



Floors Working Group

E1.76 - 202x, Tension Wire Grids Public Review 3 comment resolutions

Reference document: E1.76 - 202x, *Tension Wire Grids* (Document number Floors/2022-8001r5a)

ANSI Public review period: 12 May 2023 through 26 June 2023

Question: In your opinion, do you think the requirements of E1.76 - 202x, *Tension Wire Grids* (DCN Floors/2022-8001r5a) are reasonable, and adequately address the intended subject matter?

Responses:

Commenter	Response
Steve Walker, Steve Walker Associates (SW)	Objections to prior resolutions
Jedd De Lucia, The Shalleck Collaborative (JDL)	Okay but needs improvement
Christina Keryczynskyj, Charcoalblue (CK)	Okay but needs improvement
Bruce Darden, InterAmerica Stage, Inc	Yes

Individual Comments:

No.	Commenter	Section	Comment	Resolution
1	JDL	General	Thank you very much for providing these EXCELLENT technical standards for public review. Although I have many comments and have included them on the attached, I truly appreciate the work done by the ESTA working group on this VERY important document. It will greatly benefit the industry. My comments are intended only to help improve an already excellent standard and I look forward to having the finished product out in the world as a great resource to us all. The ESTA standards program is making our theatre and entertainment venues better and safer and I speak for all in my firm when I extend our appreciation for the work that you do!	ACCEPT. Thank you.
2	JDL	General	General comment: It is unclear if the scope of the document is intended to include hangers or not.	Reject as a general comment. The comments are addressed individually Reject. First sentence of scope: "This standard for tension wire grids covers the design and application criteria including: the loading, self-weight considerations, transitions between levels, and suspension

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			<p>If so, does the live loading of the grid panels include an allowance for lighting and AV equipment that may be mounted to pipes attached to hangers or perimeter guards?</p> <p>Authors should consider if the loading criteria should consider the self weight of perimeter frames, guards and/or a #/sf allowance for lighting/AV equipment and accessory pipes.</p> <p>- OR -</p> <p>Clearly exclude the weight of the perimeter frames, guards and lighting/AV equipment and accessory pipes from the live load capacity of the Tension Grid system and clearly define the 20#/sf live and 5#/sf self load as for the grid panels and people circulating on the working surface.</p> <p>I request that the live load capacity allowance be defined to include the</p>	<p>or support from structure.”</p> <p>Answer = No. See the requirement below:</p> <p>4.2.1.1 Uniformly distributed vertical load *Walking/working surfaces of standard tension wire grid panels shall be designed to support an evenly distributed vertical load of at least 20 pounds/square foot (0.96 kN/m2). This is in addition to self-weight. *Walking/working surfaces of catwalk tension wire grid panels shall be designed to support a uniformly distributed vertical live load of at least 40 pounds/square foot (1.92 kN/m2). This is in addition to self-weight. *These live loads shall not be reduced.</p> <p>Reject. See the requirement below:</p> <p>4.2.3.3 Limitations of use The limitations of use shall be established, including:</p> <ul style="list-style-type: none"> • Quantity and/or concentration of people allowed on a panel or in a zone of the tension wire grid. • Types of rolling stock for equipment (if any) and loads of same for use on the walking/working surface. • Locations and maximum equipment loads (i.e. lighting) to be applied to frames, hangers, panels and grid wires. • Locations and maximum rigging loads (if any) to be applied to tension wire grid frames. • The rigging loads to be applied to the structure that suspends or supports the tension wire grid is out of scope for this document. <p>Note: The Limitations of Use has been</p>

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			<p>weight of pipes and lighting/av equipment within the 20#/sf.</p> <p>Reason: 20#/sf is too much weight for just people. That would allow a single 10'x10' grid panel to hold 2000# worth of people, which is approx. 8-12 full grown adults.</p> <p>Authors should consider limiting each panel to 2-4 people AND including the weight of perimeter frames, guards, accessory lighting pipes and lighting/AV equipment within the 20#/sf live load capacity of the grid panels. This will keep the overall theoretical weight of the building down without changing any of the actual, practical load.</p>	<p>expanded as the result of additional comments later in this document.</p> <p>Further Clarification: The document must be read and used holistically. The <u>Limitations of Use</u> allows the system designer and the RDP to assign these project specific loading requirements to the design.</p> <p>Whereas this is a thoughtful discussion why the loads should be kept low, another commenter (see #34) asks for the loads to be doubled to 40 PSF.</p> <p>This is a standard, not a specification. The role of consultant and the RDP is preserved.</p>
3	JDL	Foreword	<p>Remove the word "Walking" from the description in the first and second sentences, as well as throughout the document where it may occur. Tension grids are primarily a means to access technical equipment above a stage or platform. See further on this in the next comment. Change should also occur in 3.14 / 4.2.1.1, bullets 1 and 2 / 4.2.2.1.1 / A4.3.1 / 4.2.3.3 bullet 2. Reason for change: see next comment below. Page 1 - Forward:</p>	<p>Reject.</p> <p>"Walking/working surface" is the jargon for what we walk on when it is not a floor.</p> <p>Originated from OSHA 1910 Walking-Working Surfaces and ANSI/ASSP A1264.1-2017</p>
4	JDL	Foreword	<p>I recommend adding the following language to the forward: "Tension Grids are "Technical Production Areas" as defined by the IBC section 410.2.2. As such they are not to be considered to be floors, stories, mezzanines or levels of a building per building code. Reason for addition: It needs to be clear that a tension grid system is not a floor of the building or a regular walking surface, but a technical production area, to justify it's live load factor.</p>	<p>AIP</p> <p>Inserted as 2nd to the last paragraph of Foreword. Tension grid is written as tension wire grid.</p>
5	JDL	3.11	<p>Guardrail, although a common term, is called simply a guard in IBC/CBC. Suggested adding: "for the purpose of this document a guardrail is synonymous with the term guard as defined in IBC and other building codes.</p>	<p>A.I.P. This requires a bit of threading the needle. A Guard is a protective barrier, but a guardrail also includes a handrail.</p> <p>Add: For the purpose of this document a guardrail is synonymous with the term guard as defined in the 2021 IBC and other building codes.</p>
6	JDL	4.2.1.1	<p>Eliminate the second live load category for a "catwalk" tension grid.</p>	<p>Reject.</p>

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			<p>It is potentially problematic, especially when lacking a clear definition. Annex 4.2.1.1- "Catwalk" tension grid is partially defined and justified, but "narrow" is a subjective term. I request that this document either remove the second category entirely or more clearly define a "catwalk" tension grid section with dimensional criteria.</p> <p>Reason for change: The term will not be understood by an AHJ and they may apply a 40#/sf load over entire grid systems (easily misinterpreting a 10' deep by 50' wide tension grid over a stage apron as "narrow").</p> <p>Definition recommendation: "Tension grid sections which are not wider than 3'-0" (?) and are provided solely to access to stage lighting from one or both sides but not through the tension wire weave shall be considered "catwalk tension grids". "</p>	<p>A.I.P.</p> <p>Add definition of Catwalk.</p> <p>Catwalk: A narrow elevated runway or platform not less than 22" (0.56 m) wide unless accessed by a stair in which case the minimum width is 36" (0.91 m). The width shall be measured after all wall mounted devices are included. A tension wire grid that is 54" (1.37 m) or greater in width is not considered to be a catwalk.</p>
7	JDL	4.2.1.2	Change/Clarify "a" load to "one minimum concentrated load of 300 pounds..."	<p>Reject.</p> <p>The 300# concentrated loads are allowed anywhere on the horizontal surface.</p> <p>The <u>Limitations of Use</u> shall further limit the occurrence or proximity of the concentrated loads.</p> <p>Add to 4.2.3.3 Quantity of concentrated loads per panel, including the proximity and minimum spacing between each of these loads.</p> <p>Spelling. In paragraph 2, "tenon" correct to "tension"</p>
8	JDL	4.2.1.3	add "if adjacent frames or frames adjacent to building members are suitably tied together, the entirety of the assembly may be considered."	<p>Accept</p> <p>The proposed new clause has been added as an <i>Exception</i>.</p>
9	JDL	4.2.2.1.1	Add Exception: if supporting members have been provided within the building for the purpose of resisting vertical loads applied, the entirety of the assembly may be considered.	<p>Accept.</p> <p>The proposed new clause has been added as an <i>Exception</i>.</p>
10	JDL	4.2.2.2	Please clarify the load condition that is used to calculate the deflection criteria. Is this deflection under the 300# point loads or the maximum	A.I.P.

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			<p>uniformly distributed load of 20#/sf?</p> <p>Reason: Deflection of this amount under 300# is reasonable, however, if this deflection criteria is considered for the full uniformly distributed load of 20#, I am concerned that it will unintentionally oversize the frames, upsize the wire or result in needless addition of internal supports.</p>	<p>add: in all loading conditions.</p> <p>This is a lot of deflection, and ensures a functional walking/working surface, not a trampoline.</p>
11	CK	4.2.2.4	<p>Not clear if this is an instruction or statement.</p>	<p>Accept. Actually it is both. Rewritten:</p> <p>The maximum horizontal deflection of the frames is limited by the allowable vertical deflection of the wire rope mesh when loaded.</p> <p>Also added an annex note: A. 4.2.2.4 Horizontal deflection of frames Horizontal deflection of the frame allows the wires to go slack. The maximum vertical deflection of the mesh becomes the limiting factor as to the maximum deflection of the horizontal frame.</p>
12	JDL	4.3.1.2	<p>Second paragraph. Please clarify or provide for use over time. Wire rope on 2" centers makes a 4"sq opening only when everything is tight and straight, but the moment that one wire is shifted out of alignment that space is larger. Perhaps say "4"sq. with all cables in proper alignment." - OR- provide another size that has a reasonable margin in it. like 5"sq.</p> <p>Reason: To allow for some mild deformation of the perfect squares/shapes when a systems is first installed.</p>	<p>Accept</p> <p>Note this has been renumbered to 4.3.1.5</p> <p>The weave may vary from square to diamond to trapezoidal, as long as the design opening does not exceed 4 in² (25.8 cm²) with all cables in proper alignment.</p> <p><i>Note the "design opening" not the actual opening due to misalignment.</i></p>
13	CK	4.3.1.2 and 4.3.1.3	<p>Swap order of sections</p>	<p>AIP</p> <p>Move 4.3.1.2 Weave to after new clause 4.3.1.4 (wire rope adjusting)</p>
14	JDL	4.3.1.4	<p>add "One or both ends for wire rope termination shall be threaded to maintain wire rope deflection within max criteria per 4.2.2.2"</p> <p>Reason: Combined vertical deflection and wire rope termination hardware (4.3.1.4) should be considered over time to consider wire rope stretch. If the terminations are "dead", there would be no way to tighten them and correct back to acceptable deflections. Recommend requiring</p>	<p>AIP</p> <p>New clause:</p> <p>4.3.1.4 * The wire rope termination may be equipped with an adjusting method to maintain wire</p>

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			at least one end is threaded.	<p>rope deflection within max criteria per 4.2.2.2.</p> <p>*A.4.3.1.4 Many tension wire grids are constructed using techniques that do not require tension adjusting hardware.</p>
15	JDL	4.3.2.1	Include the minimum self weight as stated in the annex. change to: "Self weight of the grid frame and wire rope shall be included in the tension wire grid design and shall be a minimum of 5#/sf	<p>Reject.</p> <p>Delete Annex note A.4.3.2.1 There have been previous requests to delete this annex note. This comment and others in this review demonstrate the confusion of including this annex note.</p> <p>New section 4.2.3.4 Self-weight of tension wire grid – This enumerates what is included in the self-weight.</p>
16	JDL	4.3.2.2	<p>Please change this language to "Open or exposed gaps between adjacent frames shall be less than 4" and shall be a minimum of 2". Gaps exceeding 4" shall comply...or be covered..."</p> <p>Reason for change: Use of 2.5"+ square tube hangers, especially in areas with high seismic requirements, require larger gaps. <4" is commonly recognized as a safe opening size. In addition, it is difficult to replace or tighten wires with only a 2" gap. 3" allows for better servicing of wires which ultimately leads to increased safety.</p>	<p>Reject.</p> <p>Walking-working surfaces are governed by OSHA 1910 which defines a holes as:</p> <p><i>Hole</i> means a gap or open space in a floor, roof, horizontal walking-working surface, or similar surface that is at least 2 inches (5 cm) in its least dimension.</p> <p>Section 29 CFR 1926.501(b)(4) states: Holes. (i) Each employee on walking/working surfaces shall be protected from falling through holes (including skylights) more than 6 feet (1.8 m) above lower levels, by personal fall arrest systems, covers, or guardrail systems erected around such holes. (ii) Each employee on a walking/working surface shall be protected from tripping in or stepping into or through holes (including skylights) by covers.</p>

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				<i>So the options are to either cover the gap or designate the gap as a rigging well See 4.3.5</i>
17	JDL	4.3.2.2	Include reference/link to the rigging wells requirement or re-state it here.	Accept. See 4.3.5 Rigging Wells.
18	JDL	4.3.6.1	"...shall BE painted..."	Accept.
19	CK	4.3.4	Elaborate on how far the perimeter frames may extend.	Accept . My understanding is this is a construction detail of particular systems. Add: Less than 8" above the walking/working surface. <i>Any rise of 8" or greater would require a handrail.</i>
20	JDL	4.3.7	Section 4.3.7 indicated crossing lighting pipes to be considered as part of the system. I recommend including the hangers as a defined part of the systems and having the aggregate load of lighting pipes and lighting/AV equipment mounted to the pipes quantified in this standard to be considered as the [minimum] total load on the hangers, It should be within, not additive to, the 25#/sf of the overall system as an overall #/sf for the building. i.e. for each 10x10 square tension grid panel, the building sees a 2500 pound live+dead load, regardless of the sum of the parts if less.	Reject. As stated, stage lighting mounts are a common <u>accessory</u> . They are not always part of the system. Not all Tension Wire Grids have hangers. Some are supported by the structure very near the floor level. The self-weight of the Tension Wire Grid varies widely depending the method of construction and the length and width of each panel. See new: 4.2.3.4 Self-weight of tension wire grid
21	JDL	5 & 6	recommend simply referring to other existing codes and standards to prevent the need for this standard to be updated when those are. Wouldn't it be better to refer to other standard for dimensional criteria for stairs, and all criteria for edge protection, in the case of future revision. for section 5, I recommend a statement tying all stairs, ramps and handrails to establish and governing code. As it stands here, only the	Reject. The FWG has previously stated that it is best to bring these requirements into one document, and revise them as necessary if or when an applicable code is revised.

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			rise/run is tied to code (although all applicable code would still govern).	
22	JDL	6.1	define a minimum height where this edge protection is required. 30" would match code and OSHA.	Accept. Add: Edge protection is required wherever the distance from the platform to the lower surface is 48" or greater. Many codes, including the IBC set this distance at 30". There are specific exceptions including: 1015.2 (5) At elevated walking surfaces appurtenant to <i>stages</i> and <i>platforms</i> for access to and utilization of special lighting or equipment. Local code requirements prevail.
23	JDL	6.2	I recommend eliminating this section and simply referring to other codes. see above. for example, the 200# lateral load matches current IBC but would need to be updated if IBC were to change.	Reject. The FWG has previously stated that it is best to bring these requirements into one document, and revise them as necessary if or when an applicable code is revised.
24	JDL	6.4.1	recommend reducing this to "less than 30" and to required guard[rails] above that in accordance with OSHA and IBC code.	Accept. exceeds 1 foot (0.3 m) but is less than 4 feet- (1.2 m) 30" (76 cm),
25	JDL	6.4.1	paragraph 2- The Term "guard" is used here, although correct, guardrail is what is in the definitions. Defining as both would resolve this.	Accept. Guard is now in definitions.
26	JDL	6.4.1	paragraph 3- section 6.2 does not define this height. Also, 4' exceeds what is safely allowable by standard codes. I recommend using 30".	Accept.
27	JDL	7.1.1	Add "maximum number of people per panel" [max of 2 recommended]	AIP. Add: Maximum number of people per panel, zone or other limiting factor. <i>Panels are of such widely varied sizes that no number of people recommendation is provided.</i>

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28	JDL	7.1.1	add in bold, larger letters "DO NOT BOUNCE" and "Maintain a 2" x 2" weave."	AIP. Section 7.3 Additional signage added.
29	JDL	7.1.2	add "Protection of assembly during maintenance or construction activities of adjacent work."	Reject. Nothing specifically added.
30	JDL	7.2	bullet 2: add "and in other languages appropriate for the region of installation."	Reject: Existing Bullet #3 covers this issue: Signage shall be in additional languages commonly read understood by the personnel using the facility.
31	JDL	8.2	I recommend referencing and linking the inspection requirements with ESTA 1.47 for static rigging systems. Although it seems to match, if tied to the other, updates would not be needed when changes occur.	Reject. On the surface a nice idea. However the documents are not controlled by the same Working Group, and have other fundamental issues: Tension Wire Grids are out of scope E1.47 Exclusions: The building structure. The requirements for the inspectors skill are not relevant to the TWG. Also onerous to require 5,000 hours of experience to inspect a grid.
32	JDL	9.4	add that these rules shall be listed in the posted signage.	AIP Added: 7.3 Additional Signage <i>This signage is non-mandatory and is crafted on a per project basis.</i>
33	CK	9.6	Replace "provide" with "install".	Accept
34	CK	A.4.2.1	A.4.2.1 Consider changing minimum grid loading to 40psf instead of 20psf; working on a grid is not akin to working on a roof. By this logic, 300lb concentrated loads would have to be spaced 15ft apart. If keeping 20psf minimum loading, provide the closest allowable distance for concentrated loads. [T]ension misspelled in 2nd paragraph.	AIP <i>Response is made to the normative 4.2.1 not the referenced annex note.</i> Add: Each panel must allow for at least one concentrated load. The Limitations of Use (See 4.2.3.3) shall define project specific requirements. The Operating instructions and user information (See 7.1.1) shall state

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				<p>these limits.</p> <p>Add to 4.2.2.3 Limitations of Use: Quantity of concentrated loads per panel, including the proximity and minimum spacing between each of these loads.</p> <p>Spelling of Tension corrected.</p>
35	CK	A.4.3.1	Anything above 1/4" difference is considered a trip hazard.	<p>AIP No change requested.</p> <p>Annex notes are used to convey information to the designer so that intelligent choices can be made.</p> <p>Some styles of tension wire grid present relatively smooth surfaces with minimal gaps between panels. Other designs have very distinct joints where the frame is above the walk/working surface.</p> <p><i>The fit and finish of technical spaces often presents challenge for the feet, but even more so having to duck for head clearance.</i></p>
36	JDL	A.7.1.1	If there is an additional load causing deflection on the tension grid it will cause a cross slope for a wheelchair.	AIP No change requested.
37	CK	A.7.1.1	Offer examples of how to make a grid accessible or eliminate the sentence beginning with "With that understanding..."	Accept. Struck sentence.
38	SW	Objection to prior PR comment resolutions	<p>The resolutions to comment 40 and to my objection the PR1 resolution (comment 103) still do not address my comment. This standard creates two categories of tension wire grid panels, one that requires a minimum uniform load of 20 PSF and one that requires 40 PSF but offers no definition to differentiate the categories beyond the term "catwalk".</p> <p>Nothing in the standard prohibits designing standard tension wire grids for higher loads, indeed section 4.2.3.3 requires a determination of the loads from people and equipment on the grid which might necessitate higher design loads. The annex note further explains why some panels may have a higher design load but offers no specific requirements for "catwalk". The reference to 410.2.2 of the 2021 IBC only notes that they may be constructed of any approved material and do not require fire resistance. Unless there is a specific definition for a catwalk tension wire</p>	<p>AIP As the commenter notes, "Nothing in the standard prohibits designing standard tension wire grids for higher loads, indeed section 4.2.3.3 requires a determination of the loads from people and equipment on the grid which might necessitate higher design loads."</p> <p>The word Catwalk has now been defined for the purpose of this standard.</p> <p>The inclusion of the IBC 410.2.2 has been expanded:</p>

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			<p>grid, the requirements for catwalk panels need to be deleted. After reviewing my records, I am aware of twelve companies that have installed tension wire grids in the USA and Canada, only one has designated "catwalk" panels.</p>	<p>The designer is directed to Section 410.2.2 of the 2021 IBC. "These areas shall not be considered to be floors, stories, mezzanines or levels in applying this code."</p>