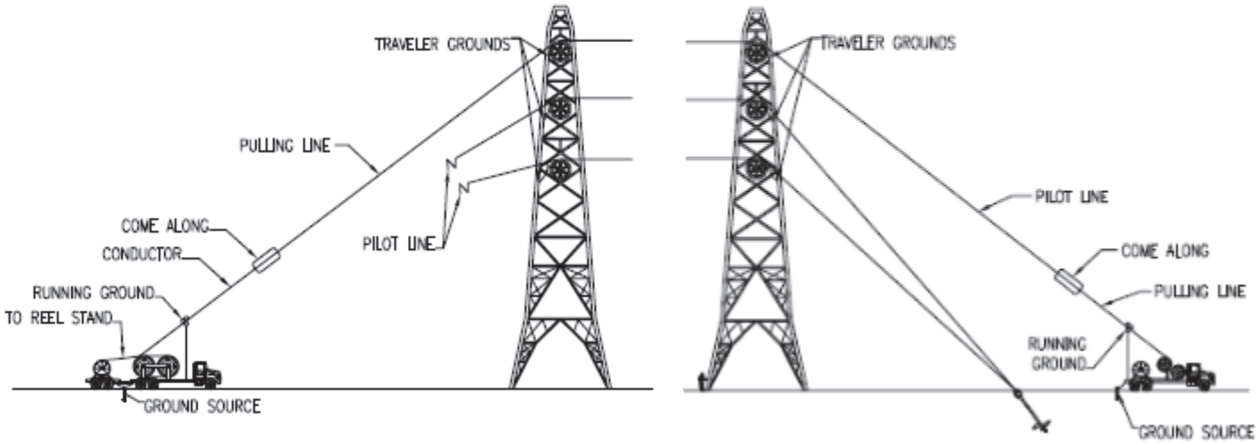
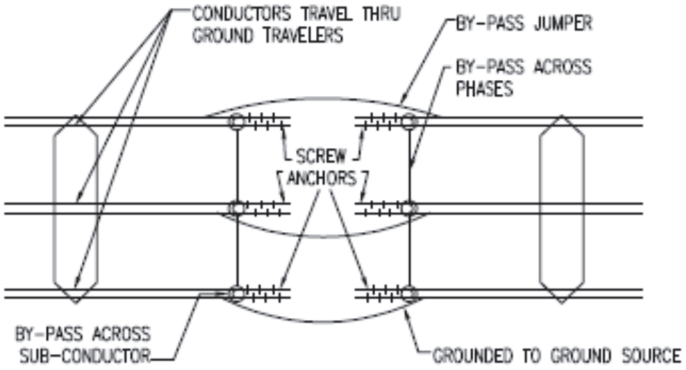
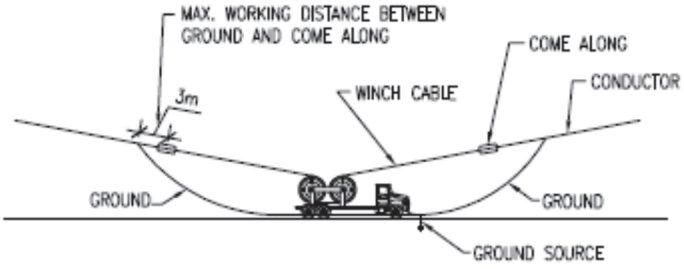
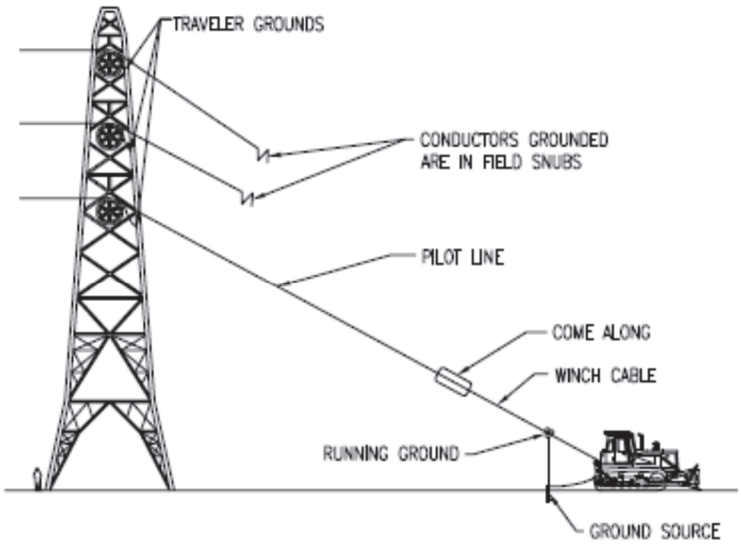
Snub Structure Loading

During the construction of an overhead line, some structures will experience loads due to the temporary snubbing of the conductors to facilitate pulling, sagging/tensioning, and splicing. These structures are often referred to as “snub structures”. The IEEE 524 *Guide to the Installation of Overhead Transmission Line Conductors* has many references to snubbing, snub structures, and snub structure loading. Some examples of snub situations from IEEE 524 are as follows;









During the pulling and sagging/tensioning operations, the deadend structures at the end of the tension section(s) will experience these snub loadings. Due to the extreme tensions and loads that deadend structures are designed for under extreme meteorological events, they are usually adequate for the everyday tensions experienced during the construction operation. However, it is obviously a good idea to verify this, especially for lattice towers

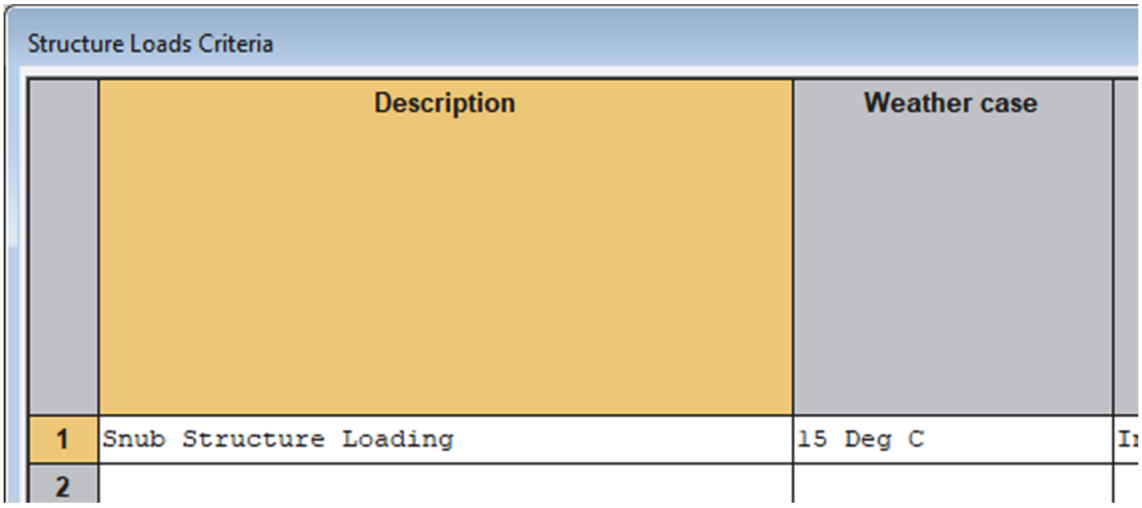
The most common type of snub loadings that can govern structure designs are for a splicing operation. As conductors are only available in finite lengths, and traditional compression splices cannot be pulled through the travelers as it will damage them, splices must be made within the spans where they will remain. The downward angle that the snub off operates at can create higher vertical and longitudinal loadings than the structures adjacent to the splice might have been designed for. The departure slope for the splicing operation is a major factor in these loads. The IEEE 524 recommends a slope of no more than 3:1 (run:rise) and this is a commonly accepted maximum slope in North America and other places. However, others may use even greater slopes which can make these loads extreme. There is nothing wrong with this, provided that the structures can handle them.

In some cases, due to terrain or access constraints, the pullers, tensioners, and splicing operations may also induce a line angle which creates transverse loads on the structures that may be greater than the intact loads and these must be considered as well.

In response to client requests, Power Line Systems introduced several advanced functions in **PLS-CADD** version 16.31 that enable a line engineer to analyze their **TOWER** or **PLS-POLE** structures for snub loadings. All of these capabilities can be accessed under the *Criteria / Structure Loads* menu.

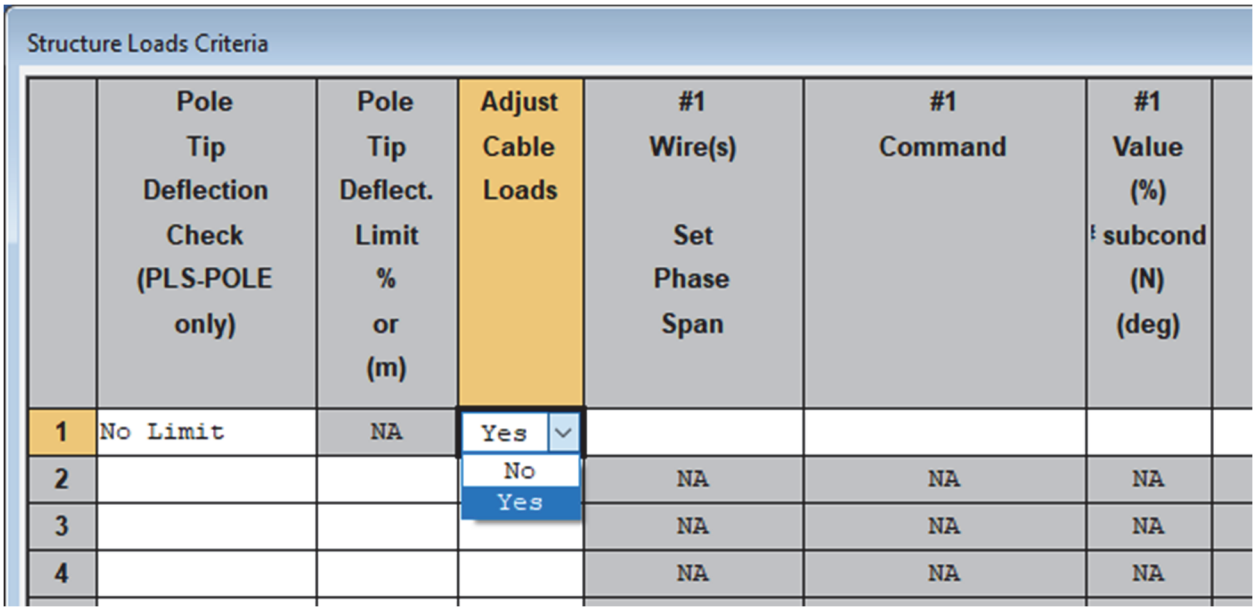
Before the loads can be created, a Weather Case must be defined to be used during the snubbing activities. This is usually a 60° F / 15° C ‘Everyday’ weather case. While most perform their snubbing under light wind conditions, some may use higher wind loading that should be in the ‘Stringing’ weather case.

In ***Criteria / Structure Loads***, create a load case for your Snub Structure Loading. Select your 'Stringing' Weather case and fill out the rest of the information in the row accordingly;


Structure Loads Criteria

	Description	Weather case	
1	Snub Structure Loading	15 Deg C	I:
2			

When you get to the "Adjust Cable Loads" column select "Yes";

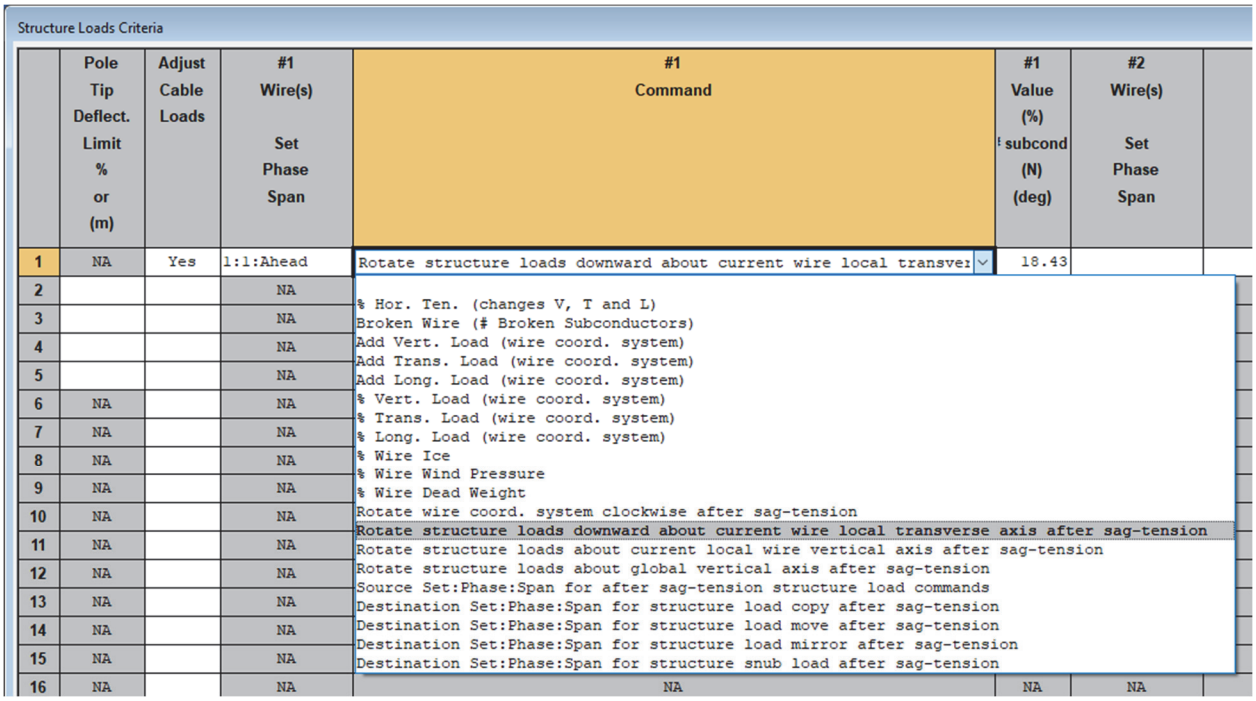

Structure Loads Criteria

	Pole Tip Deflection Check (PLS-POLE only)	Pole Tip Deflect. Limit % or (m)	Adjust Cable Loads	#1 Wire(s) Set Phase Span	#1 Command	#1 Value (%) subcond (N) (deg)	
1	No Limit	NA	Yes				
2			No / Yes	NA	NA	NA	
3				NA	NA	NA	
4				NA	NA	NA	

This will allow you to adjust the cable loads from the 'as designed' state of the model in PLS-CADD. This is an extremely powerful feature that has been available since the 90's and allows for many unbalanced loadings such as differential ice, differential wind, broken conductors and subconductors, adjusting loads by a percentage and adding concentrated loads. See Section 7.3.12.7 of the PLS-CADD User Manual for a full description of the existing capabilities.

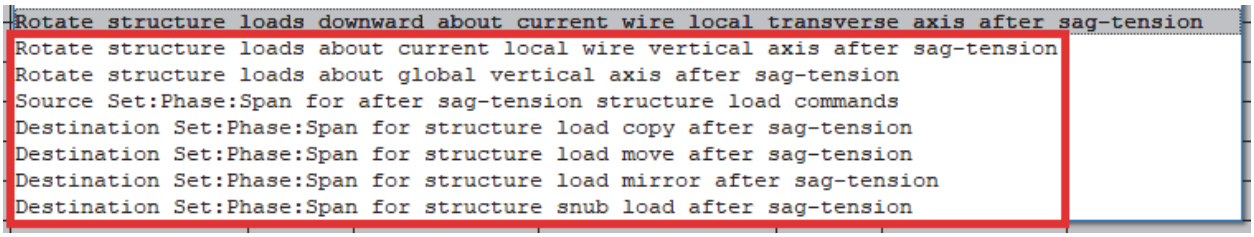
With Version 16.31, we added new options that provide considerable flexibility in modeling Snub Structure Loadings.

The first new option is to “Rotate structure loads downward about current wire local transverse axis after sag-tension”. This option can be used to quickly create a snub loading for a splice location in the middle of a line. This command will take the calculated transverse, vertical and longitudinal loads for the selected Set:Phase:Span, rotate the axis of those loads by the entered rotation angle, and then calculate new loads in the global coordinate axis. If you follow the 3:1 (run:rise) IEEE 524 practice, you can use a rotation angle of 18.43°.



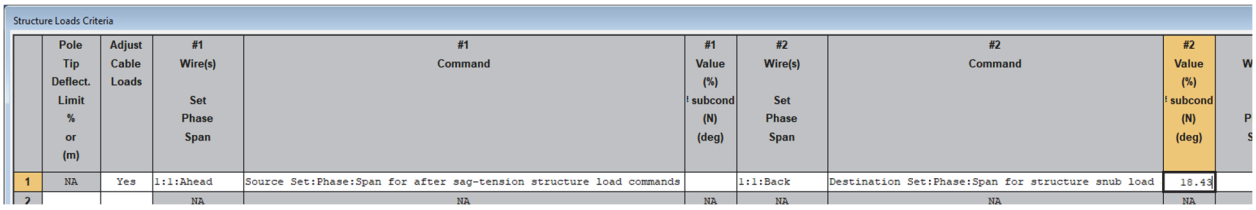
It should be noted that this option will ADD whatever angle you select to the already calculated ‘vertical departure angle for the intact structure loads. So, if your wire is departing the structure already at a 5° angle, the direction of the wire tension for this calculation would be at 23.43°. This is conservative for a 3:1 slope, so if you are OK with being a little conservative this is fine. However, you could also subtract your departure angle from the calculated 3:1 angle (13.43°) and you would have your approximate loadings for the 3:1 slope.

There may be situations where the approach of rotating wire loads is not applicable or preferred, such as considering the departure angle of the conductor is not desired or in situations where you may not have a full tension ‘final design’ wire to rotate the loads with on the pulling side of a deadend or you would like more control to define the pulling slope or pulling location. In these situations, the next seven (7) new commands allow the user to specify a particular set:phase:span and essentially do anything that they want with any wire loads in any location on a structure.



Note that multiple commands can be chained together to rotate any load horizontally and/or vertically, mirror loads, copy loads, and even move loads at a particular set:phase;span (in the case that the pulling load is applied at a different location on the structure than the final wire final location). These new cable load adjustment commands can only be used on a single set:phase;span at a time and cannot be used for the options for Back Spans, Ahead Spans or Back+Ahead Spans options.

Let's take for example a deadend structure that is starting a line. We will call it Structure #1. There is a Substation structure, but it is just a slack span from the Substation structure to Structure #1. We can't 'adjust' the slack span loads to get a full pulling tension on the back side of Structure #1, so we need to take the ahead span wire loads, copy them, put them on the back side of Structure #1, and then turn them down to create the snub loadings on the other side of the traveler. This requires two (2) commands. The first command is to take the full tension of the ahead wire (1:1:Ahead in the screen capture below), create a "Source" from it by choosing the "Source Set:Phase:Span for after sag-tension structure load commands". The 'Value' input is not used for this command and should be left blank. For the second command, we can choose the "Destination Set:Phase:Span for structure snub load after sag-tension" command, and we give it the value of the 18.43° 3:1 slope angle to pull that tension down towards the tensioner or the puller.


Structure Loads Criteria

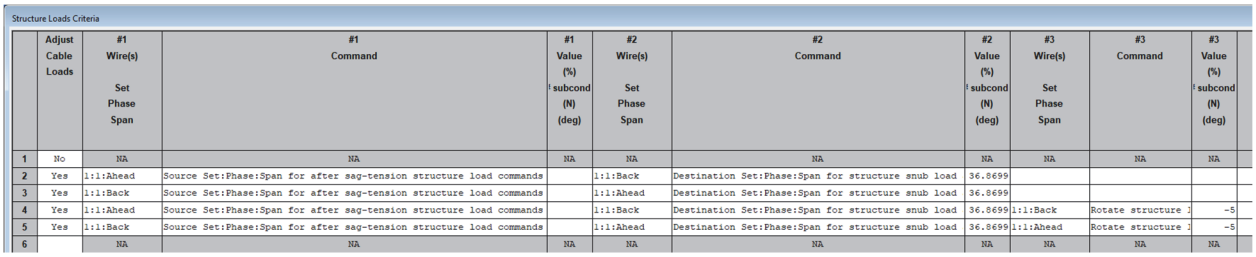
	Pole Tip Deflect. Limit % or (m)	Adjust Cable Loads	#1 Wire(s) Set Phase Span	#1 Command	#1 Value (%) ! subcond (N) (deg)	#2 Wire(s) Set Phase Span	#2 Command	#2 Value (%) ! subcond (N) (deg)
1	NA	Yes	1:1:Ahead	Source Set:Phase:Span for after sag-tension structure load commands		1:1:Back	Destination Set:Phase:Span for structure snub load	18.43
2			NA	NA	NA	NA	NA	NA

One important point to make is that the additional loads on the backside of Structure #1 would normally be in ADDITION to any 'final design' wires in your PLS-CADD project, so we will automatically remove the final design wire loads from any attachment that you choose as a Destination Set:Phase:Span for the snub load command. This is particularly important to do in the case of a splicing snub off as you do not want to add the snub loads to the span of wire that is already there. This automation by PLS-CADD eliminates the need for the user to remember to remove the final design wire manually. If in the rare condition that you were pulling in a new wire while you did have an existing wire up, this could easily be modeled by just putting another Set:Phase close to the existing Set:Phase and moving the snub loading to that added Set:Phase.

If you are not able to set the pulling site up in line with the line, a third command can be used to rotate the loads for such a line angle. The "Rotate structure loads about global vertical axis after sag-tension" command could be used on the appropriate Set:Phase:Span to account for this angle.

While this can be a bit complex, it is very flexible and allows engineers to simulate nearly every (if not all) pulling scenarios that might be encountered during the construction of a line and addresses the requests of our users.

Finally, as Structure Loads Criteria are applied to every structure in a line (based on their Structure Groups membership), the structure at the end of a line before the end Substation structure may have the snub loading on the ahead side of the structure and not the back like Structure #1, and you may have a snub loading for a splice ahead or back on any structure in the line. Multiple Structure Load Cases will be required to model all possible scenarios. The example settings in the following screen capture show how four Structure Loads Cases will envelope any combination of ahead or back snub off loadings on any structure in a line with any deviation angle of up to 5 degrees for the snub loading.



Structure Loads Criteria

	Adjust Cable Loads	#1 Wire(s) Set Phase Span	#1 Command	#1 Value (%) subcond (N) (deg)	#2 Wire(s) Set Phase Span	#2 Command	#2 Value (%) subcond (N) (deg)	#3 Wire(s) Set Phase Span	#3 Command	#3 Value (%) subcond (N) (deg)
1	No	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	Yes	1:1:Ahead	Source Set:Phase:Span for after sag-tension structure load commands		1:1:Back	Destination Set:Phase:Span for structure snub load	36.8699			
3	Yes	1:1:Back	Source Set:Phase:Span for after sag-tension structure load commands		1:1:Ahead	Destination Set:Phase:Span for structure snub load	36.8699			
4	Yes	1:1:Ahead	Source Set:Phase:Span for after sag-tension structure load commands		1:1:Back	Destination Set:Phase:Span for structure snub load	36.8699	1:1:Back	Rotate structure 1	-5
5	Yes	1:1:Back	Source Set:Phase:Span for after sag-tension structure load commands		1:1:Ahead	Destination Set:Phase:Span for structure snub load	36.8699	1:1:Ahead	Rotate structure 1	-5
6		NA	NA	NA	NA	NA	NA	NA	NA	NA

We encourage you to try this today and see how PLS-CADD can automate your Snub Loading calculations. Carefully compare the results from PLS-CADD to what you have traditionally done and if you have any questions feel free to send a BAK file to our support engineers who will be glad to help.