Regulatory Frames…IBC

Issues affecting superstructure

Professionals & Codes

- Professionals are licensed with a societal trust to ***protect the health safety and welfare of the general public***
- To fulfill this public trust, builders, architects, engineers and building officials have developed performance guidelines for meeting life safety obligations in the design and construction of buildings

Codes…for every region

- UBC - The uniform building code, published by the International Conference of Building Officials
- BOCA - The BOCA code, published by the Building Officials Code Administrators
- SBCCI - Southern Building Code Congress International
- These are mostly superceded at this time

A Unified Code

- IBC 2000 - Written by BOCA, ICBO & SBCCI will begin to be adopted during the year 2000, will resolve some of the regional code differences & conflicts….except for..
- NFPA - National Fire Protection Administrators, authors of the fire code used in most government funded projects.

The general idea of codes

- Keep the building's life safety infrastructure intact long enough to evacuate the building's occupants and allow fire fighters a relatively safe environment to fight the fire…(limit collapse during firefighting)

Key Strategies of the Code

- The ***taller*** a building is, the longer it's construction has to survive a fire…(to give occupants time to climb down a stair, In the first World Trade Center bombing, it took occupants over ***three hours*** to walk down 100 or so stories!)
- The ***bigger*** a building is in area, the longer it's construction has to survive a fire…(to give occupants time to make their ways to exits and evacuate the building)

Key Strategies of the Code..2

- The less ambulatory the occupants are, the better the longer the building's life safety infrastructure has to survive intact in a fire. So Hospitals, Nursing homes, Asylums, prisons, where the occupants are not free or not able to walk out of the building must be built to ***survive longer*** in a fire.

Implications

- This means the better a building is built, the bigger and taller it can be… or that it can be used for less ambulatory people.
- Generally the code considers building construction as falling into two general categories, Combustible (can burn) and Non-Combustible (can't burn)

Process

- Most codes follow a similar process, asking the designer to
  - First categorize the kind of use planned for the building into and OCCUPANCY type.
  - Next categorize the CONSTRUCTION type planned to meet the height, and area given by the project's program, site, and conceptual design
  - Next specify the quality of the construction in the number of HOURS each assembly will survive during a fire, based on approved tests (U.L., Factory Mutual….)

Allowable Height & Area table

- Most codes will have a table or matrix listing the occupancy type on the left, and asking the designer to read across to the right to match up the height and area allowed for that occupancy with the projects programmatic requirements.

Height & Area table

Area per floor

		Non-combustible						Combustible		
Height (feet)		Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Group	H / A	UL	160'	65'	55'	65'	55'	65'	50'	40'
A1	H	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
B	H	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000

•So in this example, a type B occupancy, with a design program requiring 40,000 square feet on a site small enough to require a 4 story building could be built like a type IV HT building.

•If we only considered area per floor, the type V-A would work allowing up to 18,000 square feet per floor….but type V-A is limited to 3 floors in height so, we move left to the next construction type, type IV-HT….but being heavy timber, its not so useful for the office building, we move over to the left one more and find type III-B which is big enough per floor, and allows 4 floors. So we work to type III - B requirements.

Let's see that again..

		Non-combustible						Combustible		
Height (feet)		Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Group	H / A	UL	160'	65'	55'	65'	55'	65'	50'	40'
A1	H	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
B	H	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000

•First, we look at the concept for the office building, in this case the program calls for 40,000 s.f. and the site is driving a 4 story concept.

•Next we look at the type 'B' occupancy for office building

Step two...

		Non-combustible						Combustible		
Height (feet)		Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Group	H / A	UL	160'	65'	55'	65'	55'	65'	50'	40'
A1	H	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
B	H	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000

•Next, knowing the building will be 4 story and 40,000 square feet, we know it is 10,000 square feet per floor.

•Checking the 'A' row in the 'B' occupancy we find that type V - A allows 18,000 s.f. per floor, plenty for our application

Step three...

		Non-combustible						Combustible		
Height (feet)		Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Group	H / A	UL	160'	65'	55'	65'	55'	65'	50'	40'
A1	H	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
B	H	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000

•Now we check the allowable height for Type V - A and find that it allows 3 stories….not enough for our project.

•So we keep looking...

Step Four

		Non-combustible						Combustible		
Height (feet)		Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Group	H / A	UL	160'	65'	55'	65'	55'	65'	50'	40'
A1	H	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
B	H	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000

- We move to the left (the direction of more fire resistive construction) and find type IV-HT allows enough area per floor (36,000) s.f. and enough height (5 stories)
- But the HT behind the Type IV designation means we would have to build out of heavy timber, which limits materials, opportunity for systems integration, and acoustical qualities in order to preserve the fire resistive nature of Heavy Timber construction.

- So we keep looking….

Step Five

		Non-combustible						Combustible		
Height (feet)		Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Group	H / A	UL	160'	65'	55'	65'	55'	65'	50'	40'
A1	H	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
B	H	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000

- Again we move to the left (the direction of more fire resistive construction) and find type III - B allows enough area per floor (19,000) s.f. and enough height (4 stories)

- So Type III - B is our Construction Type for construction for the project.

The lowest construction type allowed

		Non-combustible						Combustible		
Height (feet)		Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Group	H / A	UL	160'	65'	55'	65'	55'	65'	50'	40'
A1	H	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
B	H	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	23,500	19,000	36,000	18,000	9,000

It is common to work the project into the lowest allowable construction type when the architectural idea does not drive the selection of the superstructure. This reduces cost and provides a little more detailing flexibility during design development

What does it mean????

- So it looks like Type III - B will work for us. What does that mean in terms of the materials for beams, columns, walls, roofs, partitions and the fire protection of each?

- In the IBC, Table 601 describes the fire resistance ratings (in hours) for each building element.

Ratings for construction types

Building Element	Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Structural Frame (incl col. girders, trusses)	3	2	1	0	1	0	HT	1	0
Bearing walls int. Bearing walls ext.	3 3	2 2	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Non-Bearing Walls / partitions	SEE	TABLE	602	AND	SECTION	603			
Floor construction Including supporting beams & joists	2	2	1	0	1	0	HT	1	0
Roof construction Including supporting beams and joists	1-1/2	1	1	0	1	0	HT	1	0

- This table gives the required ratings for each construction element.
- A building is rated by its weakest element! So even if the structural frame was poured concrete (type 1 construction) if the floor was not protected, the weakness of the floor in fire would drag the whole building down to a type IIB, IIIB or VB. (where it may be too big, too tall, or the wrong occupancy to pass inspection!)

Ratings for construction types

Building Element	Type I A	Type I B	Type II A	Type II B	Type III A	Type III B	Type IV HT	Type V A	Type V B
Structural Frame (incl col. girders, trusses)	3	2	1	0	1	0	HT	1	0
Bearing walls int. Bearing walls ext.	3 3	2 2	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Non-Bearing Walls / partitions	SEE	TABLE	602	AND	SECTION	603			
Floor construction Including supporting beams & joists	2	2	1	0	1	0	HT	1	0
Roof construction Including supporting beams and joists	1-1/2	1	1	0	1	0	HT	1	0

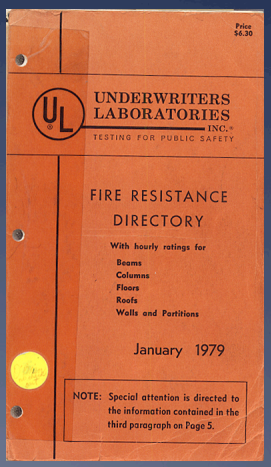
- Now that we have a construction type selected (III B), we need to determine the required fire protection ratings for each element.
- Our Type III - B construction shows 0 hours of protection required for every building element except interior bearing walls

Ethics, Morals, Conscience

- So, not having a required rating for many of the building components is good news and bad news.
- Good news because all we have to do is maintain noncombustibility and we meet the code.
- Bad news because we know that the building structure can fail pretty quickly during a fire. Steel begins seriously losing strength at 1200 degrees, and most fires hit 1600 degrees in the first 10 minutes!
- So what to do, It's not hard to protect the steel with a layer of drywall, and even though it's not required, it will help the columns and trusses last longer.
- Sprinkling can many times give the owner a reduced insurance rate that can offset the cost of the system over the life of the mortgage.

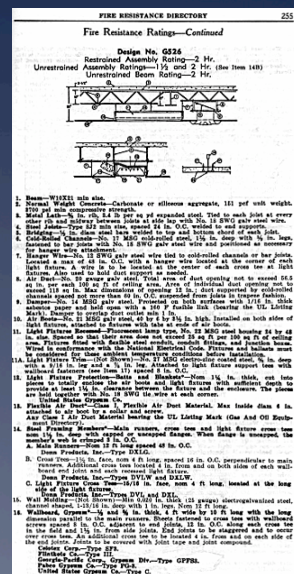
What makes a rating?

- The hours of protection offered by fire protecting materials to building elelments have been established by full scale fire testing of various component assemblies by testing labs like UL, or Factory Mutual.



Testing to failure

- A testing lab like U.L. will construct a full scale assembly to the manufacturer's (who pays for the test) specification.
- Then U.L. will expose it to fire on one side, recording temperature, deformation, smoke contribution, while loading the assembly to its design load, until it fails.
- U.L. reports the performance in its fire resistance handbook.



FIRE RESISTANCE DIRECTORY 255

Fire Resistance Ratings—*Continued*

Design No. G526
Restrained Assembly Rating—2 Hr.
Unrestrained Assembly Ratings—1½ and 2 Hr. (See Item 14B)
Unrestrained Beam Rating—2 Hr.

1. **Beam**—W10X21 min size.
2. **Normal Weight Concrete**—Carbonate or siliceous aggregate, 151 pcf unit weight. 2700 psi min compressive strength.
3. **Metal Lath**—⅜ in. rib, 3.4 lb per sq yd expanded steel. Tied to each joist at every other rib and midway between joists at side lap with No. 18 SWG galv steel wire.
4. **Steel Joists**—Type 8J2 min size, spaced 24 in. O.C. welded to end supports.
5. **Bridging**—½ in. diam steel bars welded to top and bottom chord of each joist.
6. **Cold-Rolled Channels**—No. 17 MSG cold-rolled steel, 1½ in. deep with ½ in. legs, fastened to bar joists with No. 18 SWG galv steel wire and positioned as necessary for hanger wire attachment.
7. **Hanger Wire**—No. 12 SWG galv steel wire tied to cold-rolled channels or bar joists. Located a max of 48 in. O.C. with a hanger wire located at the corner of each light fixture. A wire is to be located at the center of each cross tee at light fixtures. Also used to hold duct support as needed.
8. **Air Duct**—No. 20 gauge galv steel. Total area of duct opening not to exceed 56.5 sq in. per each 100 sq ft of ceiling area. Area of individual duct opening not to exceed 118 sq in. Max dimensions of opening 12 in.; duct supported by cold-rolled channels spaced not more than 60 in. O.C. suspended from joists in trapeze fashion.
9. **Damper**—No. 14 MSG galv steel. Protected on both surfaces with 1/16 in. thick asbestos paper and held open with a 160 F fusible link (bearing the UL Listing Mark). Damper to overlap duct outlet min 1 in.
10. **Air Boots**—No. 21 MSG galv steel, 40 by 6 by 3½ in. high. Installed on both sides of light fixtures, attached to fixtures with tabs at ends of air boots.
11. **Light Fixtures Recessed**—Fluorescent lamp type, No. 22 MSG steel housing 24 by 48 in. size. Spaced so that their area does not exceed 25 sq ft per 100 sq ft of ceiling area. Fixtures fitted with flexible steel conduit, conduit fittings, and junction boxes. Wired in conformance with the National Electrical Code. Fixtures and ballasts must be considered for these ambient temperature conditions before installation.

11A. **Light Fixture Trim**—(Not Shown)—No. 27 MSG electro-zinc coated steel, ⅝ in. deep with a 9/16 in. leg and a ⅞ in. leg. Attached to light fixture support tees with wallboard fasteners (see Item 17) spaced 8 in. O.C.

12. **Light Fixture Protection—Batts and Blankets***—Nom 1¼ in. thick, cut into pieces to totally enclose the air boots and light fixtures with sufficient depth to provide at least 1½ in. clearance between the fixture and the enclosure. The pieces are held together with No. 18 SWG tie wire at each corner.
    United States Gypsum Co.
13. **Flexible Air Duct***—Class I, Flexible Air Duct Material. Max inside diam 6 in. attached to air boot by a collar and screw.
    Any Class I Air Duct Material bearing the UL Listing Mark (Gas And Oil Equipment Directory).
14. **Steel Framing Members***—Main runners, cross tees and light fixture cross tees nom 1½ in. deep with capped or uncapped flanges. When flange is uncapped, the member's web is crimped 3 in. O.C.
    A. Main Runners—Nom 12 ft long spaced 48 in. O.C.
       Donn Products, Inc.—Type DXLG.
    B. Cross Tees—1½ in. face, nom 4 ft long, spaced 16 in. O.C. perpendicular to main runners. Additional cross tees located 4 in. from and on both sides of each wallboard end joint and each recessed light fixture.
       Donn Products, Inc.—Types DVLW and DXLW.
    C. Light Fixture Cross Tees—15/16 in. face, nom 4 ft long, located at the long side of the light fixtures.
       Donn Products, Inc.—Types DVL and DXL.
15. **Wall Molding**—(Not Shown)—Min 0.020 in. thick (25 gauge) electrogalvanized steel, channel shaped, 1-13/16 in. deep with 1 in. legs. Nom 12 ft long.
16. **Wallboard, Gypsum***—½ and ⅝ in. thick, 4 ft wide by 10 ft long with the long dimension parallel to the main runners. Sheets fastened to cross tees with wallboard screws spaced 8 in. O.C. adjacent to end joints, 12 in. O.C. along each cross tee in the field and 1½ in. from side joints. End joints to be staggered and to occur over cross tees. An additional cross tee to be located 4 in. from and on each side of the end joints. Joints to be covered with joint tape and joint compound.
    Celotex Corp.—Type SF3.
    Flintkote Co.—Type III.
    Georgia-Pacific Corp., Gypsum Div.—Type GPFS3.
    Pabco Gypsum Co.—Type PG-3.
    United States Gypsum Co.—Type C.

Specifying

- The tested assemblies are then available for specifying by architects and engineers.
- These specifications are ***very*** specific, U.L. records the kinds of screws, any wire ties, and all products in the assembly.
- It is the position of U.L. that any change in the specification would mean an unpredictable level of performance in the field.
- So what is specified must be what's built…but isn't always.

Specifics on Systems & Materials

- As we review different construction systems and materials we will make special note of the code's expectations for the performance of those materials….and how the design & construction industry meet the performance requirements.