ICC AD HOC COMMITTEE ON TALL WOOD BUILDINGS

RESPONDS TO CONCERNS RAISED ON

CODE PROPOSALS ADDRSSING TALL WOOD BUILDINGS

(AUGUST 1, 2018)

The International Code Council (ICC) established the Ad Hoc Committee on Tall Wood Buildings (TWB) in December 2015. This committee studied the building science for tall wood buildings, and has proposed revisions for the 2021 edition of the International Building Code (IBC) in the current 2018/2019 Cycle to address building construction using mass timber.

The committee worked for two years to develop code proposals in an open and transparent process. It should be noted that all of the meeting notices, agendas, support documents, presentations and minutes were posted on the TWB website: https://www.iccsafe.org/codes-tech-support/cs/icc-ad-hoc-committee-on-tall-wood-buildings/. In addition to the committee members, who represented many interests, including the engineers, architects, building and fire code officials, fire service, materials representatives, and testing laboratory representatives, the committee also welcomed over 170 others as interested parties who signed up to be on the TWB email distribution list in order to follow and comment on committee proceedings. Four Work Groups were created which were comprised of both committee members and interested parties, with their work product being considered by the full committee. Committee members have routinely spoken about the committee activities to interested parties at various conferences and meetings to further ensure open and inclusive discussion exploring the issues of tall wood buildings.

The TWB code proposals were assigned the following code change proposal numbers:

G28-18: IBC 403.3.2, High Rise Sprinkler Water Supply

G75-18: IBC 504.3, Height, Feet

G80-18: IBC 504.4, Height, Stories

G84-18: IBC 506.2, Allowable Area

G89-18: IBC 508.4.4.1/509.4.1.1, Fire Separations, Occupancy and Incidental Uses

G108-18: IBC 602.4 (also definitions and IBC 601), Types of Construction

FS5-18: IBC 703.8, Performance method for noncombustible protection

FS6-18: IBC 703.9, Sealant/Adhesives at Edges

FS73-18: IBC 708.2.1, Fire and Smoke Protection

FS81-18: IBC 722.7, Prescriptive method for noncombustible protection

G146-18: IBC 3102, Membrane Buildings

G152-18: IBC Appendix D, Fire Districts

F88-18: IFC 701.6, Owner's responsibility

F266-18: IFC 3308.4, Fire Safety during construction

Interested parties are invited to visit cdpACCESS to review the committee proposals and the supporting justifications. Click here.

The TWB code proposals were heard at the ICC Committee Action Hearings in Columbus, OH in April 2018. While all of the code proposals were ultimately approved by the various Code Development Committees, several concerns were raised by committee members and interested parties.

This document seeks to inventory the concerns raised, and to provide a summary response from the TWB committee.

Concern 1:

The changes are overreaching and lack true technical support for many concepts proposed

Response:

The changes proposed by the committee are a result of careful analysis of: current building codes; the results of numerous fire tests, including the ATF fire tests; and a performance-based approach to ensure that tall wood buildings provide similar performance compared to current construction types allowed by the code.

Technical support is achieved by requiring that the new construction types meet fire resistance rating requirements that already apply to other construction types. The proposals rely on demonstrated performance of mass timber when tested to standard and natural fire exposures, and how this performance compares to existing construction types. .

Concern 2:

Safeguards during construction have not been adequately addressed. We have seen the difficulty in protecting buildings under construction or stick built construction. The fire service capabilities of a tall-wood building are not part of the code and could easily exceed the capabilities of the responding fire service without building protection (automatic sprinklers, interior partitions, etc.)

Response:

It is important to note that the term "stick built" does not describe what is presented by the mass timber structure. There are no light-weight wood elements permitted within these buildings. While the term "stick-built" may be representative of current Type III and V construction buildings, one should not confuse mass timber buildings with light-frame wood buildings. The committee carefully examined the difference in behavior of mass timber compared to wood frame in response to fire. Note that proposed mass timber buildings exceeding the allowable height for current Type IV-HT require the extensive use of noncombustible material to be applied directly to the surface of combustible building elements.

Specific code language (Item F266-18) is proposed to address construction fire safety requirements. Currently, Type IV buildings are permitted to be 6 stories (even greater when podium concept is used) to a height of 85 feet. The committee used this existing threshold to trigger the construction fire safety requirements when mass timber buildings are proposed to exceed a maximum height of 6 stories (above grade plane). These include the requirement for a construction standpipe, and providing a water supply for fire department operations. In addition, where the final design requires noncombustible protection of the mass timber, the proposed code provisions require installation of the noncombustible protection for the mass timber elements, both interior and exterior, during the construction process. Additionally, the building envelope must be installed as the noncombustible protection is installed. This serves to limit the contribution from mass timber in a construction fire.

Though this protection during construction is not required for other construction types in today's code, it is proposed by the TWB Committee as a means to provide reasonable safety during construction of these taller buildings of combustible construction.

Concern 3:

Proposals lack a complete technical basis for height and stories utilized in the changes. There has been discussion that this type of construction has a fire-resistive rating similar to that of concrete typically used in fire-resistive and noncombustible construction, although it has not been fully justified. The data is derived from fire demonstrations.

Response:

The TWB used a rational, comparative/empirical performance based approach to developing the heights and areas in the proposals. The approach is validated by the results of fire testing, including the ATF fire tests. Numerous tests also validate the fire-resistance rating of mass timber elements. The TWB proposals address the issue of non-combustible construction versus the contribution of the mass timber to the fire load by requiring minimum levels of non-combustible protection for the mass timber elements in the taller buildings (Types IV-A and IV-B Construction).

Following is a discussion for heights that speaks to each individual type of construction proposed.

Proposed Type IV-A: *Currently, Type I-A is permitted unlimited heights, depending on occupancies. The proposed Type IV-A construction is required to have exactly identical fire resistance ratings as Type I-A construction, but is limited in allowable height. Although the proposed Type IV-A has the same fire resistance rating requirements as Type I-A, the committee decided to limit the height of Type IV-A, specifically to address firefighting concerns (see last section below). The heights provided for Type IV-A construction are lower than what is permitted for Type I-A construction, even with identical fire resistance rating requirements.*

Proposed Type IV-B: *Currently, Type I-B is permitted to heights up to 12 stories (180 feet), depending on occupancies. The Type I-B has tabular values for fire-resistance ratings that equal those proposed for Type IV-B. However, a big difference occurs where, per Section 403 of the IBC, the fire resistance rating of building elements for Type I-B are permitted to be reduced in high-rise buildings. This reduction is not permitted for Type IV-B. The net effect is that the fire resistance ratings for Type IV-*

B are greater than those required for Type I-B when applied to these buildings. As such, it is a conservative treatment to limit Type IV-B to the same heights allowed for Type I-B.

Proposed Type IV-C: *The heights for IV-C construction are based on the existing requirements for Heavy Timber construction (now termed Type IV-HT). Type IV-C construction is fully exposed wood, but still requires a fire resistance rating of 2-hours for the structural frame; only dimensional criteria are provided for Type IV-HT. Type IV-HT is currently permitted to a height of 85 feet; conservatively, no additional height in feet is proposed for Type IV-C. However, due to the greater fire resistance rating of IV-C construction, the committee proposed additional stories for Type IV-C construction, as the fire resistance rating provides greater compartmentation within the building.*

With respect to justifying the fire-resistive rating, it's not clear exactly what needs to be justified. The proposal Item G108-18 includes a table that sets out fire resistance rating requirements (see table below). Type IV-A is directly correlated to existing Type I-A, while both Type IV-B and Type IV-C are correlated to Type I-B. These are quantifiable data points that ensure similar performance from various structural assemblies, regardless of the materials used. Please note that this data was not, and cannot, be derived from the ATF fire tests. Rather, data from standardized tests, such as ASTM E-119, were used to develop fire resistance ratings. Also note that CLT floor/ceiling and wall assemblies have achieved 2-hour and 3-hour fire-resistance ratings, respectively, in standardized tests, as is required by the table setting forth rating requirements. Further, mass timber is not permitted to utilize the fire-resistance rating reductions set forth in the building code for high-rise buildings, so mass timber building elements will often provide greater fire resistance ratings than currently required of other construction types, which is a conservative approach taken by the committee.

Table 601 Fire Resistant Rated Construction

BUILDING ELEMENT	***Type I***		***Type II***		***Type III***		***Type IV***				***Type V***	
	A	*B*	*A*	*B*	*A*	*B*	***A***	***B***	***C***	*HT*	*A*	*B*
Primary structural frame	*3*	*2*	*1*	*0*	*1*	*0*	***3***	***2***	***2***	*HT*	*1*	*0*
Bearing walls,												
Exterior	*3*	*2*	*1*	*0*	*2*	*2*	***3***	***2***	***2***	*2*	*1*	*0*
Interior	*3*	*2*	*1*	*0*	*1*	*0*	***3***	***2***	***2***	*1/HT*	*1*	*0*
Nonbearing walls and partitions, Exterior	*See Table 602*											
Nonbearing walls and partitions, Interior	*0*	*0*	*0*	*0*	*0*	*0*	***0***	***0***	***0***	*See Section 2304.11.2*	*0*	*0*
Floor Construction	*2*	*2*	*1*	*0*	*1*	*0*	***2***	***2***	***2***	*HT*	*1*	*0*
Roof Construction	*1-1/2*	*1*	*1*	*0*	*1*	*0*	***1-1/2***	***1***	***1***	*HT*	*1*	*0*

Concern 4:

The proposals provide a greater per floor area increase than what is allowable for buildings constructed of concrete and steel. Technical justification has not been provided to substantiate the increase in these areas.

Response:

The proposals do not allow a greater per floor area than that which is currently permitted for buildings of concrete or steel. They do allow greater areas than those currently permitted for wood frame construction but as has been pointed out, mass timber is very different from light frame construction, either combustible or noncombustible. Thus, the comparison needs to be made to Types I and II construction. The allowable areas table permits buildings of unlimited area for Types I-A and I-B construction for many occupancy classifications. The committee used a performance based approach that centered on comparing Type IV-B to Type I-B construction. While such an approach could be used to justify unlimited areas for some of these new construction types for certain specific occupancies, the committee instead decided to limit the size of these buildings. This provides a conservative approach to introducing these types of construction into the code. In other words, rather than being an increase in the allowable areas, these proposals actually limit the size of these buildings of similar performance, versus the construction Types I-A and I-B. Unlike unlimited area high-rise buildings permitted for most Types I-A and I-B buildings, the allowable area per floor decreases as Types IV-A and IV-B buildings increase in height, as required in Sections 506.2.3 and 506.2.4

Concern 5:

In a number of metropolitan cities, the staffing levels will permit an adequate short-term response to initiate suppression operations on upper levels of a high-rise building in a relatively short period of time. A major consideration for our membership is that the vast majority of our jurisdictions around the country and internationally lack the response capabilities to effectively initiate an effective suppression effort in the same relatively short time period.

Response:

This is an open-ended question, as each jurisdiction will make different decisions about the standard response plan to operate effectively for their particular needs. It is imperative that the fire service be a part of the building design from the preliminary design stage to ensure that any challenges are addressed. The committee deliberated with the goal to ensure that tall wood buildings do not pose any greater risk than currently presented by buildings of other construction.

When looking at heights in the code, there are three general ranges of height. The first range is up to about 80 feet or so. This is evidenced by the requirement for high-rise criteria when the building exceeds 75 feet to the highest occupied floor, and also the overall building height of 85 feet for certain types of construction. This height of 80 feet also correlates to the upper reaches of most fire department apparatus ladders, when factoring in available access locations and potential obstructions to ladder operations.

The second range starts at about 80 feet and goes up to 420 feet. When buildings rise above 80 feet or so fire operations transition to interior vertical travel via stairs/elevators and the use of fire hose connected to standpipe systems in order to put water on the fire. The 420 feet is a relatively new criteria in the code, resulting from the work in reviewing the World Trade Center events. The 420 feet specifically correlates to firefighting capabilities, and, more specifically, the requirements stipulated for standpipe system design.

A single fire engine is capable (without tandem pumping) of supplying 300 psi pressure while flowing. NFPA 14 requires a residual pressure of 100 psi at the most hydraulically remote standpipe outlet. This leaves 200 psi for elevation. Using the standard factor of 0.433 psi/ft elevation, this yields a height of 461 feet. Understanding the way that heights can be measured, a safety factor is provided to cap this height range at 420 feet in the codes.

In other words, a single fire engine (without need for tandem pumping operations) can reasonably be expected to supply standpipe systems per NFPA 14, with a factor of safety at a height of 420 feet. This height calculation is independent of construction materials; regardless whether the high-rise is made of wood or is made of steel and concrete, the height of 420 feet is a conservative height to ensure the successful operation of standpipe systems with the first engine to feed the Fire Department Connection.

Past 420 feet high, the code adds several protective criteria. Following from the discussion above, building heights above 420 feet can complicate the standpipe operation by requiring tandem umping or other arrangements to ensure system performance, and so additional safeguards are added to mitigate these issues. Heights over 420 feet are not contemplated by the committee proposals for tall wood buildings.

There is a reason that the heights proposed by the Ad Hoc Committee fell below 420 feet. An early committee proposal allowed a height up to 360 feet (24 stories), knowing that setting a maximum building height of 360 feet would provide more factor of safety than the code limit of 420 feet. However, due to initial feedback to the height proposal, the committee ultimately decided to propose 270 feet (18 stories) for the tallest height, which is very conservative in light of the 461 ft height calculation described above, and ensures a reasonable scenario for the fire service.

Concern 6

Concerns raised about the Type IV-B construction type and how it fits into the typical methodology of the code. Current code has options for construction where construction types are described, and then provide a version that is protected and another that is not protected. There is concern that Type IV-B straddles between the two concepts, and is not appropriate for inclusion in a model code. Essentially, Type IV-B is a vanity proposal to provide the architects allowance for exposed wood in taller buildings, but does not fall within the framework of the IBC.

Response:

The three proposed construction types are distinctly different. Type IV-B is a lesser construction type than IV-A construction, as IV-A allows no exposed mass timber and requires 3-hour ratings for the primary structural frame which includes columns and bearing walls. Type IV-B is different from Type IV-

C, in terms of allowed exposed wood that may potentially contribute to the fire (even though the required fire resistance ratings are the same). In effect, all of the new construction types have increasing safety factors as one compares from IV-C, to IV-B, to IV-A in a continuum of increased protection. Rather than a straddle between two concepts, the proposals set IV-B as another ladder rung as the code lays out a total of 4 (with IV-HT) construction types, with increasing protection as each higher construction type is introduced. With this mindset, the committee felt that the Type IV-B construction type was valid for inclusion with the TWB code proposals.

Concern 7

There are concerns about fire fighter response time and access up the building

Response:

There is a relatively new section of the codes that require fire department access elevators for buildings that are 120 feet in height. It should be noted that this code requirement will apply to all types of construction, including Type IV buildings. Also in this proposal, for any building greater than 75 feet in height to top occupied level, egress stairs are required to be of higher construction than the building. This ensures that the stairs remain a safe haven for emergency responders to access the building.

Concern 8

Concern that a two-story mock-building does not replicate a 18-story building

Response:

Certainly, constructing buildings of all variations of height for testing is prohibitive and not expected of other construction materials. The process of extrapolation does allow for scaling. One of the things to remember are the test conditions for the ATF fire tests, specifically tests 1-3. The sprinkler system was not installed, there was no simulation for response of fire operations either through the FDC or with hose lines from a standpipe system, there was no occupant intervention, and the window was removed at the very beginning to ensure sufficient ventilation and fire growth (which negates wind argument). The fire reached over 20MW in size, and by all reasonable measures, the fire was contained in the area of origin and died out after content burnout. Regardless if that room is on level 1 or level 10 or level 100, the same fire principles apply regarding fire size and compartmentation.

Concern 9

Wind should have been part of the testing but not considered due to lack of time.

Response:

There is no basis for claiming that there is a lack of time. The test protocol was established without any wind being necessary, and the test series was conducted in timeframes expected by the committee. There was never a committee intent to require the inclusion of wind in the testing.

Wind issues have been brought up for exterior wall testing, and in discussing the tall wood buildings. There is a mixing of issues to highlight wind concerns, and using the tall wood building analysis to bring exterior wall issues up in a different venue.

With respect to the fire testing with tall wood buildings, there is concern that the wind issue is being brought up without due consideration of the actual test conditions. The fire was provided the combustion air needed by providing fully opened window openings starting at time zero. Please note that wind speeds generated by entrained air approached 15 mph during testing. Fully opened windows are not expected to be present for the vast majority of fire scenarios. With the limited amount of building leakage, there is little air that can be pushed into the fire compartment from an outside wind, and certainly less than was entrained through the openings provided in the fire testing. As such, wind is a red herring issue with respect to the fire testing and the results therefrom.

With respect to exterior wall testing, there certainly is validity that, since the fire is already occurring outside of the building envelope, wind effects can impact exterior fire growth, in terms of fire geometry and in fire intensity. However, this is an issue that applies to tall buildings of all materials, and is not unique to tall wood buildings. With respect to tall wood buildings, the committee has proposed exterior wall claddings be noncombustible, save for the minor exception for water barriers. In other words, the metal/foam composite panels and the exterior combustible foams that are permitted in other types of construction, are not permitted in tall wood buildings. The committee is neutral to changes to exterior wall test requirements to address wind effects, as long as any code proposals are material neutral and focused on material performance.

Concern 10

Where in the proposals are there requirements for bolstering the reliability of fire protection for these buildings?

Response:

There are several ways that the ATF tests and the code proposals ensure reliable fire protection.

First, the sprinkler system design used in testing the sprinkler-protected scenarios utilized a density of 0.05 gpm/sf. This was to ensure no issues with proposing these materials in low-rise buildings, which traditionally utilize a NFPA 13R sprinkler system. However, please note that high-rise buildings over 60 feet tall will require a density of 0.10 gpm/sf in accordance with NFPA 13.

Second, the committee proposed a specific code change in order to provide two means of water supply to a building. Normally, this code requirement is only applied to buildings with height exceeding 420 feet. For tall wood buildings, the committee proposed requiring the redundant water supplies at a height of 120 feet.

Finally, the third point is nuanced, as there is no code proposal to point to, but there is significant conservatism provided for the fire flow requirements that establish volume of water supply for buildings. When using the fire flow chart in Appendix B, there are significant reductions in fire flow permitted for protected types of construction. For example, look at the differences between Type III-A (1-hour frame, typically light-frame wood) and Type III-B (also typically light-frame wood, but with no fire resistance

rating). In nearly every range of building size, the code allows more than twice as much of Type III-A building area than Type III-B building area, for the same fire flow, even though the rating is only 1-hour. For the new construction types, even though the ratings are 2-hours or greater, no additional building area is being allowed for the same fire flow; all Type IV construction types have to be protected with fire flow as if they are the unrated heavy timber type of construction, which is a very conservative approach.

Concern 11

The rules for Type IV-B to allow exposed portions of mass timber are too complex

Response:

The exposed timber percentages were derived directly from the ATF tests. Please note that the equations are new, but rather simple. The calculations are no more complex than the allowable area formulas or other formulas that are presented already in the code. There is a simple percentage to apply (either 20% for ceiling, or 40% for wall), and then a ratio formula that ensures multiple small exposed portions does not exceed the limits provided from the percentage method. After working with the formulas, it was clear that, after some initial learning curve, design professionals assigned to design and review projects would be comfortable with applying the formulas.

Concern 12

The fire testing was for a residential use scenario, so there is no basis for heights and areas proposed for other occupancies, such as F, H, M, and S.

Response:

It is unreasonable to expect a separate test for each separate occupancy. The committee conducted the testing for the most likely of the occupancy use groups, being the residential scenario. To pivot from the residential test to other occupancies, the committee depends on the variable heights and areas that the code provides to distinguish different occupancies. The code already addresses the different hazards associated with different occupancies, by providing less height and/or area for more sensitive and hazardous occupancy use groups.

All of the heights and areas proposed are derived from the existing methodology in the codes. The heights for IV-C are based on the existing heights for IV-HT, with a factor due to increased fire resistance ratings. For Type IV-B, the committee relies on a performance based approach to use the existing heights allowed for Type I-B construction, to provide the heights for Type IV-B. Finally, for Type IV-A, these are also based on the heights of Type I-B, again with a factor to recognize the increased fire resistance ratings. All area allowances are based on the existing Type IV-HT areas. Since the proposed construction types are based on the existing heights and areas from the code, and since the existing heights and areas are already variable in order to accommodate the varying types of construction, the proposed height and area tables already address the variable hazards of occupancies for these new construction types.

Concern 13

There is concern that fire-resistance protection of connections is not fully addressed.

Response:

Please note that existing code requirements already require that fire resistance rating encasement must include the entire primary structural member be protected, including the connections (IBC Section 704). The wood design standard (Section 16.3 of the National Design Specification) also requires the connections be protected to the same degree as the structural members. This is the requirement for current construction types, and would also apply to the new Type IV construction types proposed. While not a specific new proposal from the committee, the committee determined that the existing code provided clear guidance regarding protection of connections. It is expected that during design and review, the details for each type of connection will be in conformance with the code requirements, as is currently done for existing construction types.

Concern 14

Concern about seismic areas and the reliability of water supply.

Response:

This is handled by current code provisions in IBC Section 403. The same provisions that address this issue for existing construction types of high-rise heights, will apply to the new Type IV construction types that are high-rise. This means that the secondary water supply requirements for high-rise buildings in specific seismic zones will apply to tall wood buildings as well. Also, as noted in a previous response, the committee proposed a specific code proposal in order to provide two means of water supply to a building. Normally, this code requirement is only applied to buildings with height exceeding 420 feet. For tall wood buildings, the committee proposed requiring the redundant water supplies at a height of 120 feet, which is specifically more conservative than other construction types.

Concern 15

There is concern that the proposal for the performance approach for noncombustible protection is too simple, and has concerns about comparing tests from different time frames

Response:

Comparative testing to determine component fire resistance is the basis of many figures provided in the code. The performance based proposal uses standard tests familiar to many recognized test laboratories. The use of standard test procedures is essential to ensure that tests at different locations and time frames can be compared.

Concern 16

In the proposal for construction fire safety, there is a need to assure that the fire code official, in addition to the fire chief, is referenced when determining the required water supply

Response:

The committee has committed to looking at the code proposal again with the purpose of developing a public comment to address this comment.