PLANNING ADVISORY NOTICE

Comprehensive Structural Analysis vs. Feasibility Study

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PAN Advisory Group:
TIF Board of Directors

The International Building Code (IBC) has adopted the ANSI/TIA-222 Standard as the governing standard for the analysis of antenna supporting structures. This recognition by the IBC is vital as it allows for proper design, maintenance, and modification of monopoles, towers, and other antenna supporting structures (together, "Structures"), which, consequently, enables telecommunications infrastructure to perform with incredible reliability (for more on the reliability of telecommunications infrastructure see the TIF White Paper "Reliability of Telecommunications Structures." A proper structural analysis is critical to ensuring that the quality and reliability of this infrastructure is upheld as well as achieving code compliance. The purpose of a compliant structural analysis is to allow the licensed engineer of record ("EOR") to document the results of a structural assessment based on a proposed loading change to the structure in accord with the requirements of the ANSI/TIA-222-H Standard. The EOR has several means by which to communicate the results of an analysis; a comprehensive structural analysis (which are typical within this industry), a feasibility study, or a structural opinion letter. Each of these analysis types

Tank Additions - Equipment

CL (ft)	Kz	qz*G (psf)	30 (psf)	Manufacturer	Equipment	Height (in)	Width (in)	Depth (in)	Weight (lbs)	Cf	Front Area (ft^2)	Side Area (ft^2)	Use CFD?	Shielding Factor	Azimuth (°)	A_r (ft^2)	Quantity	p_w (psf)	Vu (kip)	OTM (kip-ft)
115				** MOUNT:	Tripod **												1			
120	1.32	25.56	30.00	GENERIC	4-BAY DIPOLE	58	3	3	0	1.2	1.208	1.208	No	1.00	180	1.20833	1	36.00	0.044	5.220
124	1.32	25.73	30.00	GENERIC	4-BAY DIPOLE	96	3	3	0	1.2	2.000	2.000	No	1.00	180	2	1	36.00	0.072	8.928
85				** MOUNT:	Catwalk Railing **												1			
90	1.24	24.05	30.00	RAYCAP	RC3DC-3315-PF-48	28.93	15.73	10.3	32	1.3	3.160	2.069	No	0.00	60	3.37217	1	39.00	0.000	0.000
100	1.27	24.59	30.00	COMMSCOPE	SBNHH-1D65C	96.6	11.9	7.1	49.6	-	7.710	3.340	Yes	1.00	60	6.74752	1	30.00	0.202	20.243
100	1.27	24.59	30.00	COMMSCOPE	SBNHH-1D65C	96.6	11.9	7.1	49.6	-	7.710	3.340	Yes	1.00	60	6.74752	1	30.00	0.202	20.243
90	1.24	24.05	30.00	SAMSUNG	B2/B66A RF4439d-25A	18.66	14.96	10.04	74.7	1.3	1.939	1.301	No	1.00	60	2.096	1	39.00	0.082	7.357
90	1.24	24.05	30.00	SAMSUNG	B5/B13 RF4440d-13A	18.66	14.96	9.06	72.5	1.3	1.939	1.174	No	1.00	60	1.98602	1	39.00	0.077	6.971
100	1.27	24.59	30.00	SAMSUNG	MT6407-77A	35.06	16.06	5.51	81.57	1.3	3.910	1.342	No	1.00	60	3.11688	1	39.00	0.122	12.156
90	1.24	24.05	30.00	RAYCAP	RC3DC-3315-PF-48	28.93	15.73	10.3	32	1.3	3.160	2.069	No	1.00	160	3.67736	1	39.00	0.143	12.908
100	1.27	24.59	30.00	COMMSCOPE	SBNHH-1D65C	96.6	11.9	7.1	49.6	-	7.710	3.340	Yes	1.00	160	8.38738	1	30.00	0.252	25.162
100	1.27	24.59	30.00	COMMSCOPE	SBNHH-1D65C	96.6	11.9	7.1	49.6	-	7.710	3.340	Yes	1.00	160	8.38738	1	30.00	0.252	25.162
90	1.24	24.05	30.00	SAMSUNG	B2/B66A RF4439d-25A	18.66	14.96	10.04	74.7	1.3	1.939	1.301	No	1.00	160	2.26663	1	39.00	0.088	7.956
90	1.24	24.05	30.00	SAMSUNG	B5/B13 RF4440d-13A	18.66	14.96	9.06	72.5	1.3	1.939	1.174	No	1.00	160	2.2232	1	39.00	0.087	7.803
100	1.27	24.59	30.00	SAMSUNG	MT6407-77A	35.06	16.06	5.51	81.57	1.3	3.910	1.342	No	1.00	160	4.13318	1	39.00	0.161	16.119
90	1.24	24.05	30.00	RAYCAP	RC3DC-3315-PF-48	28.93	15.73	10.3	32	1.3	3.160	2.069	No	1.00	300	3.37217	1	39.00	0.132	11.836
100	1.27	24.59	30.00	COMMSCOPE	SBNHH-1D65C	96	11.9	7.1	49.6	-	7.710	3.340	Yes	1.00	300	6.74752	1	30.00	0.202	20.243
100	1.27	24.59	30.00	COMMSCOPE	SBNHH-1D65C	96	11.9	7.1	49.6	-	7.710	3.340	Yes	1.00	300	6.74752	1	30.00	0.202	20.243
90	1.24	24.05	30.00	SAMSUNG	B2/B66A RF4439d-25A	18.66	14.96	10.04	74.7	1.3	1.939	1.301	No	1.00	300	2.096	1	39.00	0.082	7.357
90	1.24	24.05	30.00	SAMSUNG	B5/B13 RF4440d-13A	18.66	14.96	9.06	72.5	1.3	1.939	1.174	No	1.00	300	1.98602	1	39.00	0.077	6.971
100	1.27	24.59	30.00	SAMSUNG	MT6407-77A	35.06	16.06	5.51	81.57	1.3	3.910	1.342	No	1.00	300	3.11688	1	39.00	0.122	12.156
90	1.24	24.05	30.00	PCTEL	MPRD2449 W/ CONICAL HORN	26	26	14	36	1.3	3.687	2.528	No	1.00	300	4.03262	1	39.00	0.157	14.155
90	1.24	24.05	30.00	GENERIC	3' DISH W/ SHROUD	36	36	24	0	1.3	7.069	3.000	No	1.00	250	5.23668	1	39.00	0.204	18.381
90	1.24	24.05	30.00	GENERIC	4' DIPOLE	48	2	2	0	1.2	0.667	0.667	No	1.00	180	0.66667	1	36.00	0.024	2.160
90	1.24	24.05	30.00	UBIQUITI NETWORK	AM-V5G-TI	28.4	5.87	2.98	8.2	1.3	1.158	0.588	No	0.00	310	1.19437	1	39.00	0.000	0.000
90	1.24	24.05	30.00	SIKLU	EH-ANT-2FT-DL5 W/ EH-8010FX-ODU	26	26	16	0	1.3	3.687	1.444	No	0.00	60	3.09443	1	39.00	0.000	0.000
90	1.24	24.05	30.00	UBIQUITI NETWORK	AM-V5G-TI	28.4	5.87	2.98	8.2	1.3	1.158	0.588	No	1.00	80	0.77982	1	39.00	0.030	2.737
115	1.30	25.33	30.00	GENERIC	20' DIPOLE	240	2	2	0	1.2	3.333	3.333	No	1.00	180	3.33333	1	36.00	0.120	13.800
90	1.24	24.05	30.00	SIKLU	EH-ANT-2FT-DL5 W/ EH-8010FX-ODU	26	26	16	0	1.3	3.687	1.444	No	1.00	150	3.91526	1	39.00	0.153	13.743
90	1.24	24.05	30.00	UBIQUITI NETWORK	AM-V5G-TI	28.4	5.87	2.98	8.2	1.3	1.158	0.588	No	1.00	170	1.24216	1	39.00	0.048	4.360
75				** MOUNT:	Standoff Arm **												1			
79	1.20	23.40	30.00	GENERIC	8' OMNI	96	2.375	2.375	0	1.2	1.583	1.583	No	1.00	180	1.58333	1	36.00	0.057	4.503
																	Σ		3.395	328.871

*The water tank was not designed for communications equipment. All communications equipment is assumed to be an addition and included in the 10% increase allowed in the lateral-force-resisting system per 2018 IEBC Section 1103.2.

Results **Remark:** NG

	Original Demand	Additional Demand	Total Demand	% Increase	Result
Base Shear, V_u (kip)	50.9	5.5	56.5	10.88	NG
Moment at Base, OTM (kip-ft)	2943.6	527.33	3470.9	17.91	NG

Controlling Load Type: Base OTM **% Increase:** 17.91 %
Base V_u: 10.88 %
Base OTM: 17.91 %

Figure 1 - Example of a Feasibility Study results of a water tank supporting telecommunication equipment. *Contact NATE at towertimes@natehome.com for the download of this graphic.*

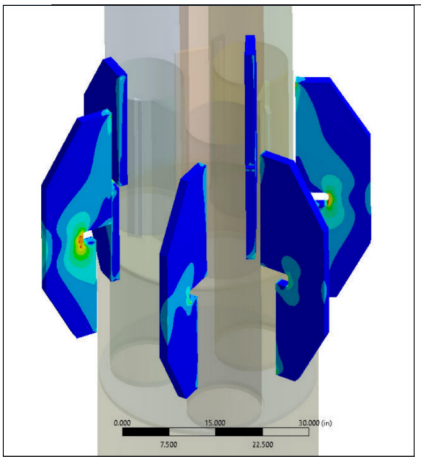

Figure 2 - Comprehensive Finite Element Analysis of Eucalyptus Pole Connection

have specific applications and limitation. It is important for all stakeholders to understand when each type can and should be used. Understanding these types of deliverables will allow all stakeholders to make the most financially prudent decisions while ensuring code compliance for jurisdictional approval.

A feasibility study is defined as "a preliminary structural analysis of an existing structure to evaluate the feasibility of a proposed changed condition or to determine the increase in the demand-capacity ratio for a proposed changed condition, limited to the investigation of the overall stability of the structure and the strength requirements for the main load carrying members of a structure."[1] An example of a feasibility study is shown in Figure 1 below. These are the analysis results of a water tank supporting telecommunication equipment. The depth of analysis performed in a feasibility study is limited to the main load bearing members, not including the assessment of any connections or the foundation. A feasibility study deliverable is often presented as a summary letter that only includes a comparison of the existing and proposed loading with minimal results of the main structure members. A feasibility study is an ideal deliverable for stakeholders looking for an idea of the impact from a proposed loading change and/or if it creates a changed condition. This allows clients to make appropriate design decisions early in the process while limiting the financial cost of making loading changes.

Next, a comprehensive structural analysis is defined as "a structural analysis of an existing structure to determine conformance to this Standard regarding the overall stability and the adequacy of structural members, connections, anchorages, and foundations."[2] The primary difference in the scope of a comprehensive analysis compared to a feasibility study is that a feasibility study focuses only on the main members of a Structure and may not include an assessment of the connections or a structural analysis of the foundation. An example of a connection analysis result for a modified Eucalyptus pole is shown in Figure 2. The deliverable for a comprehensive structural analysis includes detailed calculations and results of each component including applied load magnitudes and locations, main load carrying members, connections between members, anchorage, and foundation. This level of analysis and reporting is required for jurisdiction approval and physical implementation of a changed condition. A comprehensive structural analysis is required when a changed condition occurs, meaning an increase in the demand-capacity ratio exceeds 5%.

Lastly, a structural opinion letter is a signed and sealed document often used when the demand-capacity ratio of any load bearing member of the Structure is not expected to exceed the changed condition threshold. If a changed condition is not triggered by the new loading, the EOR may issue a structural opinion letter on the basis of the previously completed comprehensive structural analysis. This can be a financially beneficial way to document a change in the design without the need for a full comprehensive structural analysis.[3] It must be noted that separate, minor changes must be weighted together to determine if the cumulative change of the demand-capacity ratio is greater than 5%. As an example, if a completed antenna replacement causes a 3% change to the demand-capacity ratio, then a subsequent mount replacement causing a 4% change to the demand-capacity ratio must consider the prior 3% change caused by the antenna replacement. As such, the mount replacement would result in a cumulative change to the demand-capacity ratio of 7%. Because the cumulative change to the demand-capacity ratio exceeds 5%, a significant changed condition occurred; a structural opinion letter would not be sufficient to determine the structure's capacity. A comprehensive structural analysis would potentially be required for the proposed mount replacement, based on these increases and the last known structural demand-capacity ratio of the structure and foundation. A structural opinion letter must be based on the most recent comprehensive structural analysis with changed condition implemented.

ANSI/TIA-222 has evolved over time to recognize the industry need for this array of service offerings. Before the release of ANSI/TIA-222-G, the Standard recognized only "structural analysis" with a limited definition of the requirements. The release of ANSI/TIA-222-G in 2007 introduced the concept of a feasibility structural analysis to the telecommunication industry, and with it, the introduction of the changed condition requirements for structural analysis. Changed condition criteria were further expanded with the release of ANSI/TIA-222-H in 2017. The changed conditions requirements were established to

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identify when a comprehensive structural analysis is required. A feasibility study is commonly used to validate that the requirements for a changed condition are not met, and therefore a comprehensive structural analysis is not required. The feasibility study may provide stakeholders with a more cost-effective means to make decisions in a timely manner as well as maintenance of their assets. A detailed review of the changed condition rules are available in the TIF White Paper "An Examination of "Changed Conditions"; as defined by ANSI/TIA-222-H."

While a comprehensive structural analysis and a feasibility study are viable options, it is important to understand the limits that draw the line between the two types of engineering deliverables. A feasibility study can be completed with little more than the wireless equipment loading data and details of the structure main load-carrying members. Feasibility study reports must state that "a comprehensive analysis shall be required before the implementation of a changed condition."[4] Once a significant changed condition is confirmed, then a full comprehensive structural analysis is required, if the project is to move forward. The comprehensive structural analysis must include the assessment of connections within the Structure system and the connection between the structure and the foundation through the anchorage. An exemption for the foundation analysis is allowed where a comprehensive structural analysis determines the adequacy of the foundation via a comparison between the original foundation design reactions and current analysis base reactions.[5] This exemption does have the following limitations:

- The foundation assessment does not extend to the anchorage or any above-grade structural assessments.
- The structural analysis must state clearly when the foundation comparison of reactions is used instead of a comprehensive structural analysis of the foundation.

The decision to proceed with a feasibility study instead of a comprehensive structural analysis should be based on a discussion between the EOR and the client. A feasibility study can be a great communication tool between the stakeholders of a project to facilitate decision making, while minimizing future issues and reducing the likelihood of project delays. It is important for the growth of the telecommunications industry that all stakeholders understand what engineering assessment options are available and when to use them properly. Figure 3 provides a brief comparison between the previously discussed structural analysis deliverables includes the typical application and limitations of each type.

In closing, it is suggested that readers seek additional information from the ANSI/TIA-222-H standard itself as well as the referenced TIF White Papers. It is our hope that this Planning Advisory Notice will encourage communication between all the various stakeholders engaged in the deployment, maintenance, and modification of telecommunications infrastructure. Increased communication between stakeholders will result in a higher level of quality, which supports the safe working environment that allows for efficient deployment.

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[1] See ANSI/TIA-222-H Section 15.2.

[2] See ANSI/TIA-222-H Section 15.2.

[3] A structural opinion letter is not officially defined or recognized by the ANSI/TIA-222-H Standard.

[4] See ANSI/TIA-222-H Section 15.6.3.

[5] See ANSI/TIA-222-H Section 15.6.2.

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Deliverable	Prerequisites	Application	Limitations	Description	Relative Cost
Comprehensive Structural Analysis	None	Required when increase in demand-capacity ratio exceeds 5%	None	Analysis of overall stability of structure members, connections, anchorage, and foundation	$$$
Feasibility Study	Prior completed Comprehensive Structural Analysis or original design documentation	Evaluate proposed changed condition or change in demand-capacity ratio.	Comprehensive analysis required prior to implementation of a changed condition	Preliminary analysis of structure's main load carrying members only	$$
Structural Opinion Letter	Prior completed Comprehensive Structural Analysis	Minor loading changes for comfortably passing structures	Not directly recognized by ANSI/TIA-222	Addendum of comprehensive analysis to document minor change conditions	$

Figure 3 - Comparison of structural analysis deliverable types