Loadings and Structure Groups

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Introduction

- PLS-CADD Loading Analysis
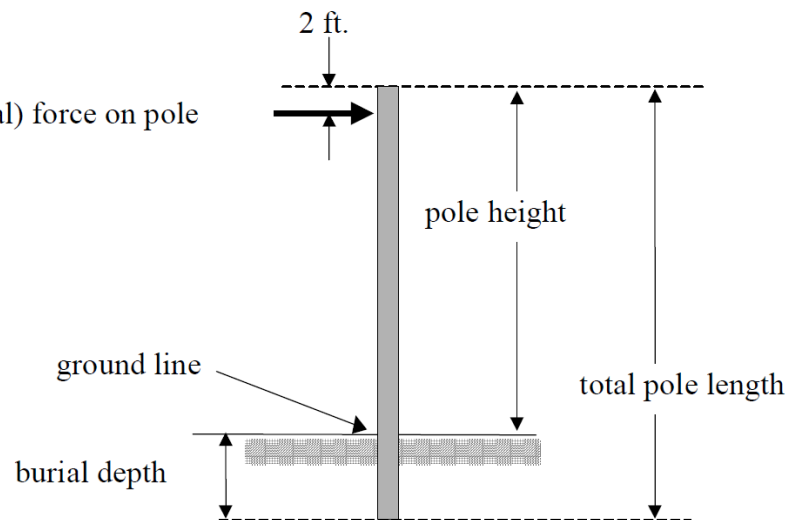 - Structure Loads (Methods 3 & 4)
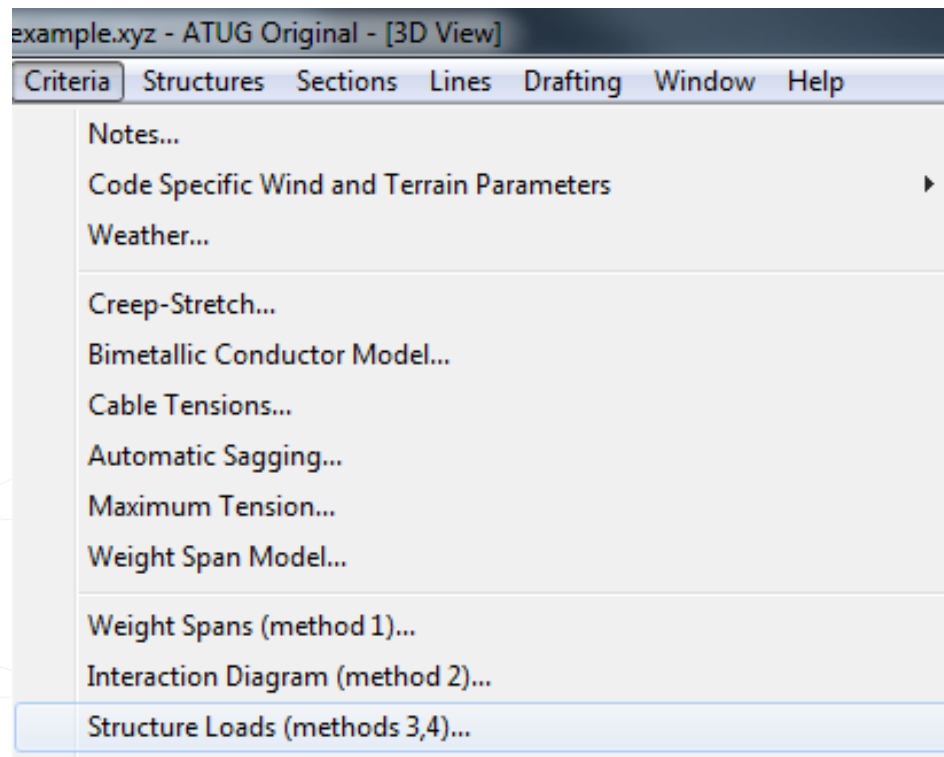
Structure Design Considerations

- After determining minimum ground clearances
  - Wire span distances
  - Wire span tensions
  - Transverse loads (horizontal wind on pole, wires)
  - Vertical loads (weight of wires, equipment)
  - Unbalanced loads (tension variations at angle poles)

2 ft.

lateral (horizontal) force on pole

pole height

ground line

total pole length

burial depth

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Structure Design Evaluation

- How do you model the impact of these loads?
  - Material Strength
  - Loading Criteria
  - Weather and Load Cases
- ASCE7 details environmental loading information
- ANSI O5.1 establishes the capacity of poles
  - Dimensions, tolerances, grades of materials, etc.
- NESC specifies the loads for pole analysis
  - Minimum safety requirements for installation, maintenance, and operation of overhead systems

Grades of Construction

- Determine appropriate size/strength of poles

NESC Grades of Construction

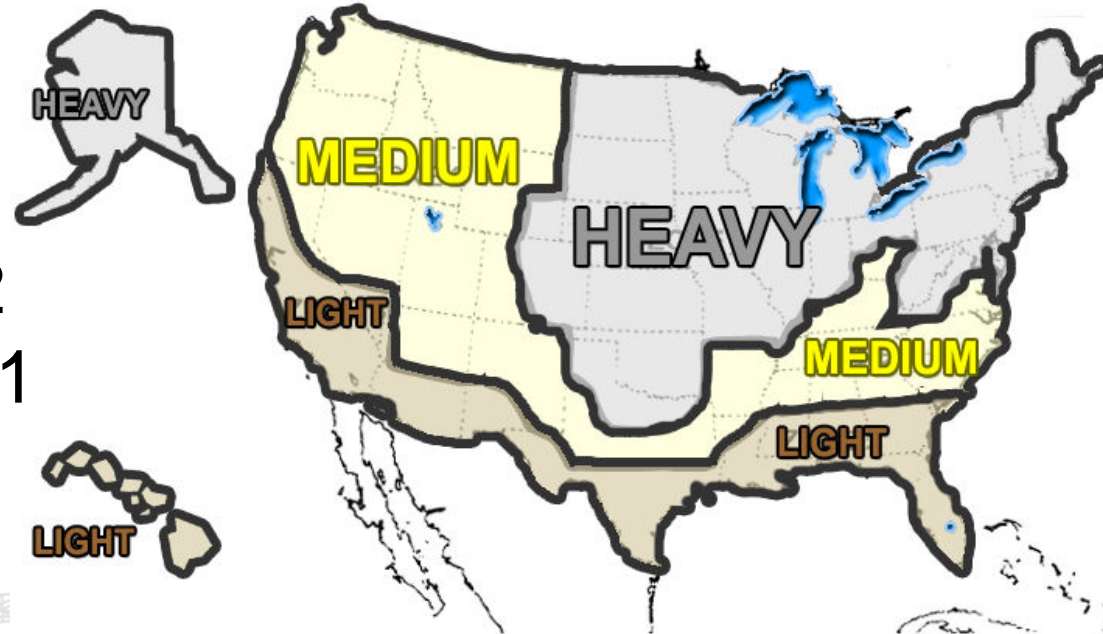Grade B – RR & Hwy crossings, varying supply voltage levels

Grade C - Typical power or joint-use distribution applications

Grade N – Communication use only

*California's G.O. 95 follows a similar breakdown with Grades A, B, and C but an additional Grade F is added for bonded & grounded cables

Loading Districts

- ## Determine wind and ice loading districts

NESC 2012
Figure 250-1

*G.O. 95 separates California into Light and Heavy Loading Zones based on elevation that is below or exceeds 3000' above sea level

Strength Factor Reductions

- NESC recognizes that structures will experience some level of deterioration over time
  - Wood and reinforced concrete structures, xarms, braces
    - Grade B can be reduced to 2/3 of initial strength requirement
    - Grade C can be reduced to 3/4 of initial strength requirement
    - NO reduction allowed for metal and prestressed-concrete
  - RUS Guidelines allow 2/3 reduction for wood
  - G.O. 95 allows 2/3 reduction for Grades "A" & "B"
    - 1/2 reduction allowed for Grades "C" and "F"

Introduction to Structure Groups

- Structure Loads Criteria Table
  - Contains all data needed to define a structure load tree
  - Structure check only gives you the worst-case load result
  - Default table settings are fine for all-new or as-built analysis, but a mixed project requires multiple steps
    - Run Structure Usage report with new strength factors, save file
    - Go to Structure Loads Criteria Table, reduce strength factors
    - Run Structure Usage report with reduced factors, save file
    - Combine report results to see usage of all new & existing poles
    - Restore Structure Loads Criteria Table to standard values

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Structure Loads Criteria Table

Structure Group Table

- All structures initially belong to the "All" group

Structure Groups Criteria

Note: First row is reserved for mandatory 'All' group to which all structures belong.

	Group Name	Group Description	Rule For Group Membership
1	All	Built in group that all structures belong to	Automatic: all structures
2	Has DE	At least one dead end set on structure	Automatic: has a DE between sets 1 and 60
3	No DE	No dead end sets on structure	Automatic: has no DE between sets 1 and 60
4	All sets DE	All sets on structure are dead end	Automatic: has only DE between sets 1 and 60
5	Not all sets DE	At least one set on structure is not dead end	Automatic: has non DE between sets 1 and 60
6	Angle	Structure near nonzero line angle	Automatic: line angle outside 0.00 to 0.00 (deg) within 0.33 (f
7	PLS-POLE	PLS-POLE created structure	Automatic: PLS-POLE created
8	PLS-POLE has DE	PLS-POLE created structure with at least one dead end	Automatic: PLS-POLE created and has a DE between sets 1 and 60
9	PLS-POLE no DE	PLS-POLE created structure without any dead end sets	Automatic: PLS-POLE created and has no DE between sets 1 and 60
10	PLS-POLE angle	PLS-POLE created structure near nonzero line angle	Automatic: PLS-POLE created and line angle outside 0.00 to 0.00
11	TOWER	TOWER created structure	Automatic: TOWER created
12	TOWER has DE	TOWER created structure with at least one dead end se	Automatic: TOWER created and has a DE between sets 1 and 60
13	TOWER no DE	TOWER created structure without any dead end sets	Automatic: TOWER created and has no DE between sets 1 and 60
14	TOWER angle	TOWER created structure near nonzero line angle	Automatic: TOWER created and line angle outside 0.00 to 0.00 (d
15			
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Structure Group Table Modifications

- Add Group Name, Description, and Rule
  - For example, rule is useful for a station range of a certain type
- Go back to this table to keep track of structure counts

	Group Name	Group Description	Rule For Group Membership	Load Cases For Group	Structures In Group
1	All	Built in group that all structures belong to	Automatic: all structures	2	13: P1001 (Ex.), P1002 (Ex.), P1003 (New),
2	Has DE	At least one dead end set on structure	Automatic: has a DE between sets 1 and 60	0	13: P1001 (Ex.), P1002 (Ex.), P1003 (New),
3	No DE	No dead end sets on structure	Automatic: has no DE between sets 1 and 60	0	0
4	All sets DE	All sets on structure are dead end	Automatic: has only DE between sets 1 and 60	0	10: P1001 (Ex.), P1002 (Ex.), P1005 (Ex.),
5	Not all sets DE	At least one set on structure is not dead end	Automatic: has non DE between sets 1 and 60	0	3: P1003 (New), P1004 (New), P1011 (Ex.)
6	Angle	Structure near nonzero line angle	Automatic: line angle outside 0.00 to 0.00 (deg) within 0.33 (f	0	12: P1002 (Ex.), P1003 (New), P1004 (New),
7	PLS-POLE	PLS-POLE created structure	Automatic: PLS-POLE created	0	11: P1001 (Ex.), P1002 (Ex.), P1003 (New),
8	PLS-POLE has DE	PLS-POLE created structure with at least one dead end	Automatic: PLS-POLE created and has a DE between sets 1 and 60	0	11: P1001 (Ex.), P1002 (Ex.), P1003 (New),
9	PLS-POLE no DE	PLS-POLE created structure without any dead end sets	Automatic: PLS-POLE created and has no DE between sets 1 and 60	0	0
10	PLS-POLE angle	PLS-POLE created structure near nonzero line angle	Automatic: PLS-POLE created and line angle outside 0.00 to 0.00	0	10: P1002 (Ex.), P1003 (New), P1004 (New),
11	TOWER	TOWER created structure	Automatic: TOWER created	0	0
12	TOWER has DE	TOWER created structure with at least one dead end se	Automatic: TOWER created and has a DE between sets 1 and 60	0	0
13	TOWER no DE	TOWER created structure without any dead end sets	Automatic: TOWER created and has no DE between sets 1 and 60	0	0
14	TOWER angle	TOWER created structure near nonzero line angle	Automatic: TOWER created and line angle outside 0.00 to 0.00 (de	0	0
15	New	New structures with standard safety factor values	Manually assigned by user	0	3: P1003 (New), P1004 (New), P1010 (New)
16	Existing 250B 2/3	Existing structures with NESC 2/3 reduction	Manually assigned by user	0	10: P1001 (Ex.), P1002 (Ex.), P1005 (Ex.),
17	Existing 250C&D 3/4	Existing structures with NESC 3/4 reduction	Manually assigned by user	0	0
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Structure Groups Criteria

Note: First row is reserved for mandatory 'All' group to which all structures belong.

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Structure Groups in Criteria Table

- Copy your standard criteria lines

- Update the "existing" criteria with reduced strength factors

- Select applicable structure groups (2/3 or 3/4 reduction)

Structure Loads Criteria

	Description	Weather case	Cable condition	Wind Direction	Strength Factor Steel Poles Tubular-Arms Towers	Strength Factor Wood Poles	Strength Factor Concrete Poles Ultimate	Strength Factor Concrete Poles First Crack	Strength Factor Concrete Poles Zero Tension	Strength Factor Guys	Strength Factor Non-Tubular Arms	Strength Factor Braces	Strength Factor Insulators	Strength Factor Foundation	Structure Groups On Which To Apply	Pole Tip Deflection Check (PLS-POLE only)
1	RULE 250C NA+ (new)	NESC Light Di	Initial RS	NA+	1	0.75	1			0.9	0.75	0.75	1	1	'New'	No Limit
2	RULE 250C NA- (new)	NESC Light Di	Initial RS	NA-	1	0.75	1			0.9	0.75	0.75	1	1	'New'	No Limit
3	RULE 250C NA+ (existing)	NESC Light Di	Initial RS	NA+	1	0.5625	1			0.9	0.5625	0.5625	1	1	'Existing 250C&D 3/4'	No Limit
4	RULE 250C NA- (existing)	NESC Light Di	Initial RS	NA-	1	0.5625	1			0.9	0.5625	0.5625	1	1	'Existing 250C&D 3/4'	No Limit
5	RULE 250B NA+ (new)	NESC Light Di	Initial RS	NA+	1	0.65	1			0.9	0.65	0.65	1	1	'New'	No Limit
6	RULE 250B NA- (new)	NESC Light Di	Initial RS	NA-	1	0.65	1			0.9	0.65	0.65	1	1	'New'	No Limit
7	RULE 250B NA+ (existing)	NESC Light Di	Initial RS	NA+	1	0.433333	1			0.9	0.433333	0.433333	1	1	'Existing 250B 2/3'	No Limit
8	RULE 250B NA- (existing)	NESC Light Di	Initial RS	NA-	1	0.433333	1			0.9	0.433333	0.433333	1	1	'Existing 250B 2/3'	No Limit
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Structure Group Assignment

- Staking Table – Manually Select Structure Group

	Manual Structure Group Membership	Location Number	Structure Number	Structure Height (ft) – Class	Structure Family
1	'Existing 250B 2/3'	1	P1001 (Ex.)	50' / CL1	Wood
2	'Existing 250B 2/3'	2	P1002 (Ex.)	50' / CL1	Wood
3	'New'	3	P1003 (New)	65' / CL1	Wood
4	'New'	4	P1004 (New)	55' / CL1	Wood
5	'Existing 250B 2/3'	5	P1005 (Ex.)	35' / CL1	Wood
6	'Existing 250B 2/3'	6	P1006 (Ex.)	45' – CL1	Wood
7	'New'	10	P1010 (New)	40' – CL1	Wood
8	'Existing 250B 2/3'	9	P1009 (Ex.)	50' – CL1	Wood
9	'Existing 250B 2/3'	12	P1012 (Ex.)	40' / CL1	Wood
10	'Existing 250B 2/3'	11	P1011 (Ex.)	45' / CL1	Wood

Structure Group Demonstration
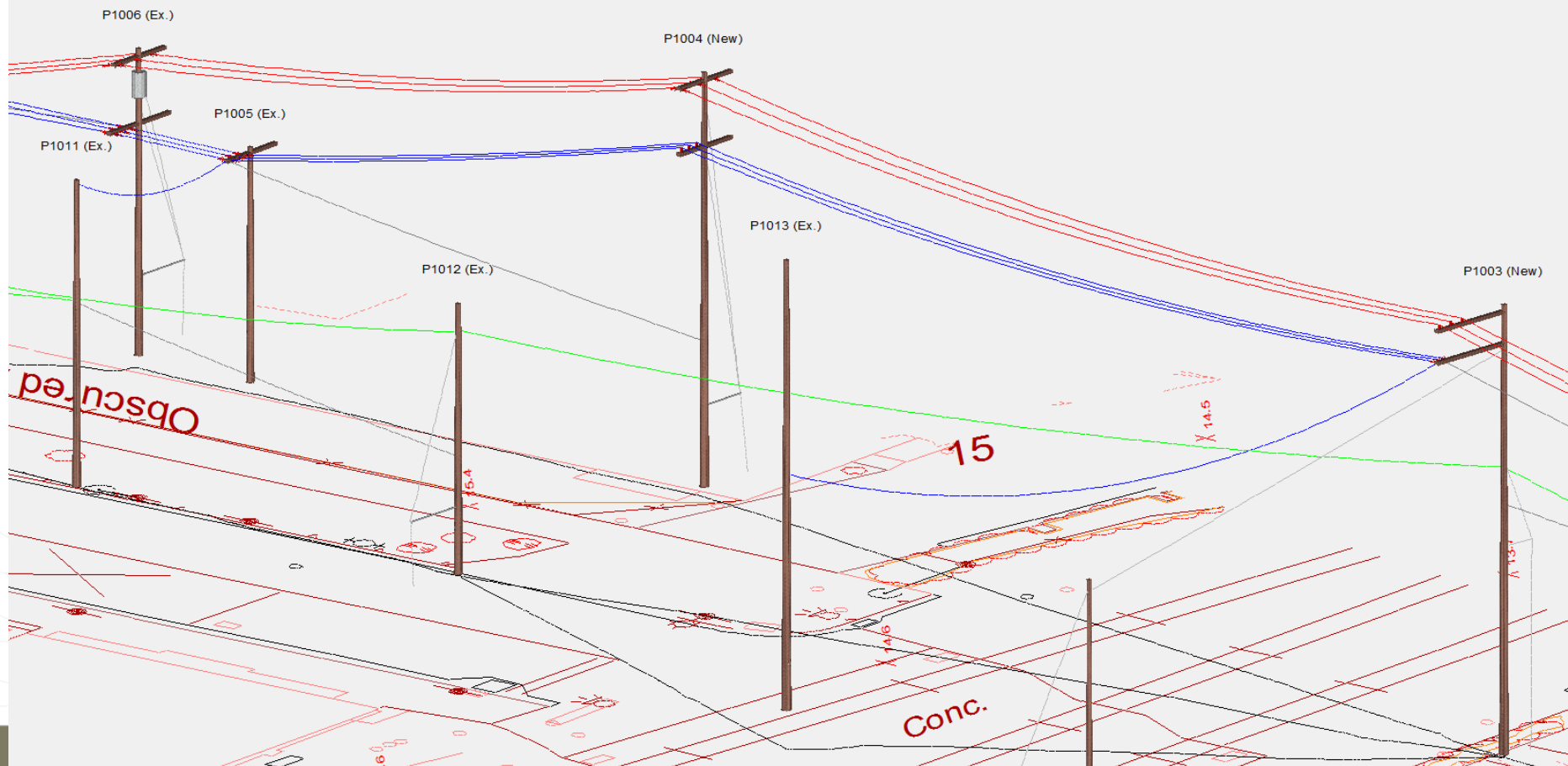
Structure Group Reporting

- Structure Groups Eliminate Structure Check Mistakes/Omissions

Structure Name	Structure Strength Usage	
	Existing Structure Group	Existing & New Structure Groups
P1001 (Ex.)	72.5%	72.5%
P1002 (Ex.)	39.3%	39.3%
P1003 (New)	71.7%	107.5%
P1004 (New)	39.1%	39.1%
P1005 (Ex.)	16.9%	16.9%
P1006 (Ex.)	72.3%	72.3%
P1010 (New)	76.5%	114.7%

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Structure Group Benefits

- Eliminate multiple steps to revise structure criteria
- Eliminate the need to save multiple criteria files or continue changing strength factors during modeling
- Eliminate the need to run multiple structure checks
- Eliminate the need to sort & combine strength data
- PLS-CADD keeps track of Structure Group quantities
- Smoother, more efficient design process

Thank you for your time!

Any questions?