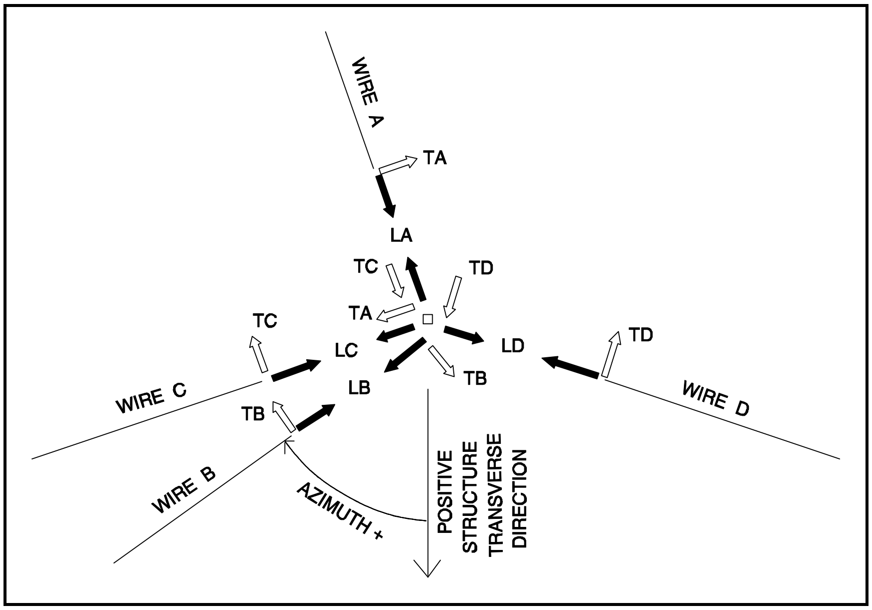

Fig. 15-3 Top view of radiating wires

Each wire has two end points, the origin being the attachment point to the structure and the end being at the other extremity of the span. Internally, these end points are located in a global X,Y,Z coordinate system, where Y is North, X is East and Z is up. However, structure loads are defined by their components in the structure transverse and longitudinal directions. Therefore, you will need to define the structure transverse direction (direction shown in the plan view of Fig. 15-3) relative to the global Y-axis. This is done by entering the *Bearing of Transverse Axis* (angle from Y-axis to transverse structure direction between -180 and + 180 degrees, positive if clockwise) in the top left part of the **Model Setup** dialog (see Fig. 15-2). The arrows labeled TA, TB, TC and TD in Fig. 15-3 show the wind reactions at the ends of the wires and the corresponding loads on the structure (in the span coordinate systems). These wind loads are reported by **PLS-CADD/ LITE** as positive quantities if their actions on the structure have positive projections in the direction of the structure transverse axis: this is the case for all the wind load arrows shown in Fig. 15-3.

All data needed to install and sag wires are entered in the Loads Setup dialog box which you reach with **Line/ Setup**. The columns which make up the table of the **Model Setup** dialog box depend on your choice of method for installing and sagging the wires. In that table, each wire is described by the following data:

15.1.1 Data needed regardless of selection of installation and sagging methods

Description:	Alphanumeric description of wire
Cable Name:	Clicking on this button takes you to the cable library where you select a wire type
Wires in Bundle:	In case you attach a bundle of wires to the structure, this is the number of wires (subconductors) in the bundle
Ruling Span:	Length of ruling span used to make sag-tension calculations (default is horizontal projection of span)
Display weather case:	Weather case used for displaying the wire picked from list of available weather cases. If the weather case includes wind, the wires will be displayed twice, once for the wind blowing perpendicular to the wire in one direction and once for the wind blowing in the opposite direction
Display Condition:	Wire condition (Initial, after Creep or after Load) used for displaying the wire
Display Color:	Color used for displaying the wire
Insul. Counter Weight:	Weight that is added to the design vertical load produced by the wires at the structure attachment point. This may be used to include the insulator weight in your loading tree if your structure program does not take care of it automatically (**TOWER** and **PLS-POLE** can add insulator weights to loading trees) or to handle the counterweight that may be hung at the tip of a suspension insulator to decrease insulator swing.

15.1.2 Defining attachment at structure

15.1.2.1 With global coordinates of attachment points

This option is enabled if you do not select *Use Existing Structure File* in the top left area of the dialog box.

Data outside of the wires table:

Base Z: Elevation at base of structure used to draw horizontal line representing ground

Data needed for each wire:

Origin X, Y and Z: Global coordinates of the attachment point to the structure

15.1.2.2 By importing a structure model with already defined attachment points

This option is enabled if you select *Use Existing Structure File* in the top left area of the dialog. With this option, you can import a **TOWER** or **PLS-POLE** model with predefined attachment points.

Data outside of the wires table:

Base X, Y and Z: Global coordinates of the point at the structure base which has 0, 0, 0 local coordinates in the structure program. **PLS-CADD/ LITE** will use this information to obtain the global coordinates of all structure attachment points as defined in the **TOWER** or **PLS-POLE** model and display identifying names for these attachment points in the column labeled **Orig. Label**. The identifying name is " *i : j* ", where " *i* " represent the set number and " *j* " the phase number in the **PLS-CADD Link** table of **TOWER** or **PLS-POLE**.

15.1.3 Defining end of each span

For each wire, the location of the span end (the origin being the structure attachment point) needs to be defined. There are three options available. The columns which are displayed in the wires table depend on your selection in the **Span End Attachment Point** area of the **Model Setup** dialog. If you select more than one option in the **Span End Attachment Point** area, you will enable the **End Mode** column in the wires table where you will be able to select a particular option for each individual wire.

15.1.3.1 With global coordinates of end point

If you select *XYZ Coordinates* (or *Coordinates* in the **End Mode** column) you will enable the **End X**, **End Y** and **End Z** columns in which you will enter the global coordinates of the span end for each wire.

15.1.3.2 With azimuth, span length and vertical projection

If you select *Azimuth and Span Length* (or *Projection*s in the **End Mode** column) you will enable the **Span Azimuth**, **Span Horizontal Projection** and **Span Vertical Projection** columns. The azimuth is, in the plan view, the clockwise angle, between -180 degrees and +180 degrees, measured from the structure tranverse axis to the span direction (see Fig. 15-3). The *Span Vertical Projection* is positive if the structure end of the span is lower.

15.1.3.3 With wind span and weight span

If you select *Wind and Weight Span* (or *Wind Span* in the **End Mode** column) you will enable the **Wind Span** and **Weight Span** columns. The program will display the span as if it had a length equal to twice the wind span and equal end elevations. This option is not used when you know the actual span geometry. You will only use it when you need design loads based on assumed maximum wind and weight spans, for example in the case of the design of a structure for future use. With this option, the program will calculate the loads at the end of each wire as follows:

Transverse load	=	Transverse load per unit length of wire times *Wind Span*
Vertical load	=	Vertical load per unit length of wire times *Weight Span*

15.1.4 Sagging wires

Due to the diversity of situations where **PLS-CADD/ LITE** may be used to determine loads on an existing or planned structure, we provide you with five different methods for sagging a wire. The appropriate columns which are displayed in the wires table depend on your selection in the **Sagging Options** area of the **Model Setup** dialog. If you select more than one option in the **Sagging Options** area, you will enable the **Sagging Mode** column in the wires table where you will be able to select a particular option for each individual wire.

15.1.4.1 Specifying horizontal component of tension for given temperature and cable condition

If you select *Tension* (or *Horizontal Tension* in the **Sagging Mode** column) you will enable the **Sagging Condition**, **Wire Temperature** and **Horizontal Tension** columns in which you will enter the wire condition (Initial, after Creep or after Load), the wire temperature and the horizontal component of tension at sagging, respectively.

15.1.4.2 Specifying catenary constant for given temperature and cable condition

If you select *Catenary Constant* (or *Catenary* in the **Sagging Mode** column) you will enable the **Sagging Condition**, **Wire Temperature** and **Catenary Constant** columns in which you will enter the wire condition (Initial, after Creep or after Load), the wire temperature and the catenary constant at sagging, respectively.

15.1.4.3 Specifying mid span sag for given temperature and cable condition

If you select *Mid Span Sag* (or *Mid Span Sag* in the **Sagging Mode** column) you will enable the **Sagging Condition**, **Wire Temperature** and **Mid Span Sag** columns in which you will enter the wire condition (Initial, after Creep or after Load), the wire temperature and the mid span sag at sagging, respectively.

15.1.4.4 Specifying coordinates of one point surveyed along wire for given temperature and cable condition

If you select *Surveyed Point on Cable* (or *Pt. on Cable* in the **Sagging Mode** column) you will enable the **Sagging Condition**, **Wire Temperature**, **Cable X**, **Cable Y** and **Cable Z** columns in which you will enter the wire condition (Initial, after Creep or after Load), the wire temperature and the global coordinates of a point surveyed within the span, respectively. This method is normally used when the global coordinates of both span ends and the intermediate point are surveyed at the same time.

15.1.4.5 Using the autosag function

If you select *Tension from Automatic Sagging Criteria* (or *Autosag* in the **Sagging Mode** column) the wire will be sagged automatically as tight as it can be without violating any of the automactic sagging criteria defined for your project (see Section 7.3.7).

15.1.5 Starting new project

If you chose *PLS-CADD/LITE* after clicking on **File/New**, the dialog box of Fig. 15-4 will appear. With the proper selections in that box, you will be taken directly to the **Model Setup** dialog box of Fig. 15-2 which will have already been customized for you to enter span data without any further consideration.

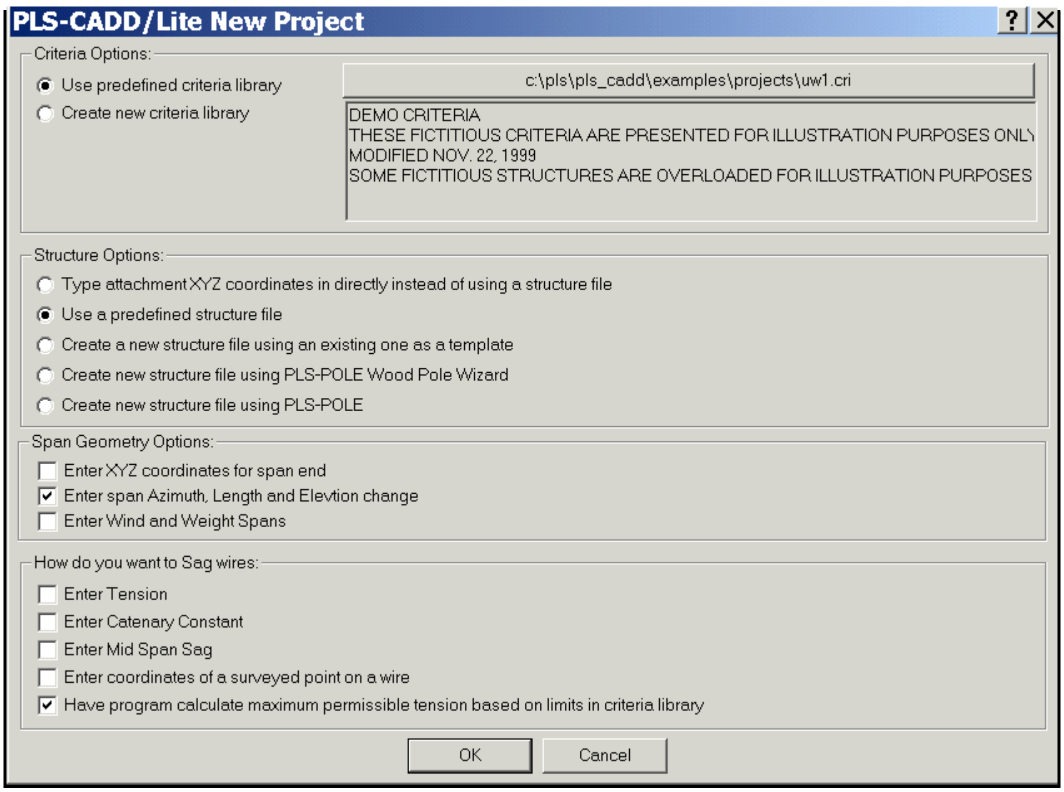

Fig. 15-4 Getting started with new PLS-CADD/ LITE project

15.2 Viewing PLS-CADD/ LITE model

When you load an existing **PLS-CADD/ LITE** project or when you click on **OK** at the bottom of the **Loads Setup** dialog box, you will get by default two views of your model as shown in Fig. 15-5. The left pane will show a profile view (projected perpendicular to the structure transverse axis) and the right pane will show a 3-d view. You can manipulate these views or open additional view windows exactly as you would with the full **PLS-CADD** program. If you do not import a structure model, you will see the wires and their attachment points, but no structure. For example, Fig. 15-6 shows the profile view (bottom right window), 3-d view (upper right window) and the loads report for a simple two-wire system that represents a drake conductor attached at a structure located at a 10 degree line angle. It took two lines of data in the **Model Setup** wires table to generate the model. The system is subjected to two load cases, the NESC Heavy Loading condition with wind blowing in both the positive and negative structure transverse directions.

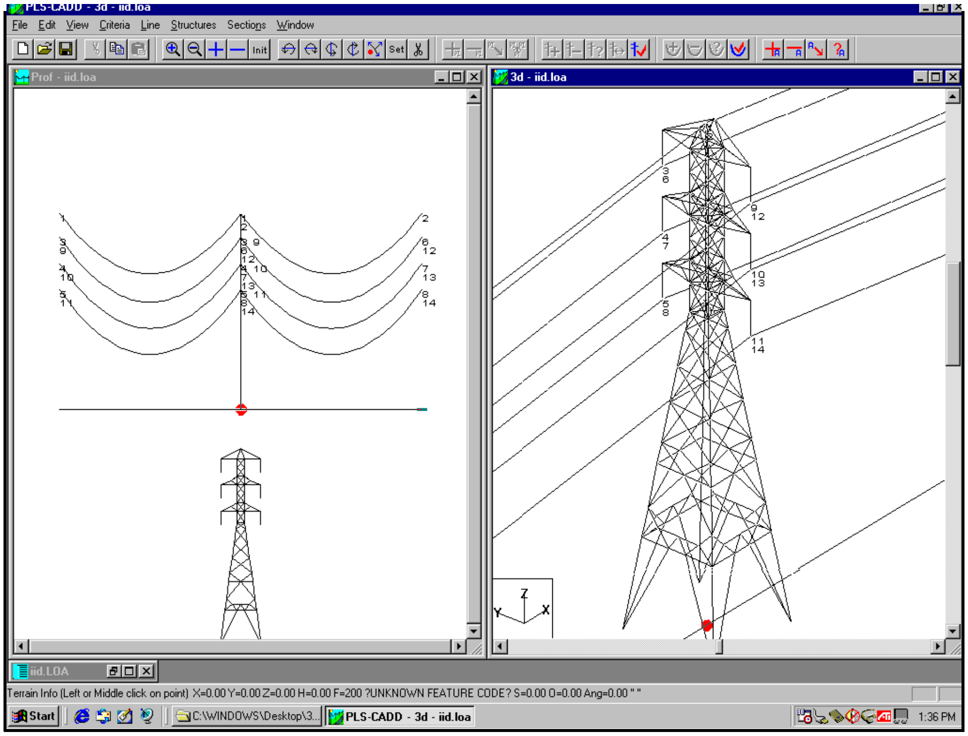

Fig. 15-5 Tower imported in PLS-CADD/ LITE

15.3 Engineering calculations and reports

Once your **PLS-CADD/ LITE** model has been developed you can use the following structure functions:

Structures/ Loads/ Report:

This function determines the design load information on the structure. As can be seen in Fig. 15-6, the loads report includes first for each load case and for each wire:

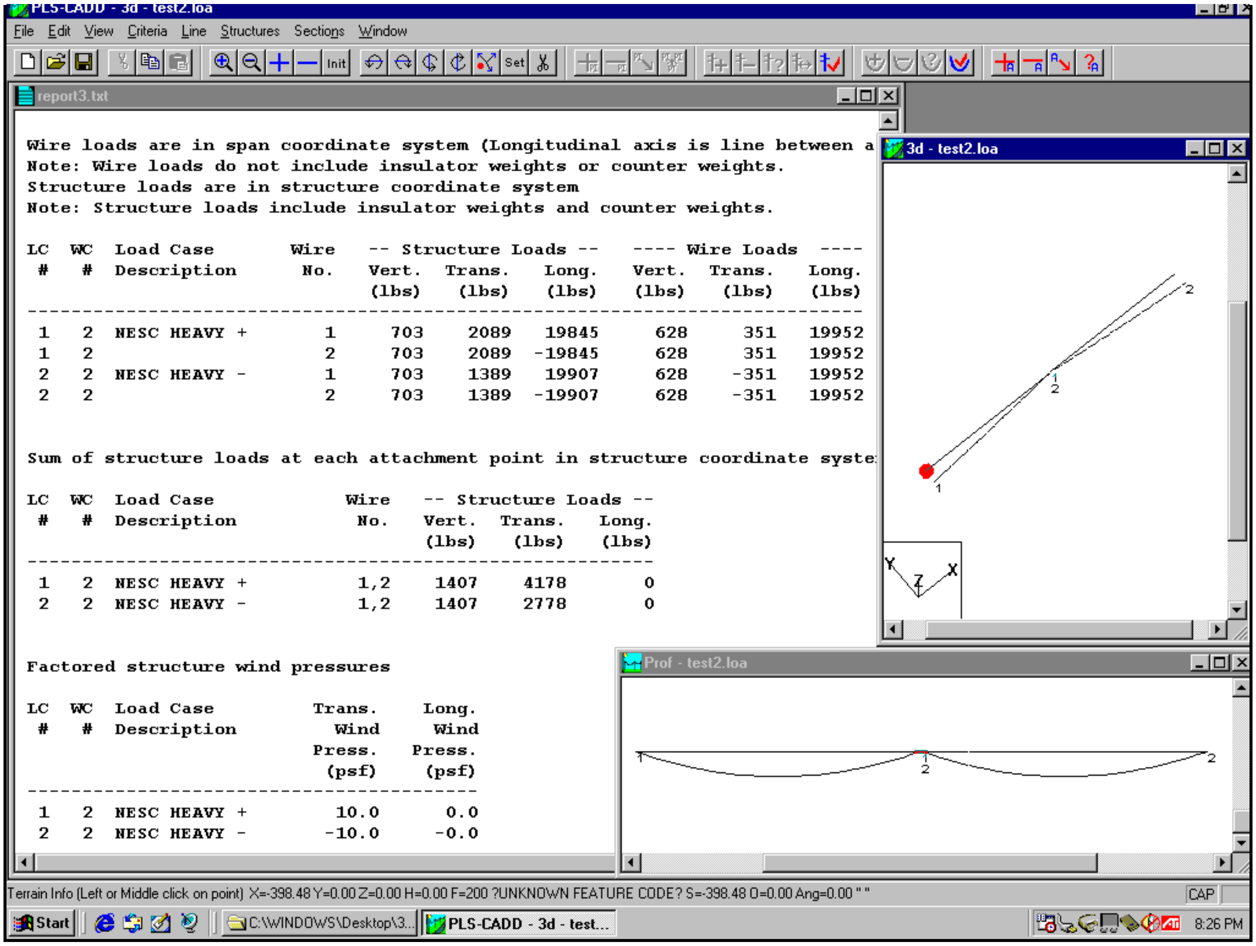

Fig. 15-6 Design loads for a simple two-wires model

1) the **Wire Loads** in the span coordinate systems. These loads are the arrows shown in Fig. 15-3 and are strictly equal to the reactions at the end of each wire times the appropriate load factors as discussed in Section 7.3.12.3. The vertical loads do not include the weights from insulators or counterweights.

2) the **Structure Loads** applied by each wire individually to the structure in the structure vertical, transverse and longitudinal directions. The vertical loads now include the factored weights of insulators or counterweights.

Then the report shows the **sums** of the loads from Item 2) above for all the wires that come to the same structure attachment point. These loads are the final design loads at the structure attachment points.

Finally the report lists the factored design computed as described in Section 7.3.12.5.

IMPORTANT NOTE:

You should be aware of the two different methods which are used to calculate design structure loads at a wire attachment point, depending on whether the wire is modeled by its actual geometry (Sections 15.1.3.1 or 15.1.3.2) or by wind/ weight spans (Section 15.1.3.3).

When a model is modeled by its actual geometry, the loads are always calculated as described in Section 7.3.12. There may be slight differences between these loads and those that you might get by simpler traditional methods which do not consider the length of wire in the span nor the span blowout under wind.

When a model is described by its wind and weight spans, the unfactored loads in the span coordinate system (those shown in Fig. 15-3) are based on the traditional assumption that: 1) the transverse wind load, T, at the end of a wire is equal to UH (see Fig. 7.2-3) times its wind span, 2) the vertical load, V, is equal to (UW + UI) times its weight span, and 3) the longitudinal load, L, is the horizontal component of tension in the ruling span caused by the resultant UR.

Structures/ Loads/ Write LCA file:

This function writes the loading tree and structure design pressures in a standard vector loads file (*.lca format) which can be used directly by our **TOWER** and **PLS-POLE** programs.

Structures/ Loads/ Write LIC file:

This function writes a wire loads file (*.lic format) that can be used by our **TOWER** and **PLS-POLE** programs to determine allowable spans.

Structures/ Check:

If you have attached wires to a **Model 4** structure (after having selected *Use Existing Structure File* in the **Model Setup** dialog box), you can use this function to apply the loading tree to the structure and have the applicable structure program (**TOWER** or **PLS-POLE**) automatically analyze the structure under that loading tree and report the results, both graphically or in text form. For example, the tower in Fig. 15-5 was analyzed and checked automatically by the **TOWER** program within two seconds of clicking on it in **PLS-CADD/ LITE.**

Note: The **Structures/ Check** function is not applicable to **Method 1** and **Method 2** structures in **PLS-CADD/ LITE**

Structures/ New:

This commands lets you create a **Method 1** or a **Method 2** structure. It cannot be used to create **Method 4** structures. Such structures are created in the **TOWER** or **PLS-POLE** programs.

Structures/ Modify:

This commands lets you edit the structure selected in the top left area of the **Model Setup** dialog box. For **Method 4** structures, you will automatically be taken to the **TOWER** or **PLS-POLE** program.

In addition to the structure functions described above, **PLS-CADD/ LITE** lets you access most of the full **PLS-CADD** section functions (see Section 11.2).

Sections/ Check, **Sections/ Sag-Tension**, **Sections/ Clearances**, **Sections/ Stringing Charts**, **Sections/ Galloping** and **Sections/ IEEE Std. 738**.

Sections/ Galloping only works if you import an existing structure.

As an example of the potential use of **Section/ Clearances**, consider the two crossing wires shown in Fig. 15-7, a high voltage conductor (parallel to the X-axis) on top of a crossing telephone line. The model was created in a few minutes by entering the global coordinates of the four wire attachment points and the coordinates of one intermediate point on each wire. Sagging was done automatically to force the wires to pass through the intermediate surveyed points. Therefore, creating the model required the entry of the coordinates of a total of only six points in two lines of the wires table. These coordinates can easily be determined in the field with any modern surveying equipment. The left pane in Fig. 15-7 is a profile view parallel to the X-axis (with vertical scales exaggerated by a factor of 10). The right pane is a 3-d view showing the conductor blowout in opposite wind directions.

Using the **Sections/ Clearances function**, we were able to determine the minimum 3-dimensional clearances between the conductor when subjected to positive or negative design wind and the telephone wire underneath for the concurrent design condition. Solving this very complex problem was immediate in **PLS-CADD/ LITE**. The values of the minimum clearances and their locations are shown by markers in the various views of Fig. 15-7.

Finally, you can obtain a complete report regarding all design criteria, loads, sags and tensions using **Line/ Report**.

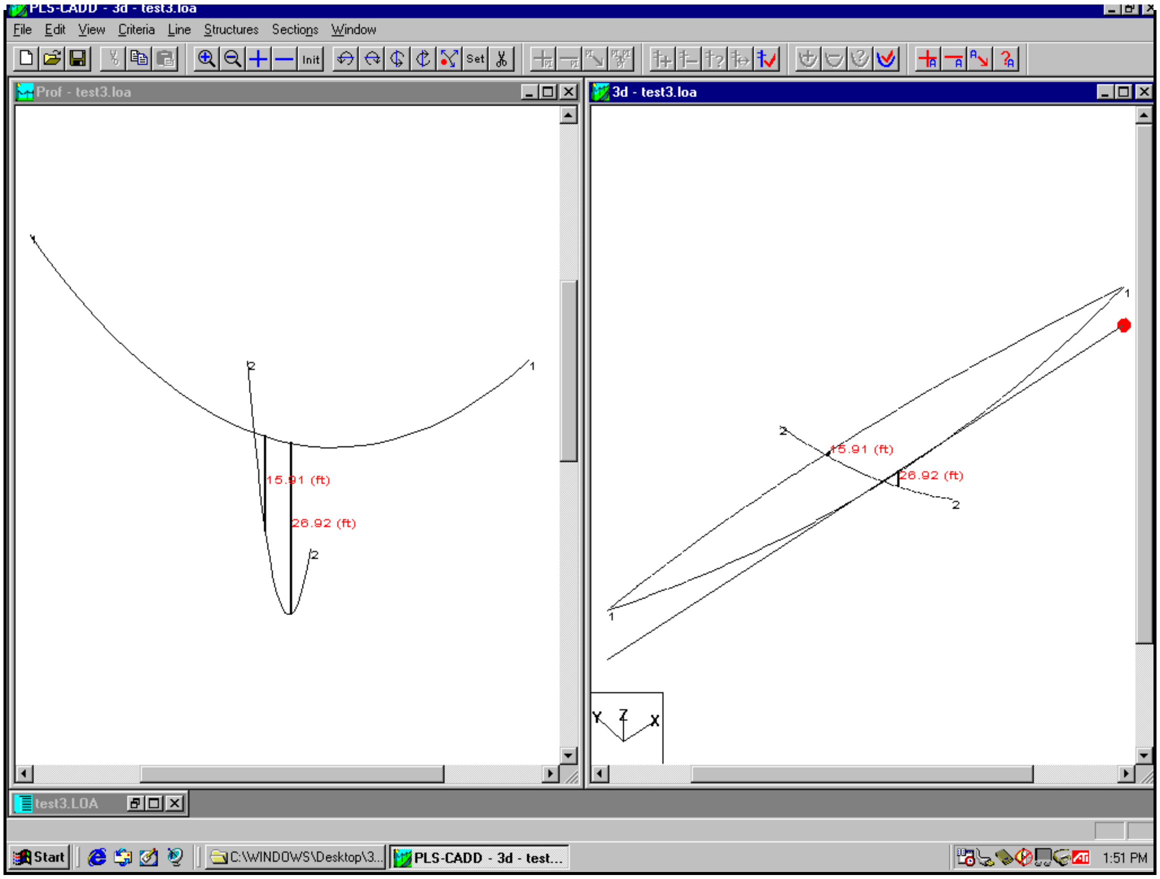

Fig. 15-7 Model of crossign wire subjected to opposite winds