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Tension Wire Grids

Approved by the ANSI Board of Standards Review on _____

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Voting members:

Observer (non-voting) members:

Interest category codes:

CP = custom-market producer
DE = designer
DR = dealer rental company
G = general interest
MP = mass-market producer
U = user

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Clauses that have an asterisk (*) have a corresponding informational entry in Annex A. The Annex contains no requirements and is informational only.

Foreword

A tension wire grid is a lightweight walking/working surface suspended above a production or access space. The open weave surface allows the free transmission of light, sound, air and atmospheric effects. Both the walking/working surface and the rigging wells at the edges of frames allow for the passage of electrical cables and rigging suspension points.

The products covered by this standard are bespoke produced and form an integral part of the building to assist in the staging of entertainment events.

Tension wire grids have been in use since at least 1949 in an anechoic chamber. Construction designs for them have evolved over the decades without a guiding document for design, loading, openings, and edge protection. Tension wire grids have evolved from black box theater lighting positions to massive access and work platforms for arena rigging.

The lack of product standards that clearly apply to tension wire grids complicates the market for them. Theatre consultants, architects, and engineers grapple with how to treat them in terms of building codes.

Stage technicians and venue managers who use tension wire grids are sometimes ill-informed as to the capacity and acceptable use of these grids. The labeling and user information requirements of this standard will rectify that situation. Students and industry professionals depend on tension wire grids to be a safe way to access their work.

While there are no existing standards in North America for tension wire grids, there is significant congruence for the minimum performance requirements among the various standards and codes that can be applied to them when used in various ways. This standard incorporates those performance requirements.

1 Scope * See Annex

This standard for tension wire grids covers the design and application criteria including: the loading, self-weight considerations, transitions between levels, and suspension or support from structure.

The standard provides deflection criteria for the woven mesh and structural frame as a walking/working system. The standard provides guidance on the size of openings permissible in the surface.

The scope includes fall protection and edge protection for the entirety of the walking/working surface, including platforms, ramps and stairs.

The standard provides consideration for accessories such as stage lighting pipes.

This standard does not apply to the structure to which the tension wire grid is attached.

Movable panels, used as part of the stage floor, trap covers, or pit fillers are outside the scope of this standard.

2 References

The following standards and documents were referenced in the writing of this standard. This standard in general does not require compliance with these standards, except where specifically stated in a requirement of this standard. However, the user of this standard is encouraged to consult these listed standards to gain an understanding of the context in which this standard has been developed.

The absence of a compliance requirement in this standard does not obviate the need to comply with a referenced standard if that compliance is required by a regulation.

- ANSI/ASSE A1264.1-2017. Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrail/Handrail Systems.
- 2010 ADA Standards for Accessible Design.
- ANSI/AISC 360 Specification for Structural Steel Buildings (most current edition)
- 2020 Aluminum Design Manual
- Structural Welding Code - Steel (ANSI/AWS D1.1).
- 2021 International Building Code® (referred to in this Standard as “the 2021 IBC”)
- 2017 ICC 300 – 2017, Standard on Bleachers, Folding and Telescopic Seating, and Grandstands
- NFPA 5000, Building Construction and Safety Code, 2021 edition (NFPA 5000-2021)
- Steel Construction Manual, 15th Edition
- ASTM A1023/A1023M-2, Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
- ANSI/ASCE 19-1. Structural Applications of Steel Cables for Buildings
- ANSI/ASCE 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- 29 CFR 1910.25, Stairways
- 29 CFR 1910.29, Fall protection systems and falling object protection-criteria and practices.
- ANSI Z535.4 - 2011 (R2017), Product Safety Signs and Labels
- ANSI Z535.6 - 2011 (R2017), Product Safety Information in Product Manuals, Instructions, and Other Collateral Materials
- Merriam-Webster’s Collegiate Dictionary, Eleventh Edition

3 Definitions

3.1 Competent person: a person who is capable of identifying existing and predictable hazards in the workplace, and who is authorized to take prompt corrective measures to eliminate hazards.

3.2 Long-wire grid. Tension wire grid in which the individual wire ropes extend to the entire width and length of the grid.

3.3 May. Indicates a feature, accessory or methodology is permissible.

3.4 Modular grid: A tension wire grid system comprised of smaller individual tension grid panels assembled into a larger system.

3.5 Must: Indicates a mandatory requirement.

3.6 Perimeter frame: Frame member to which the individual wire ropes are anchored. Perimeter frames typically occur at the outside edges of a long-wire grid or the outside of a modular grid frame.

3.7 Qualified person: A person who by possession of a recognized degree, or certificate of professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

3.8 Registered Design Professional (RDP): An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

3.9 Shall: Indicates a mandatory requirement.

3.10 Should: Indicates a recommendation that is not a mandatory requirement.

3.11 Guardrail: A railing for fall protection in areas not accessible to the general public.

3.12 Tension wire grid: A specialized walking/working surface used extensively in entertainment venues, for accessing areas above the performance and audience spaces, and specifically using a woven mesh of wire rope as the surface.

3.13 Toeboard: A protective lip at the perimeter of walking/working surfaces. Also known as a kickrail.

3.14 Walking/working surface: Any surface (including floors, roofs and platforms) walked upon by persons, used as a work area, or used to gain access to a work area.

3.15 Wire rope: Wires twisted to from strands then twisted to from a rope. The word wire in tension wire grid refers to the wire rope. Small diameter wire rope is also referred to as a cable.

4 Construction Requirements

4.1 Exposed Edges

Exposed edges, corners, and protruding parts shall be made burr-free. The use of guards, end caps, or similar methods shall be permitted.

4.1.1 Corrosion * See Annex

Metallic parts shall be protected from rust and corrosion.

4.1.2 Metal prep

All metals shall have an appropriate surface preparation for the finishing process used (e.g. sand blast, vibratory, tumble, laser strip, acid wash).

4.1.3 Ferrous metals
Ferrous metals must be primed and painted, plated, or galvanized to prevent corrosion.

4.1.4 Non-ferrous metals
Non-ferrous metals may be painted or plated as required to prevent corrosion.

4.2 Requirements for design

4.2.1 Minimum design loads

4.2.1.1 Uniformly distributed vertical load * See Annex
- 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.

4.2.1.2 Concentrated load * See Annex
Tension wire grid panels shall be designed to be able to support a minimum concentrated load of 300 pounds (14.36 kN/m^2) applied over a 12 inches by 12 inches (30.5 cm X 30.5 cm) area anywhere on the horizontal surface of the walking/working surface.

This is defined as a horizontal surface that distorts the tenon grid wires.

The point load shall not be required to be supported at the same time as the uniformly distributed load.

4.2.1.3 Horizontal loads * See Annex
The tension wire grid frame shall resist loads resulting from the wire rope tension and specified grid loads.

No horizontal loads shall be imposed upon the building except for seismic loads and sway loads caused by the movement of personnel on the grid.

Exception: If perimeter members have been provided within the building for the purpose of resisting horizontal loads applied from the tension wire grid.

4.2.2 Deflection

4.2.2.1 Vertical deflection of frames
The perimeter frame of tension wire grids shall be designed per building code requirements for strength and serviceability.

4.2.2.1.1 Frames shall provide vertical support for the walking/working surface.

4.2.2.1.2 The height difference between equally loaded adjacent panels shall not exceed ¼ inch (6.3 mm). When one panel is fully loaded and the adjacent panel has no load, the height difference shall not exceed 1/2 inch (12.7 mm). For modular grids, the height difference may be limited by attaching the grid frames together.

The difference in height between the perimeter surfaces of a tension wire grid panel and a building structural element are not bound by this requirement unless they are connected.

4.2.2.1.3 This maximum vertical deflection under load shall be determined and reported in the documentation available to the specifier or user of the tension wire grid.

4.2.2.2 Combined vertical deflection
The maximum vertical deflection, including the deflection of the grid wires and frame shall not exceed 3 inches (76 mm).

4.2.2.3 Torsional forces
Torsion in perimeter frames shall not exceed those allowable by the AISC Manual of Steel Construction or relevant standard for alternate materials.

4.2.2.4 Horizontal deflection of frames
Horizontal deflection shall be limited by the allowable vertical deflection of the wire ropes.

4.2.3 Design

4.2.3.1 Engineered design * See Annex
A Registered Design Professional (RDP) shall design the tension wire grid to meet the requirements of this standard, using established engineering practices.

4.2.3.2 The reviewing professional shall provide written or electronic calculations that enumerate the analysis performed. The analysis report shall include a description of the design methodologies used, and a summary of their results. Non-linear analysis software output results shall be provided, and written calculations shall be permitted.

4.2.3.3 Limitations of use
The limitations of use shall be established, including:

- 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.

4.3 Functional requirements

4.3.1 Walking/working surface * See Annex

4.3.1.1 Woven walking/working surface
The wire rope walking/working surface shall be connected to the perimeter frame members in tension.

4.3.1.2 Weave * See Annex
The weave shall consist of wire rope in a 2” (51 mm) square pattern. The wire ropes shall pass over and under each other at every crossing. Wire ropes in both directions shall be tensioned. The frame must maintain the spacing of the wires at the perimeter.

The weave may vary from square to diamond to trapezoidal, as long as the opening does not exceed 4 in^2 (25.8 cm^2).

Where wire ropes pass through holes or slots, the edges shall be finished to prevent sharp edges against the wire rope.

4.3.1.3 Tensioned wire ropes
The wire rope shall be constructed of steel wires twisted to form strands and then twisted to form a rope. The minimum allowable diameter of the wire rope is 1/8” (3 mm).

Wire rope shall conform to the requirements of ASTM A1023/A1023M-21, Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes. See also Federal Specification RR-W-410 J.

The wire rope shall be protected from corrosion. When environmental conditions dictate, the use of stainless steel wire rope shall be permitted. See A.4.1.1 Corrosion.

Wire ropes shall be continuous from edge to edge of the frame.

4.3.1.4 Wire rope terminations

The wire rope end termination must be perpendicular to the wire rope axis at the termination entry, or shall be self-aligning. The termination method must not create localized stress points on the wire rope or the termination, where the wire rope passes through or connects to the frame.

Wire ropes shall be terminated with swaged fittings. Fittings shall be selected and applied based on the rope material, construction type and environmental considerations.

4.3.2 Frames

Tension wire grid frames shall have welded or bolted connections between grid members and to support members. Internal bracing in one or both directions, between opposing frame members, shall be permitted in order to achieve deflection criteria of wires and to prevent horizontal deflection of the frame members.

4.3.2.1 Self-weight * See Annex

The self-weight of the grid frame and wire rope shall be included in the tension wire grid design.

4.3.2.2 Adjacent frames

Open or exposed gaps between adjacent frames shall not exceed 2” (51 mm). Gaps exceeding 2” (51mm) shall comply with the requirements for rigging wells or be covered with permanent or removable covers.

4.3.3 Suspension and support

4.3.3.1 Suspension

Tension wire grids shall be supported by the building structure. Purpose-designed supplementary steel may be required.

4.3.3.2 Hangers

Hangers shall be free of sharp edges. Sleeves, when used shall not rotate.

4.3.3.3 Support

Frames shall be supported from structural support beams.

4.3.3.4 Perimeter support

Support of grid panels by structural walls shall be permitted, provided that the wall construction will support the loads imposed by the grid system.

4.3.4 Surface transition

The walking/working surfaces of tension wire grid panels, and the transition from panel to panel, shall be free from trip-hazards and sharp edges.

The perimeter frames may extend above the walking surface and must be stepped over.

4.3.5 Rigging wells

Rigging wells with a maximum 6” (152.4 mm) opening may be formed:

- Between the edge of the support beam and the edge of the tension wire grid frame.
- Between two adjacent tension wire grid frames. A structural beam may be centered in the opening for the purpose of rigging.
- See 6.4.2 for additional marking requirements.

4.3.6 Trap door (hatch door) * See Annex

Trap doors whether single leaf or double leaf provide an access point for hoisted loads on to the tension wire grid. The process of opening the trap door presents specific open hole hazards that must be mitigated.

4.3.6.1 Edges
The edges of trap door frames and trap door leaves shall be outlined with a 2” (50.8 mm) yellow painted edge or 2” (50.8 mm) yellow and black hazard tape.

Where the flange or other horizontal surface of the frame member is less than 2” (50.8 mm) wide, that surface shall painted yellow and deemed to comply.

4.3.6.2 Guard rails
Trap doors shall be equipped with guardrails per ANSI/ASSE A1264.1-2017, Section 3. Where permanent guardrail systems are not practical, temporary guard rails must be erected.

4.3.6.3 Fall protection
A trap door presents an open hoist way. If field or operating conditions do not permit use of a guardrail system, a fall restraint or fall arrest system shall be developed and installed. Refer to 29 CFR 1910.29, Fall protection systems and falling object protection-criteria and practices.

4.3.7 Stage lighting mounts * See Annex
Stage lighting mounts (pipes) are a common accessory for tension wire grids.*

4.3.7.1 Maintain a maximum deflection of L/180 with a minimum 30 plf (44.6 kg/m) live load.

4.3.7.2 The use of steel or aluminum members are acceptable depending on the span between stanchions, supports, or hangers.

4.3.7.3 Lighting Pipes may be constructed of 1-1/2” pipe with 1.9” O.D. (48.3 mm O.D.) or 2” (50.8 mm) O.D. round tube.

4.3.7.4 The use of engineered channel strut for lighting mounts shall be permitted.

5 Additional conditions for access

5.1 Stair units

5.1.1 Securing
Stair units shall be secured to ensure that they do not shift away from any walking surface or platform to which they provide access during use.

Stair units shall be supported by grid frames or building structure. Stair units shall not be supported by the tensioned wire ropes.

5.1.2 Vertical point load for stairs * See Annex
Stair units shall be able to support a minimum point load of 1000 pounds anywhere on the walking/working surface on an area 4 inches by 4 inches (2.2 kN on an area 101 mm X 101 mm).

5.1.3 Step rise, run, and width
The step rise, tread depth and width shall comply with state and local codes. Multi-step units shall have a uniform tread depth and rise.

5.1.4 Rise toeboards
Closed risers or toeboards may be required by state and local codes.

5.1.5 Construction * See Annex
Stairs between levels of tension wire grids may be constructed of traditional materials including diamond plate or grating.

5.2 Ramps * See Annex
Ramps must be able to support the minimum design loads specified in 4.3.1 and should have the same load-bearing ability as the platform surfaces to which they are designed to lead. A slope of 1:8 (12.5%) must not be exceeded.

5.3 Handrails
Stair units and ramps having a rise of 8 inches (20 cm) or more shall be fitted with at least one handrail. Multi-step stair units and ramps wider than 47 inches (1.2 meters) shall be fitted with two handrails.

6 Edge protection

6.1 General * See Annex
The perimeter edges of all tension grid systems shall have guardrails for fall protection, and edge protection to protect against objects falling from the edges, except where a perimeter edge abuts a wall.

6.2 Guardrails * See Annex

6.2.1 Guardrail design load
Standard guardrails shall be designed to support a concentrated load of at least 200 pounds (0.9 kN) applied in any direction on the top rail. They shall be able to support a uniformly distributed load of 50 pounds per linear foot of railing length (0.73 kN/m).

Intermediate rails, bars, or panels shall be designed to withstand without failure a force of at least 150 pounds (0.7 kN) applied in any downward or outward direction at any point along the intermediate member.

6.2.2 Guardrail height and bar spacing
Standard guardrails shall have a height of at least 42 inches (1.1 m). The space between the top and bottom of the standard guardrail shall be filled with intermediate rails or a structure of bars, panels, or other elements so there is no space larger than 19 inches (48 cm).

6.3 Toeboards * See Annex
Catwalks and the perimeter edges of all tension wire grids shall be equipped with toeboards wherever the distance from the platform to the lower surface exceeds 4 feet (1.2 m). When the perimeter edge abuts a wall, toeboards are not required.

6.4 Marking of open-edge hazards

6.4.1 Elevation transition marking
Wherever the distance from the platform to the lower surface exceeds 1 foot (0.3 m) but is less than 4 feet (1.2 m), the edge of the upper platform shall be marked with continuous yellow and black hazard tape or 2” (50.8 mm) minimum yellow painted edge. If the horizontal surface of the structural element is less than 2” (50.8 mm) wide, that entire horizontal surface shall be painted yellow.

Marking is not required if guards, handrails or lighting pipes are located at or within this transitional edge.

When the distance from the platform to the lower surface exceeds 4 feet (1.2 m), the hazard tape is not required because clause 6.2 will prevail.

6.4.2 Rigging well marking
The edges of tension wire grid frames that abut rigging wells shall have a 2” (50.8 mm) minimum yellow edge of paint or tape to visually alert the end of the grid and the beginning of the rigging well. If the horizontal surface of the structural element is less than 2” (50.8 mm) wide, that entire horizontal surface shall be painted yellow.

7 Labeling and user information

7.1 User information

The following information shall be provided to the user of the tension wire grid, in a hard-copy handbook, on a website, in a free app for portable devices, or via some other convenient medium.

7.1.1 Operating instructions and user information * See Annex

The manufacturer and installer must provide a user manual with operating instructions and user information:

- Description of the installation.
- Correct use of hatchways, trap doors, swing gates, stairs and ladders that provide or limit access.
- Recommendations for preventive measures to be taken by the user (e.g., footwear, bump cap).
- The static load capacity.
- The maximum vertical or horizontal deflection under load.
- Information on variable or mobile loads (e.g., wagons, carts, wheelchairs).
- Instructions for the assembly, dismantling, and use of accessories, and the number of people required for manual handling indicated (e.g., lighting pipes, trap doors).

7.1.2 Maintenance instructions

Maintenance instructions should include the following:

- Information on inspection and maintenance including repairs and testing.
- Scope of maintenance that may be carried out without the involvement of specialists.
- Required qualification of the persons responsible for the inspection and maintenance.
- Frequency of visual and functional inspections.
- Specific hazards encountered during inspections and maintenance.
- Information on spare parts procurement.
- Instructions for user repairs and adjustments.
- Cleaning and care methods.
- Contact details of the manufacturer of the tension wire grid for technical support.

7.1.3 Warnings and safety notices

Hazards shall be identified and reported to the user by appropriate labeling and safety notices per ANSI Z535.4 - 2011 (R2017), Product Safety Signs and Labels and ANSI Z535.6 - 2011 (R2017), Product Safety Information in Product Manuals, Instructions, and Other Collateral Materials.

7.2 Signage

Information and caution signage shall be located at or near each entrance to the tension wire grid. Signage shall meet the following requirements:

- Signage shall be placed in clearly visible and accessible location(s)
- Signage shall be in English with appropriate graphics.
- Signage shall be in additional languages commonly read by the personnel using the facility.
- Signs shall be a minimum of 7” H x 10” W (17.8 cm H x 25.4 cm W).
- The signage shall state load capacities and limitations of use.
- Name and contact information of tension wire grid manufacturer and installer.

8 Inspection and maintenance

8.1 Log

There shall be a log of all inspection and maintenance activities.

8.2 Inspections

Tension wire grids shall be inspected at the manufacturers recommended interval by a qualified person. At minimum, that interval shall be after first installation, after one year of service, and every five years thereafter.

A written report including photos of any problem or watch areas shall be filed with the maintenance log.

The inspector shall note any operational procedures witnessed that are contrary to the safe use of the tension wire grid.

8.3 Inspection of areas with special concerns
High traffic areas, transitions between levels, and moving features such as trap doors may require more frequent inspections.

8.4 Inspection of modifications * See Annex
Whenever a panel is removed, it shall be inspected after it is re-installed. The removal of a panel shall always be logged in the maintenance log.

In most installations the moving of lighting pipes does not constitute a modification.

8.5 Incident reports
An inspection shall be required immediately after an abnormal event, such as running a hoisted load up into the mesh, or dropping a significant load from above onto the tension wire grid.

8.6 Reports from personnel
Whenever personnel report an incident, such as tripping on a loose wire or a cut or abrasion from a sharp edge, the area in question should be inspected.

The hazard should be identified, and an attempt to remediate the hazard implemented (e.g. caution tape, foam edge protectors, repairing the panel).

8.7 Removal from service
When a portion of the tension wire grid is found to require service (e.g. frayed or broken wire), the damaged area shall be blocked off until repaired.

9 Recommended precautions for use
Every installation of tension wire grid is custom to the architecture and serves many different functional requirements. As such, the following recommendations are to be considered when developing the operational procedures for a given facility.

9.1 Personnel
Only trained and authorized personnel may access and work on the tension wire grid.

9.2Precautions to limit falling objects

- Personnel must remove all loose items from clothing pockets.
- Loose objects must be secured, e.g. eyeglasses, cell phones and walkie-talkies.
- Hand tools small enough to fall through the weave or gaps at the edges of panels must be secured with lanyards.

9.3 Reducing hazards from falling objects
To reduce hazards from falling objects, access to the floor below must be limited. A combination of the following methods could be used:

- Post signs at all entrances to the hazard zone that overhead work is in progress.
- Lock doors where feasible that enter to the hazard zone space.
- Erect exclusion zones using stanchions and caution tape.
- Assign a spotter at the lower floor level. Spotter should remain out of the hazard zone.
- All personnel at a lower floor level must wear hardhats.

9.4 Conduct
No running, jumping or bouncing on the tension wire grid. Observe the load capacities of the tension wire grid, including the unnecessary concentration of people.

9.5 Hazards

Report observed hazards to your supervisor or instructor. Hazards may be specific pieces of equipment or operational procedures.

9.6 Maintain the weave

Close all holes in the weave, including those that may occur from repetitive traffic.

It is possible to hand work the weave to create a larger hole to pass electrical cables, static rigging or moving rigging through the weave.

Provide a non-conductive bushing to prevent the mesh from abrading the cable jacket and creating an electrical hazard.

Provide a bushing to prevent rigging whether static of moving from abrading the wire rope mesh.

Annex A

Explanatory information
This annex is not part of the requirements of this standard and is included for informational purposes only. It contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1 Scope
Movable panels, used as part of the stage floor, trap covers, or pit fillers are outside the scope of this standard because their frames are supported in many fashions, frequently without pinning the corners. In addition, the required loading for stage floors is 150 pounds/square foot (7.2 kN/m^2).

A.4.1.1 Corrosion
The site specific requirements may warrant advanced corrosion prevention measures in the following scenarios:

- Venues located in coastal regions or near brackish waters.
- Tension wire grids installed over or near fresh or saltwater aquatic pools, tanks, or aquariums.
- Tension wire grids installed over or near zoological exhibits, especially aviary where droppings may fall onto the grid.
- Tension wire grids installed inside greenhouses or biosphere with artificially controlled humidity.
- Tension wire grids installed in aquatic centers or natatorium where caustic chemicals such as chlorine and bromine are used in swimming pool water treatment systems.

A.4.2.1.1 Uniformly distributed vertical load
The 20 pounds per square foot live load is similar to the ASCE 7-16 requirement for a minimum roof live load of 20 PSF to provide for loads caused by workers and materials during repair operations.

The 2021 International Building Code specifies a minimum UDL for “Catwalks” in Table 1607.1 of 40 pounds/square foot (1.92 kN/m^2). This higher load is used for narrow grids since the weight of a person is distributed over a smaller area resulting in a higher uniform load.

The critical factors distinguishing these are the number of people anticipated to be on the grid panel and the width of the tension wire grid that can distribute these loads. For normal structural design, this is the reason for a concentrated load requirement. A narrow isolated panel needs to support a higher load since it has less width to distribute the load over than a panel connected to adjacent panels.

The designer is directed to Section 410.2.2 of the 2021 IBC for additional information.

A.4.2.1.2 Concentrated load
This point load performance requirement is taken from ICC 300.

The 2021 International Building Code specifies a minimum concentrated load for “Catwalks” in Table 1607.1 of 300 pounds/square foot (1.92 kN/m^2)

A.4.2.1.3 Horizontal loads
The frames of tension wire grids have compression loads from the wire rope pretension and grid loads. In addition, the frame has bending stresses from the vertical and horizontal loads. Some grid frames have relatively large deflections and P-delta effects may be significant.

A.4.2.3.1 Engineered Design
The registered design professional will most likely be licensed in the state or province where the tension wire grid is to be installed.

A.4.3.1 Walking/working surface
Maintaining a walking/working surface with limited trip hazards is a paramount goal. Depending on the design, the variance from the top of wire weave to top of the frames range from as little as ¼” (6.3 mm) to 4” (10 cm) or more. A walking/working surface designed with a relatively smooth surface allows the use of rolling wagons, carts or other wheeled equipment.

A.4.3.1.2 Weave
For practical reasons, most frames are square or rectangular and the weave is perpendicular to the frame.

Specialty frames that are triangular, trapezoidal, curved or irregular polygons present challenges. The weave may be adjusted from square to trapezoidal. The recommended maximum distance from the frame to the first wire should not exceed 4” (10 cm).

A.4.3.2.1 Self-weight
The self-weight of standard tension wire grid panels including woven walking/working surface may be as light as 5 pounds per square foot (24.4 kg/m2).

A.4.3.6 Trap Door (hatch door)
Loads hoisted through a trap door are generally heavier and/or larger than that which can be lifted by hand up and over the guardrails. As such, an overhead rigging beam should be part of the design to support the lifted load.

It is recommended to center the trolley beam over the door opening with sufficient headroom to clear the guardrails. Consider the magnitude of the load, and capacity of the platform where the load is to be landed.

A.4.3.7 Stage lighting mounts
Stage lighting pipes are frequently attached to the suspension hangers when same are designed for this dual purpose.

In most cases, attachments directly to one or two wires is not acceptable. Support for the base of a flat plate or stanchion by the frame or the mesh is generally acceptable within the point load limits.

A.5.1.2 Vertical point load for stairs
This is the load performance requirement for permanent stairs required by OSHA's 29 CFR 1910.25(b)(6):
Each stair can support at least five times the normal anticipated live load, but never less than a concentrated load of 1,000 pounds (454 kg) applied at any point.

A.5.1.5 Construction
Stairs could be made using tension wire grid woven work-walk surfaces, but there is little impetus to do so. The vertical point load requirement would be very onerous.

A.5.2 Ramps
The slope performance requirement (12.5%) maximum is consistent with clause 16.2.5.6.5.1 (2) in NFPA 5000-2018. Per that clause, any assembly occupancy aisle steeper than 1:8 is required to be a stairway.

A.6.1 General
Many codes and regulations require guardrail systems when then there is a potential for falling from a walking/working surface greater than 30” (76 cm) above a surface below.

ANSI/ASSE A1264.1-2017 and OSHA 29 CFR 1910.28(b)(1)(i) set this distance at 4’ (1.2 m).

A.6.2 Guardrails
These requirements are essentially those found in ANSI/ASSE A1264.1-2017 and 29 CFR 1910.29(b) with the addition of a uniformly distributed load requirement.

The designer is directed to Section 1015.2 of the 2021 IBC for additional guidance and possible exceptions.

A.6.3 Toeboards
Toeboard requirements vary depending on the type of grid panel since the grid itself provides no protection against falling objects. Grids with channel frames often use the height of the channel as the edge protection.

When the walk-work platform is greater than 4 feet (1.2 M) above the lower surface, the following is applicable:

Notice 1910.28(b)(3)(iv) includes toeboards with guardrail system: “Each employee is protected from falling into a ladderway floor opening or ladderway platform hole by a guardrail system and toeboards erected on all exposed sides, except at the entrance to the hole, where a self-closing gate or an offset must be used.” (source)

Further, OSHA standard 1910.29(k) includes standards for “protection from falling objects”. In particular, toeboards used for falling object protection are as follows:

- Toe Board Height Requirements: 29(k)(1)(ii): “have a vertical minimum height of 3.5 inches (9 cm) as measured from the top edge of the toeboard to the level of the walking/working surface”,
- Clearance : 29(k)(1)(iii): “do not have more than a 0.25 inch (0.5 cm) clearance or opening above the walking/working surface”, and
- Force: 29(k)(1)(vi): “should be capable of withstanding a force of at least 50 pounds (222 N) applied in any downward or outward direction at any point along the toeboard.”
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A.7.1.1 Operating instructions and user information

The wheels or tires of wagons, carts, and wheelchairs must be selected to perform on tension wire grids.

Tension wire grids are most commonly located in technical spaces that are not for public access. As such it is not to be assumed that a traditional wheelchair has the tire footprint that will perform well. In fact the gaps between panels as well as the rigging loft wells present significant hazards for a wheelchair, particularly if approached in a near parallel rather than perpendicular crossing. With that understanding, both the grid and the wheelchair can be made accessible for many installations. See also A.4.3.1.

A.8.4 Inspection of modifications

The removal of a panel is only to be performed by a trained crew using fall protection and observing all of the precautions for an open hoist way.