

2019 PLS-CADD Advanced Training and User Group

## Finite Element Modeling Improvements and Topics

by

Tim Cashman, PE

Power Line Systems

# Introduction

- More and more projects are being analyzed in PLS-CADD using Finite Element sag/tension modeling
- There have been several recent changes made within PLS-CADD to improve Finite Element modeling
  - New features to reduce redraw times
  - New features to selectively use L3 and L4 analysis where appropriate
  - Speed up of SAPS to reduce analysis time

# Primary Objectives of these Improvements

- 1) Provide a better user experience with Finite Element modeling;
- 2) Reduce unnecessary hair loss in the workplace;





# Primary Objectives of these Improvements

## 3) Prevent catastrophic hardware failure



# Presentation Outline

- Explain the new features and options
- Discuss common misconceptions about FE modeling in PLS-CADD
- Demonstrate the new features using an example project
- Demonstrate two methods of modeling structures with guy stub poles and span wires
- Discuss general tips when using FE modeling

# SAPS Finite Element Speed Up

- Starting in Version 15.50 of PLS-CADD, the speed of Finite Element sag-tension modeling has improved:
  - ~ 5% for Level 2
  - ~ 15% for Level 3
  - ~ 35% for Level 4

# Criteria/SAPS Finite Element Sag-Tension Dialog

SAPS Finite Element Sag-Tension

Selection below will affect type of model used when doing finite element sag-tension.

SAPS Analysis Level

L2 Finite element analysis of single section (no interaction between sections)  
(sag-tension will take longer than for ruling span but still reasonably responsive)

L3 Finite element analysis of system of sections interconnected by stiffness matrices  
(sag-tension computations will generally take a few seconds)

Level 3 options

Limit level 3 modeling to PLS-POLE structures, TOWER structures as level 2

L4 Finite element analysis of system of sections interconnected by full structure models  
(sag-tension computations could take many minutes and use large amounts of RAM depending on the model)

Level 4 options

Limit level 4 modeling to PLS-POLE structures, TOWER structures as level 3

Limit level 4 modeling to guyed or otherwise asymmetrical structures

Strip joints/members that don't move significantly from level 4 TOWER models

Use Level 2 modeling for display and insulator swing calculations

Insulator Chaining Options

Include chained insulators in L2 and L3 models (always included in L4)

This setting applies in situations where a strain, suspension or 2-part insulator is suspended from the end of another suspension or 2 part insulator or swing bracket. It is provided in order to match results generated in earlier versions.

L2 and L3 FE sag-tension models in PLS-CADD 12.16 and earlier only include insulators that support wires. The flexibility or movement of other insulators that support these insulators is not accounted for (unless using L4).

Newer versions of PLS-CADD can include these insulators that support other insulators in the FE model and account for their movement.

Turn this feature on for the most accurate model possible on any new projects. Turn it off for projects with chained insulators and sections sagged or clipped in PLS-CADD 12.16 and earlier to match earlier tensions.

L3 and L4 Options for Structure Loads

Limit L3 and L4 structure modeling to structures within specified number of spans of structure having load computed. Remaining structures will be modeled L2.

Number of spans out to extend L3/L4 structure modeling (0 if want only structure having its loads computed)

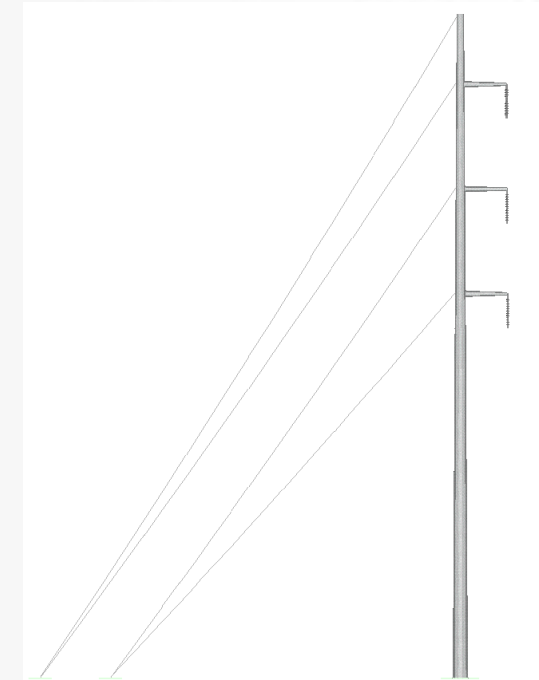
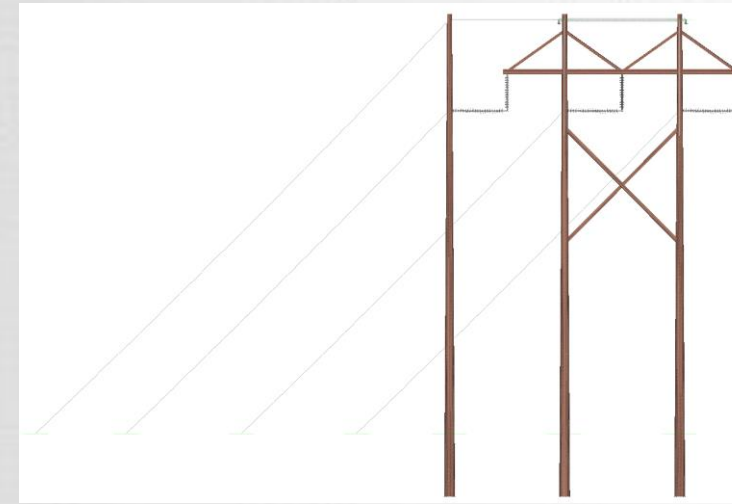
Jumper Options

Include jumpers in FE sag-tension model. Note that for L2 this can triple analysis time as model grows from single target section to target section plus up to two sections it is jumpered to. Minimal impact on L3 and L4.

OK Cancel

# What is an Asymmetrical Structure?

- Asymmetrical if any of these are true:
  - No fixed joints
  - Has guys
  - Has a different response to positive loads at attachments compared to negative loads





# If one Set is FE, all Sets will be FE for structure loads

- Starting in Version 15.30 of PLS-CADD, structure load calculations will promote all attached sections on a structure to FE condition if any section is already in FE condition.
- This eliminates scenario where loads on a structure could be based with a combination of RS and FE sag-tension runs.

# Finite Element Sag-Tension Misconceptions

Can not use FE sag-tension with Method 1, or stick structures.



# Finite Element Sag-Tension Misconceptions

Since FE is more accurate and closer to reality than Ruling Span, RS will always be more conservative.



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# Finite Element Sag-Tension Misconceptions

Clipped insulators must be used for FE sag-tension

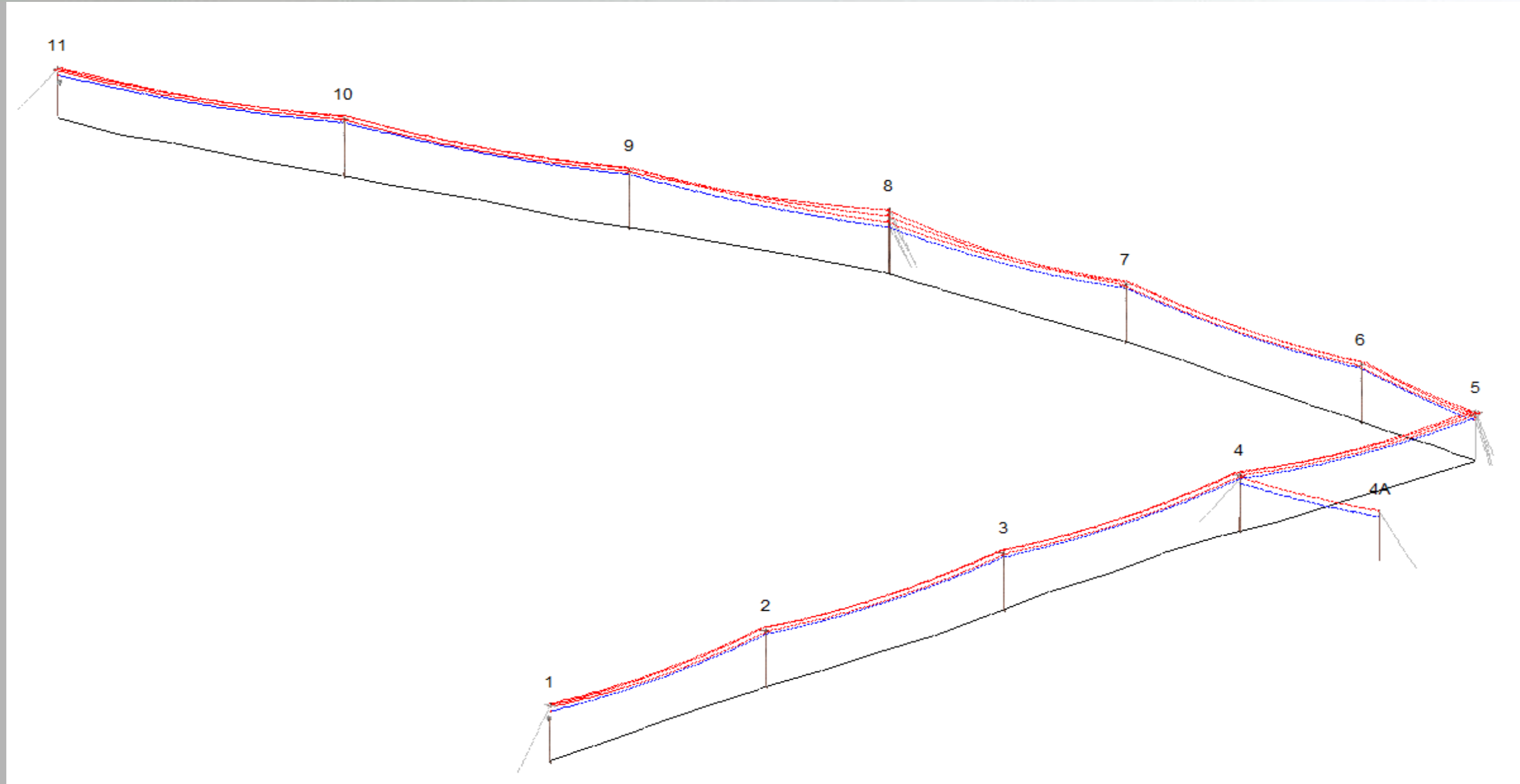




# Example Line Model for Comparison

- Created simple PLS-CADD model with 12 PLS-POLE models
  - Class 1 wood pole structures
  - 6 guyed structures (asymmetrical)
  - 6 unguyed structures (non-asymmetrical)
- Relatively even span lengths
- Distribution framings

# Criteria/SAPS Finite Element Sag-Tension Dialog



# Analysis Times for Structure 4 (Min:Sec)

	Analysis Level					
# of Spans Included in L3/L4 Structure Modeling	L4 – Max Wind @ 10°	L4 – Max Wind @ 90°	L4 – No Max Wind	L4/L3 – Max Wind @ 10°	L4/L3 – Max Wind @ 90°	L4/L3 – No Max Wind
All Spans	8:30	3:48	2:30	0:28	0:10	0:05
2 Spans	1:29	0:46	0:35	0:15	0:07	0:02
1 Span	0:38	0:18	0:11	0:12	0:05	0:02

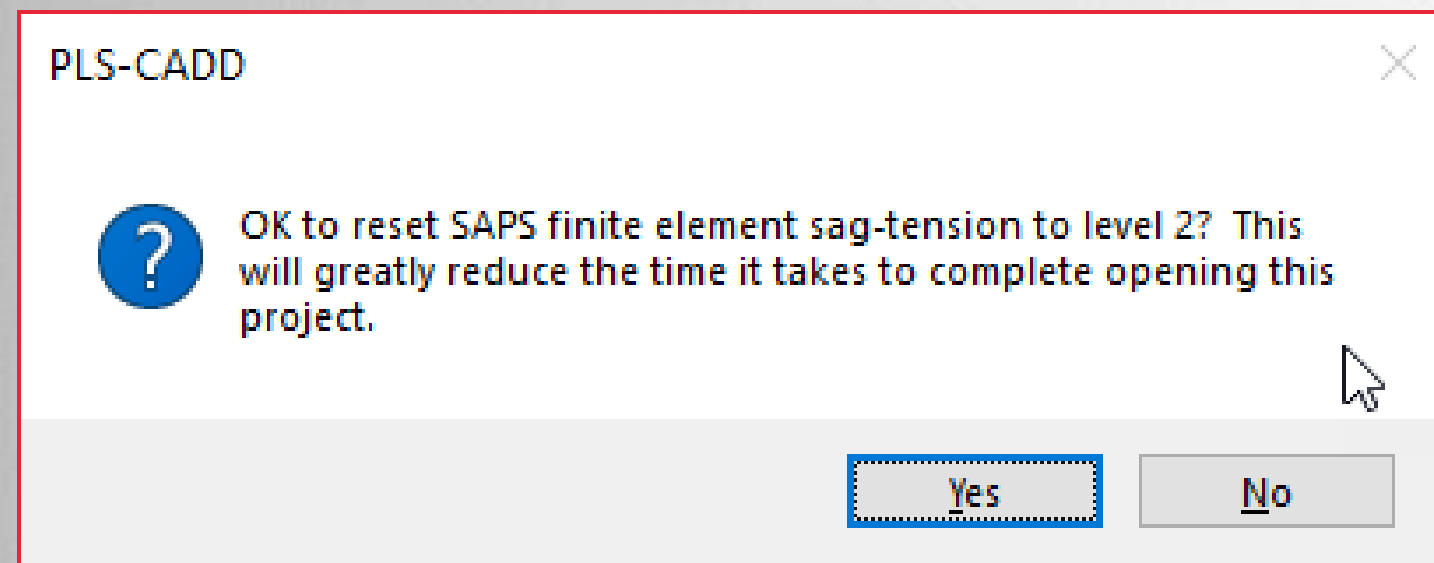
# Tips for Working with FE Sag-Tension in PLS-CADD

- Make sure all Method 4 models converge to a solution and do not have excessive usage in Level 2
- Ensure the wire termination structures are sufficiently rigid (i.e. stick structures, guyed M4 models, rigid unguyed M4 models)
- Judicious use of Max Wind direction load cases
- Utilize features discussed in this presentation and use current version of PLS-CADD



# Tips for Working with FE Sag-Tension in PLS-CADD

- When opening a model which is taking a long time due to being saved in L4, hold down the Shift key when you open the model.  
This will give you the option to open the model in L2, which will be significantly faster.



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Advanced Sag & Tension

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Materials Management

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PLS-CADD

CSA

Pole Analysis

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Distribution

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Line Optimization

## Questions?

Project Estimating

FAC 003

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Vegetation Management

1000+ Users in 100+ Countries

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Line Ratings

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