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Structural Option
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110 Third Avenue
110 Third Avenue
New York, NY 10003
10/5/05

Structural Technical Report 2

Pro-Con Structural Study of Alternate Floor Systems

1.1 Executive Summary

This report examines the existing loading conditions present in 110 Third Avenue and the appropriateness of the floor system that resists gravity loads. It also proposes four alternate floor systems to compare and contrast them to the existing system. Each system is examined for cost, constructability and conduciveness to use in a residential mid-rise setting. The current system uses an 8" flat plate CIP concrete system. Several advantages in using a flat plate system make it a convenient and cost effective system, as explored in the following report.

The four systems proposed in the report are a skip joist system, precast hollow core slab system, flat slab with drop panels system, and a steel system using composite decking. Note the steel system was examined in order to explore the use of an alternate material as the dominant structural support. Each system could be applied to 110 Third Avenue with little difficulty, but only two were effective alternatives. A skip joist system was disqualified because of the large increase in overall depth of the floor system that would be necessary. In addition, a skip joist system would be more appropriate for larger spans as the formwork costs would greatly offset any other advantages it presents. The hollow core precast slabs were a good alternative, although they would require the addition of beams throughout the floor for support. The system would maintain an 8" depth throughout the floor except along column lines where beams are located. This system should continue to be examined. A flat slab system with drop panel is also a viable system for use in 110 Third Avenue. It reduces overall depth of slab while resisting punching shear, thus saving costs (except with respect to formwork) while maintaining structural capacity. Depth of the flat slab system only increases existing depth by .75" per floor. Therefore, the flat slab system with drop panels should be examined in the future. Finally, the steel system is too deep for use in 110 Third Avenue, because it would require the loss of a floor of apartments. It should not be considered further.

1.2 Scope

The scope of this structural technical report includes a description of the existing floor system and an examination of four alternate floor systems. These alternate floor systems aim to examine the possibility of a structurally superior, more cost efficient, or better designed system than the one already in place. The report will also detail an alternate floor system that uses a completely different material. In the case of 110 Third Avenue, this alternate material is steel. After investigating the four floor systems, a conclusion is drawn about each system's plausibility in terms of pros and cons. Finally, a summary chart and discussion follows to tie all systems together.

1.3 Introduction

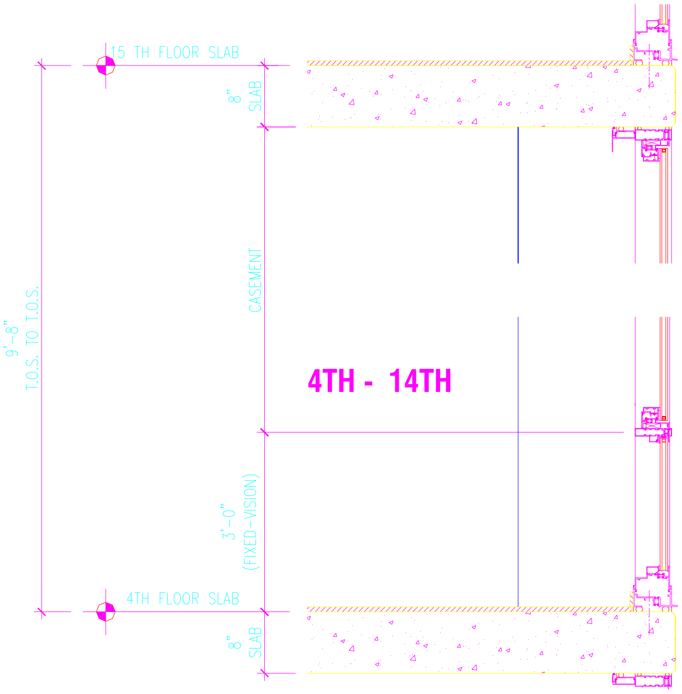
110 Third Avenue is a residential mid-rise tower that sits in the heart of Manhattan between Gramercy and East Village. Standing at 210' to the bulkhead slab, it offers 21 stories of mid-sized apartments totaling approximately 107,000 square feet of inhabitable space. The structural system of 110 Third Avenue is predominantly cast-in-place concrete. Most floors have an 8" CIP slab, but beginning with floor 15 the slab increases to as much as 24" to support cantilevered portions of the building and mechanical equipment on the roof. All slabs and columns have $f'_c = 5000$ psi. Loads are carried from the two-way slab system to concrete columns ranging from 12x12 to 40x12. The columns are continuous throughout the height of the building except for a few columns that terminate at floor 16 due to a setback in the building perimeter, and a few columns that originate on the drawings at floor 11 due to the reduction of the elevator core to column-sized portions. Footings range from 4'6" square up to 15' x 9'6". The only beams present in the structure are in the basement level and are grade beams extending from perimeter East-face and West-Face footings to the outside wall. Shear walls extend throughout the height of the building and are located mostly on the North and South sides of the building. The roof is a flat slab system that is drained by roof drains nested under pavers. Supporting columns are recessed from the façade on average 10", and therefore allow the designer to use non-bearing prefabricated panels.

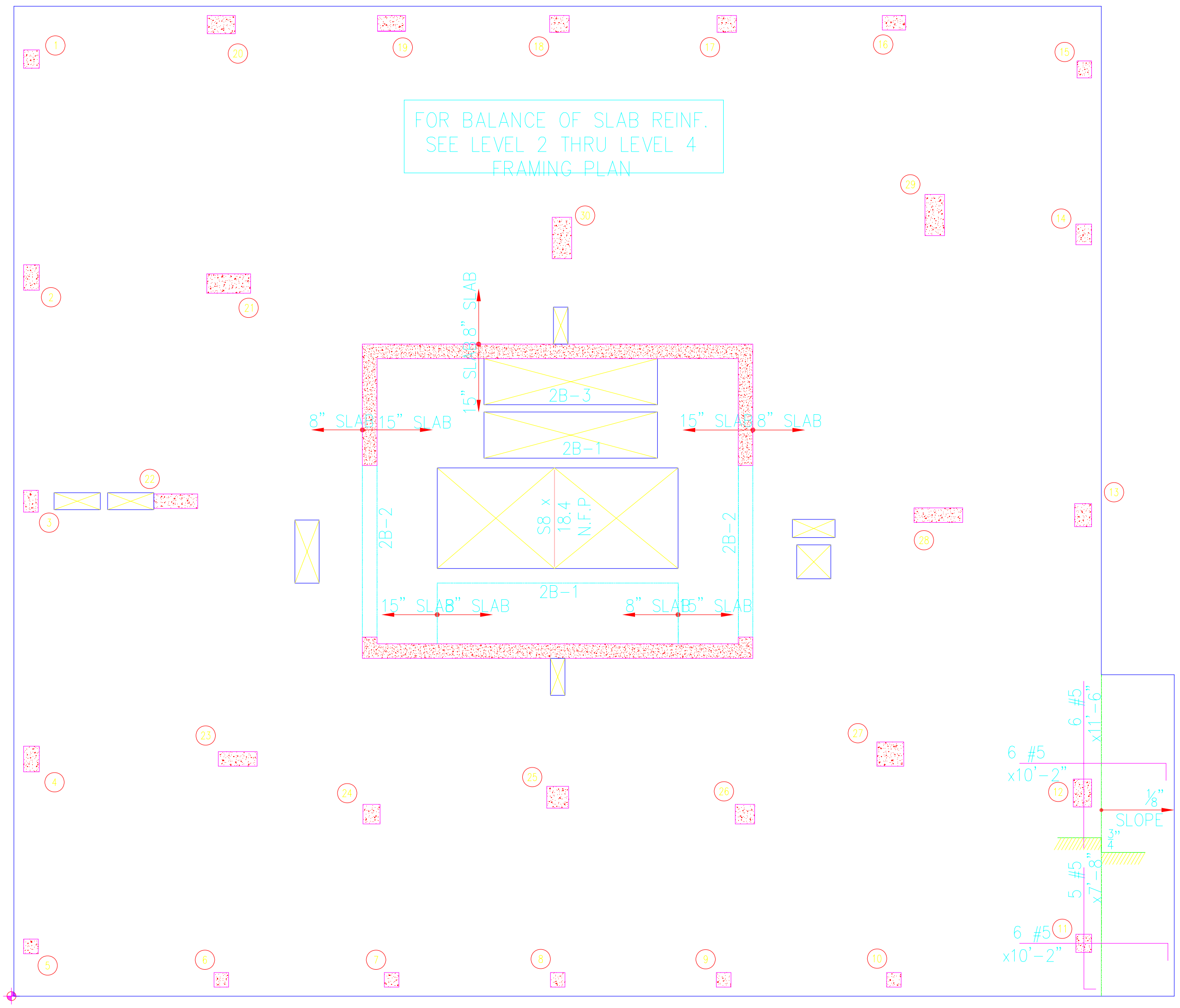
Loading conditions on the vast majority of the building are relatively light due to their use as residential space. A table below provides a complete description of loads according to drawing S.001 provided by Axis Design Group. When factored according to ASCE-07, loading throughout the apartments is only 94 psf. Low loading consequently makes the existing system, the 8" flat plate system, a very good choice in order to maximize space. Most other systems aren't competitive simply because they cannot maintain a depth of only 8".

Floor	Partition	Ceiling & Mech.	Floor Finish	Live	Total Imposed
Lobby	-	5	40	100	145
Apartment	12	-	5	40	65
Roof	-	5	25	30	60
Retail	-	5	15	100	120
Storage	-	5	-	100	105
Stairs	-	-	-	100	100
Private Roof Terrace	-	-	65	60	200
Public Roof Terrace	-	-	65	100	200
Mechanical	-	25	40	150	215
Gym	-	5	15	100	215
Courtyard	-	-	65	60	215

1.4 Existing Structural Floor System

110 Third Avenue is completely a flat plate system with columns roughly sorted into a 7x5 element bay. The building extends 68’ in the North-South direction (5 columns) and 75’ in the East-West direction (7 columns). A flat plate system supports the loads placed on the building and directly transfers the loading to the columns. No drop panels assist in the distribution of weight or add to the building’s resistance to punching shear. A central shear wall system centered around the elevator core provides lateral stability and resistance to wind and seismic loading.





Typical Floor Plan for Floors 5 through 10, other floors are very similar

Design weight of floor framing is 8" thick concrete flat plate slab at 100 PSF (S-001) A typical flat plate slab system serves the entirety of 110 Third Avenue, with a typical slab thickness of 8". Slab size increases around the elevator core to 15", and increases to 24" near the elevator core on the roof level to support mechanical equipment. Slabs are continued, in portions of each floor, past the perimeter to form balconies. The balconies have a ¾" step down from the 8" slab that makes up the entire interior space, and are therefore 7 ¼ in. thick. The flat plate slab is a great approach to a mid-rise residential tower because it saves on formwork and labor costs. All slabs are 5000 psi concrete.

Additionally, please note there is a height restriction on 110 Third Avenue limiting the overall height from grade to bulkhead floor slab to 210'. 110 Third Avenue now stands at this 210' and has no additional room to increase height. The only ways to accommodate any additional height in the redesigned floor system would be to subtract from the habitable area’s height or apply for a variance from zoning regulations that limit 110 Third Avenue.

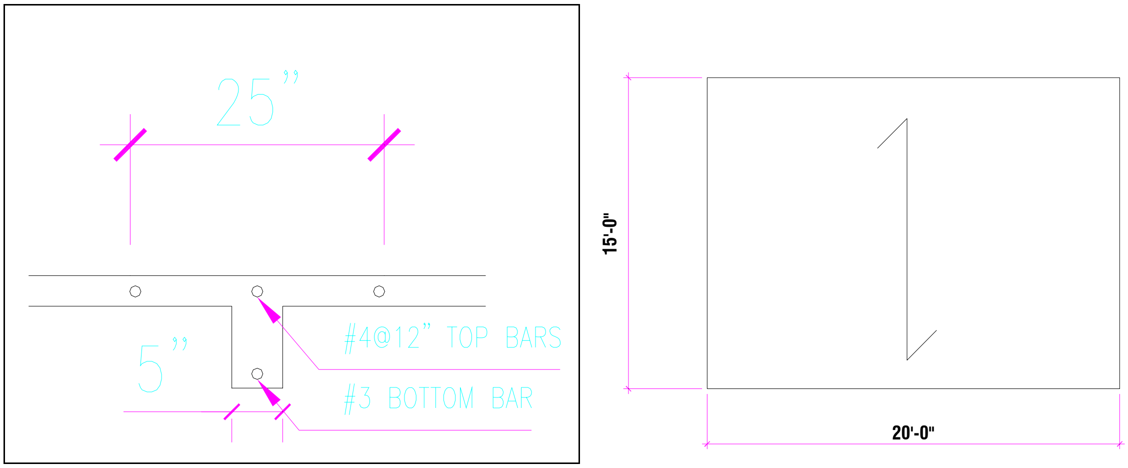
2.1 Alternate System #1: Skip Joist System

Two analyses of possible skip joist systems were performed to find the most appropriate one for 110 Third Avenue employing the use of two different column and floor layouts. Skip Joist System #1 uses the current bay sizes (about 15’ x 20’, conservatively), while Skip Joist System #2 uses a larger bay size (22’-1” x 24’-5”, typical).

2.1.1 Skip Joist System #1

Skip Joist System #1: 15’ x 20’ Bay using existing floor plan

20” Forms + 5” rib @ 25” c-c
w/ #4@12” Top Bars and #3 Bottom Bar
8” Deep Rib + 3” Deep Top Slab = 11” Total Depth

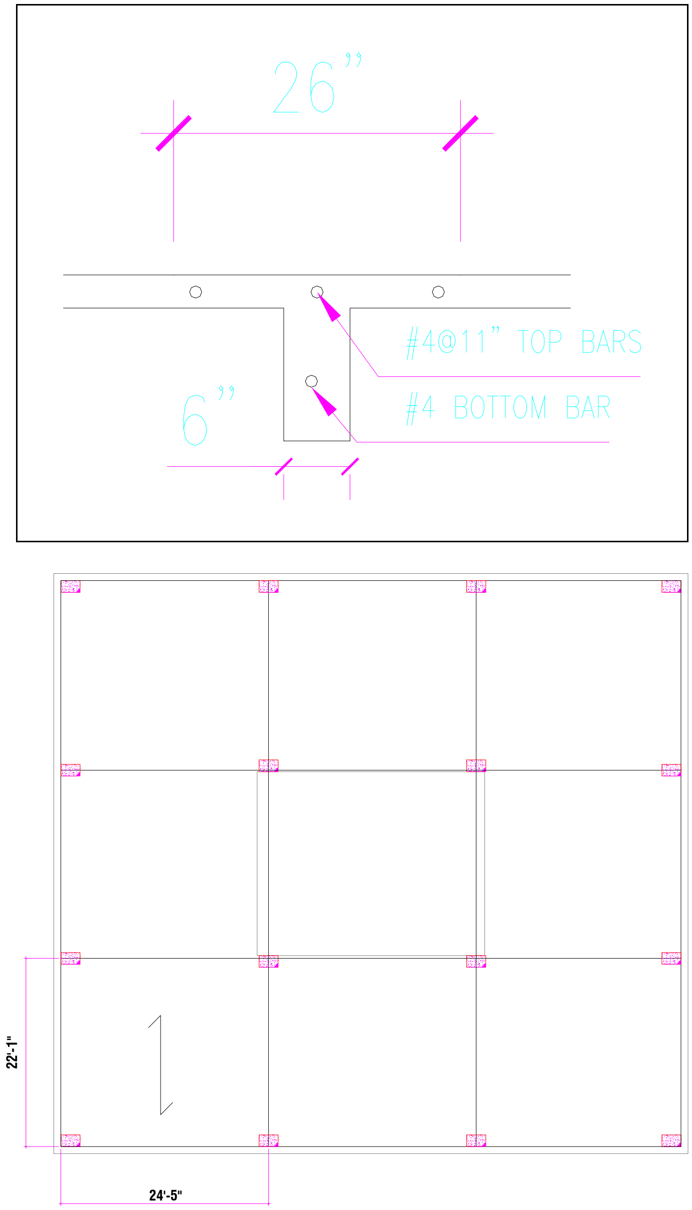


Skip Joist System #1

2.1.2 Skip Joist System #2

Skip Joist System #2: 22’-1” x 24’-5” Bay using modified floor plan

20” Forms + 6” rib @ 26” c-c
w/ #4@11” Top Bars and #4 Bottom Bar
12” Deep Rib + 3” Top Slab = 15” Total Depth



Skip Joist System #2

The above skip joist systems were designed using the 2002 version of the CRSI manual, which uses 4000 psi concrete. One can either assume that design using 4000 psi concrete applied to a 5000 psi floor slab system will be conservative, or redesign the columns to also be 4000 psi. Making the columns 4000 psi will increase their overall size, but will allow the system to be cast monolithically if the floor is also assumed to be 4000 psi. For the purposes of this report, assume the floor slab and columns will remain 5000 psi, and therefore the design is conservative.

The two systems listed above are well oversized for their intended use, simply because skip joist systems can't be applied to small bay sizes. This simple fact detracts from the attractiveness of this system. The increase of overall depth, wasted concrete due to oversizing, and more complicated formwork will basically render this system non-competitive. Even though the second system is more practical because it uses larger bay sizes, it will increase the floor depth from the current 8” to 15”. The increase in floor depth will also eliminate one floor from the final design, because of the 210’ height restriction.

2.2 Alternate System #2: Precast Hollow Core Slabs

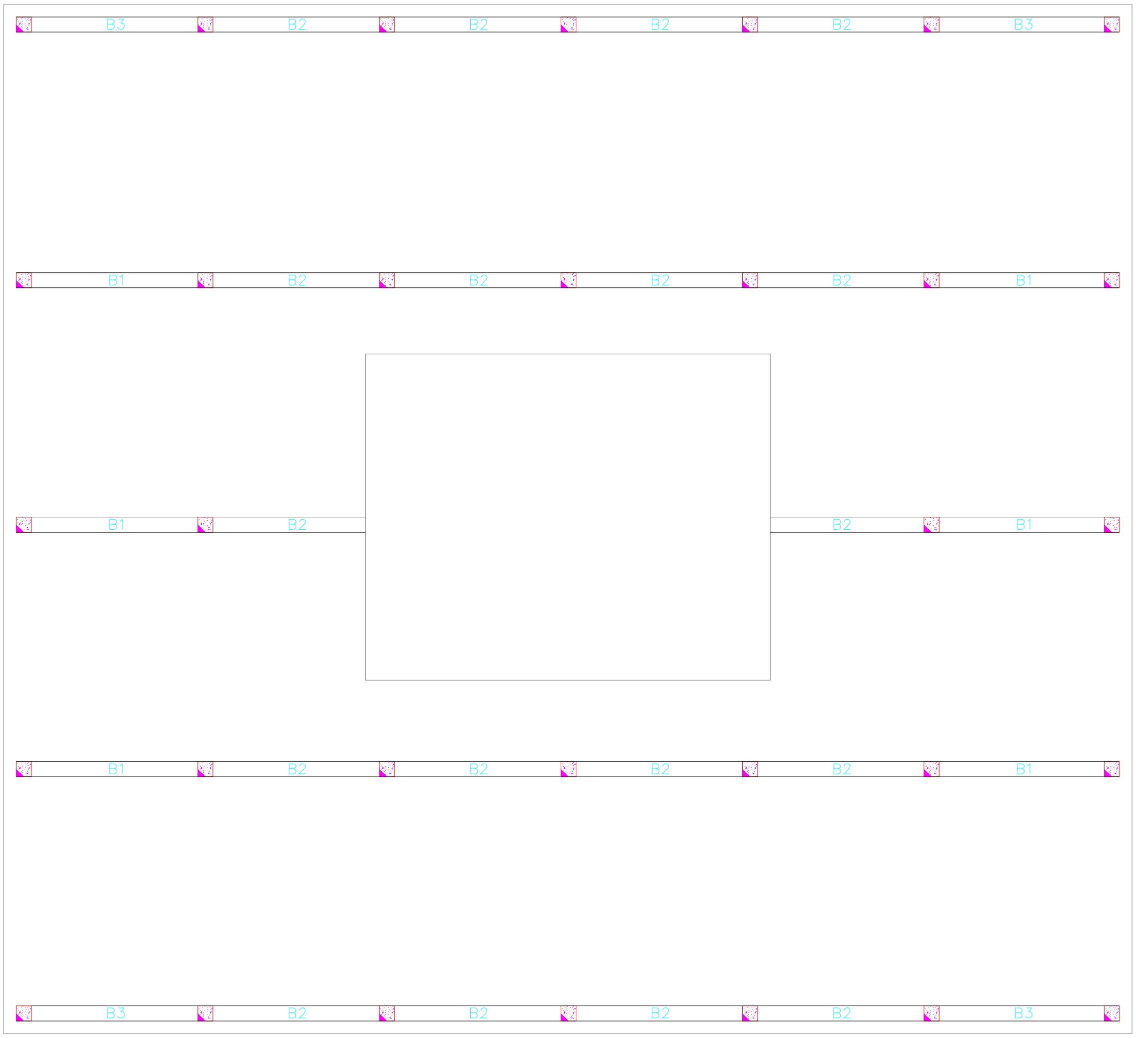
110 Third Avenue is a building that has unique challenges when switching floor systems, as can be seen when trying to apply any floor system that depends on regular bay sizes. In the case of precast hollow core slabs, the entire floor system, including the columns, has to be overhauled in order for the building to function as a whole. Therefore, assume that the typical floor plan of 110 Third Avenue is adjusted to contain regular bay sizes instead of irregular bays with irregular columns. See the included drawings for a typical bay and floor plan for this new system. The new system may adversely affect the architecture by normalizing the bays to accommodate the insertion of beams, however.

The precast hollow core slabs, like the skip joists of the last system, are oversized for the typical superimposed loads on an apartment unit. However, they are only a total of 8” thick including the 2” topping. Additionally, it was necessary to have the planks span the long direction of the bay (16’), because a 12’ span was too small to be listed in the CRSI tables. The final design for these planks is as follows:

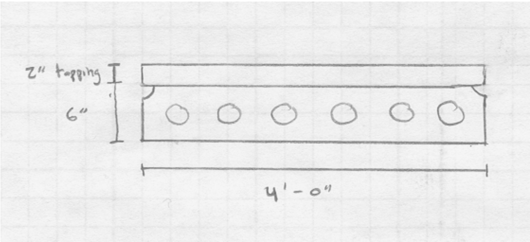
Hollow Core Plank System: 12’ x 16’ bays, typical

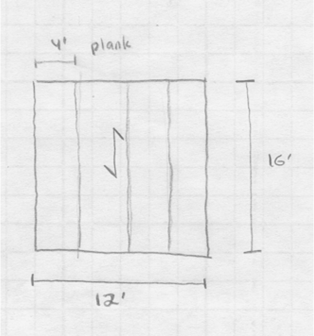
4’-0” x 6” Normal Weight Concrete, 4HC6+2
w/ 2” normal weight topping, 66-S Strands
0.2” camber, f'_c= 5000 psi

The Hollow Core Precast plank system also required the installment of additional interior and exterior beams for support. The addition of these beams increases the depth of the system in beam locations by an additional 12 inches. Provided the architects could adjust for interior beams in certain locations, this system would be a viable one to investigate further. All beams, interior and exterior, are 10” x 12” reinforced concrete. Please see included calculations for reinforcement requirements and beam details.



Precast Hollow Core System showing beam locations

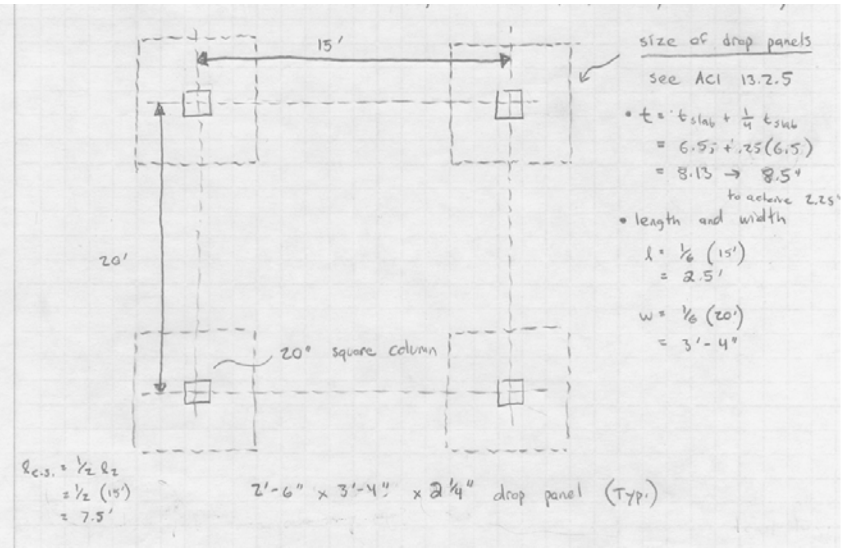




Advantages of this system lie in saving labor costs. CIP labor costs in NYC are high, so a precast system would be cost-effective in this respect. Also, the planks are small enough that moveability and access within the city won't be a problem. Cost issues, however, arise in the fact that the system itself is over-designed. A 6" slab depth is usually not an efficient use of funds, because a minimum depth of 8” is usually used. The increased load capacity simply adds to cost while not being utilized.

2.3 Alternate System #3: Flab Slab with Drop Panels

The use of a flat slab system with drop panels presents the opportunity to protect against failure modes such as punching shear while reducing slab thickness. The use of a thinner slab throughout a larger portion of the building will reduce overall concrete costs, but may lead to higher formwork costs. The analysis provided in this report of a flat slab system using drop panels produced an overall reduction in slab thickness from 8” to 6 ¼” due to the nature of the small bays throughout 110 Third Avenue. Upon initial analysis in Tech Report 1, it could be seen that the 8” slab possessed a marginal jump from the 6 ½” slab required by code. Using the size of 6 ½” in this analysis reduces the overall thickness of the slab significantly while only adding ½” thickness to each floor to allow for the insertion of drop panels. An even smaller slab thickness of 6 ¼” also meets minimum requirements, but the awkward size prevents it from being a viable option.



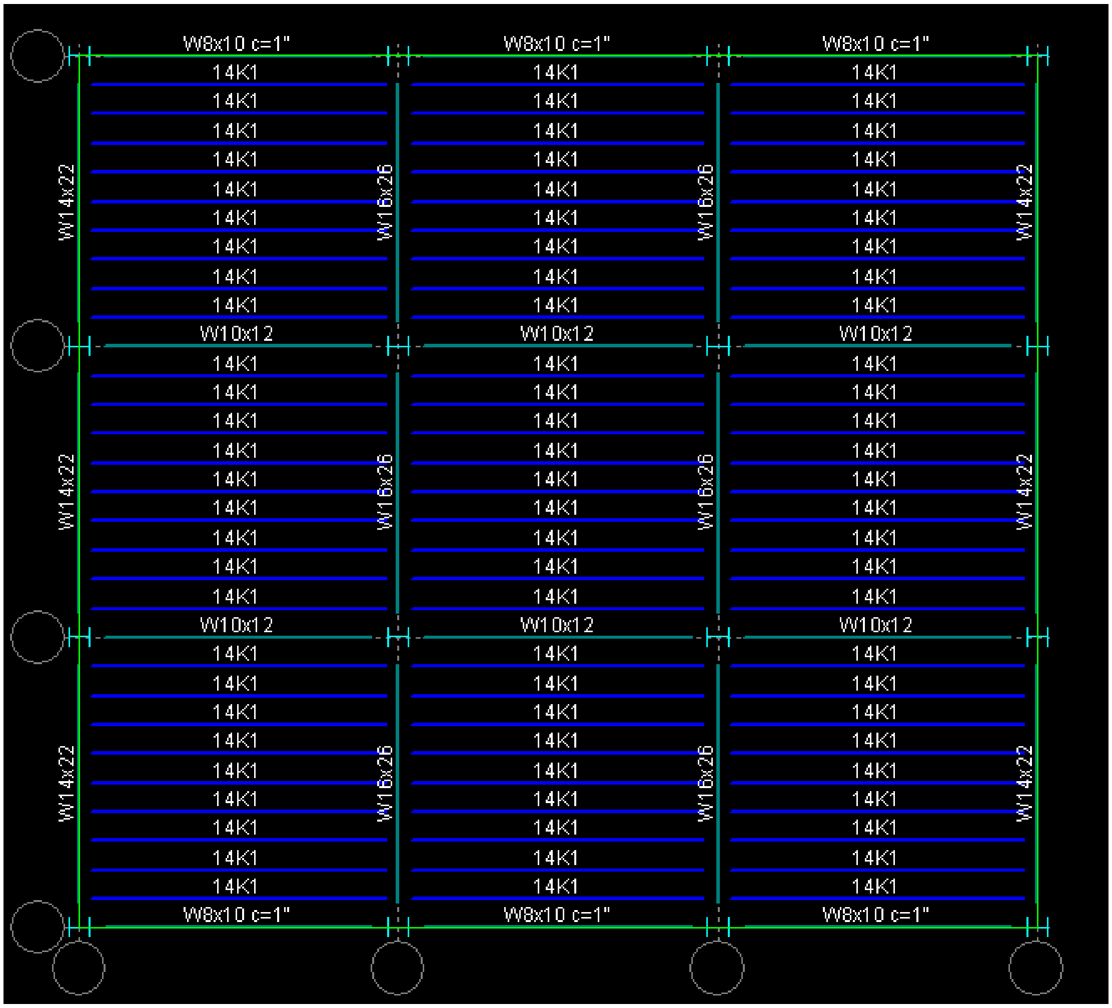
Flat Slab with Drop Panel System: 15’x 20’ bays, conservative

Slab thickness: 6.5”
w/ 2’-6” x 3’-4” x 2 ¼” Drop Panel (Typ.)
#4 @ 12” for midspan and support middle strips
#4 @ 6” for midspan and support column strips

Total depth of the floor system is 6.5” slab + 2.25” drop panel = 8 ¾”, so it will increase floor to floor height by a marginal amount. A reduction in living space of ¾” will probably be a tolerable amount to make this system an option for further study. In addition, the drop panels provide resistance to punching shear.

2.4 Alternate System #4: Steel Design- Girders, Beams, and Joists

The steel system uses composite deck, joists, beams, and girders to support the apartment loading. A steel system, however, has several disadvantages when applied to 110 Third Avenue. First, the system, even though loads are relatively small, has a larger depth than most concrete systems. For example, max sizing of beams/girders below is 16”, so overall depth of the floor system would also include a hung ceiling to cover the fireproofed beams. All other systems examined have a smaller depth, and would therefore be more advantageous. Saving height in order to maximize number of occupied floors is extremely important to the building owner. A steel system simply can’t compete with concrete systems in the same way, especially since bay sizes are small. Upon resizing the bays to an appropriate magnitude for steel beams, we can still see that the overall depth is too large. All analyses involving a steel system used normalized bays that divided 110 Third Avenue into 9 sections. Also, the center core of the building was ignored, because the current system this area as a lateral resisting system in the form of shear walls. Since the steel system will use moment frame or braced frames to resist lateral loads, the center core of the building will change.



3.1 Comparison and Discussion of Proposed Systems

Designer Nathan Shuman put it best when he said “New York City is a market quite unlike any other. A residential building like this will sell for such high prices that the high cost of concrete flat plate is almost irrelevant and always used.” The ease of constructing the existing system, a flat plate system, will lead to a faster erection time and is therefore heavily favored by contractors and owners. The faster they can sell units, the faster they can recoup costs and turn a profit. A skip joist system would take longer to construct and would add depth to each floor. The flat plate only has an 8” structural depth where the steel and skip joist systems require deeper, so there would be one less floor of apartments to sell in order to keep under the height limitations of New York City. In addition, a flat plate system makes for an attractive ceiling in comparison to skip joists and steel. The steel system would require a hung ceiling to cover the steel which requires fireproofing. In the end, the cost of a flat plate system is a little high, but there are more apartments that will be completed sooner and would like nicer as well, therefore making it the best option so far. A flat slab with drop panels is probably the next best option due to its similarity to the flat plate system with the addition of resistance to punching shear through the drop panels. Overall system depth only increases by ¾”, and depth of slab decreases to 6 ½”. This will save on concrete costs by using less concrete in the system. The additional formwork costs to form the drop panels will detract from the overall savings due to using less concrete, but the system costs as a whole are still low enough for it to be a good option.

All the systems examined in this report, except for the steel system, will not impact the use of shear walls as the lateral resisting system. In the case of the steel system, a moment frame or braced frame system would typically serve as the lateral force resisting system. Also, none of the systems will have a significant impact on the foundation system of the building, except the steel system will require a different interface for the concrete footers and steel columns.

A review of the systems explains again why each one is disqualified or kept for future examination…

The skip joist system takes longer to construct, has increased formwork costs, increased floor depth that will lose an occupied floor. On these grounds alone, it is clearly inferior to the flat plate system as well as the other systems examined in this study.

The Precast Hollow Core slabs are the same depth as a flat plate system, but require the addition of beams to support them. Precast slabs can be expensive, although they are easier to erect than a flat plate system, because they require no field shoring. Their ease of mobility would make this system fast to construct, but the use of the system depends upon the architects tolerance of the addition of 12” deep beams along column lines. The system may appear less aesthetically attractive compared to a flat plate system. Costs of erection and manufacture are unforeseen, because they depend on the going prices of labor and concrete precast slabs at the time of construction. This system will prevent the loss of an occupied floor, which is another important benefit. Overall, this system should be further examined for feasibility and compatibility with a residential setting that requires aesthetically pleasing spaces.

The flat slab system with drop panels is a very comparable system to the flat plate. It adds drop panels that subtract from the overall slab depth while adding only ¾” where the drop panels are located. Formwork costs will rise slightly while construction times and ease of construction remain basically the same. More importantly, the building owner will not lose the use of an occupied floor. In addition, the drop panels protect against punching shear. This system will save concrete while keeping other costs, except some formwork costs, basically the same. It should definitely be examined more in depth in the future.

The steel system, while allowing for much larger bay sizes and fewer columns, will require the loss of an occupied floor due to the height restrictions. Cost of steel is also rising, making the system an expensive one. The addition of fireproofing and a hung ceiling increase floor to floor heights significantly, and make construction more complicated. Overall, this system is not cost effective for the size and location of 110 Third Avenue, and should be reserved for different applications. Therefore, disqualify the use of a steel system.

3.2 Comparison Chart

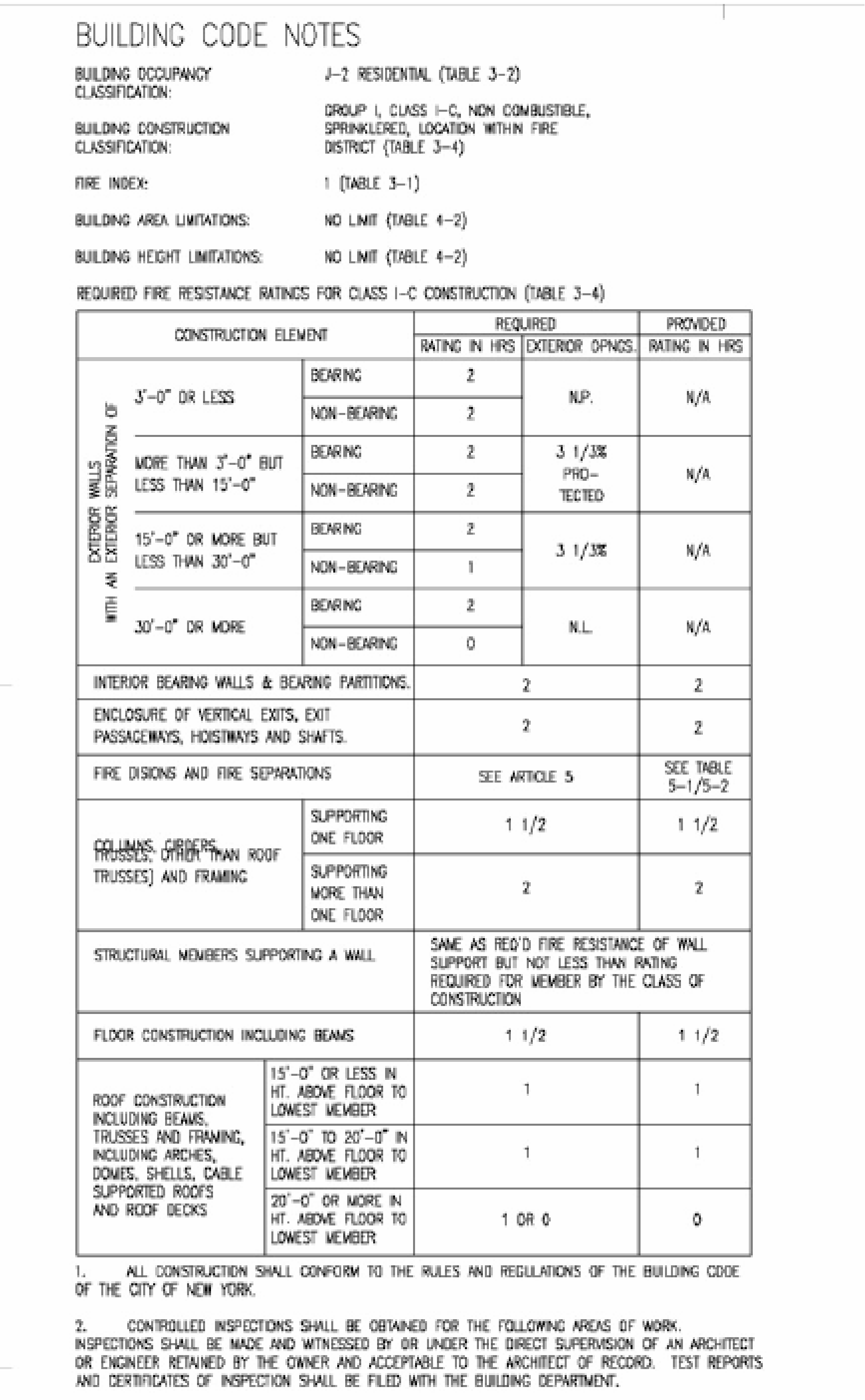
Note: This chart uses a scale of 1-5, 1 being the least and 5 being the greatest.

	Depth	**Difficulty of Construction**	**Time to Construct**	**Cost**	**Examine in the Future?**
Existing	8”	1	2	Medium	-
Skip Joist	15”	3	3	Medium	No
Precast Hollow Core	8” + 12” beams	2	1	Medium	Yes
Flat Slab w/Drop Panels	8.75”	2	2	Medium	Yes
Steel System w/Composite Deck	14-16”	4	3	Expensive	No

3.3 Summary

110 Third Avenue is inherently an ideal situation for the use of a flat plate system, or a system very close to flat plate. The owner wishes to maximize sellable space within the building, and therefore designers must minimize the structural system especially with regard to depth. For this reason, only two of the four alternate systems studied in this report should be considered in the future. First, a skip joist system should be disqualified due to its overall depth. A skip joist system, in general, should be applied to larger spans than are present in 110 Third Avenue. Even with bay resizing, a skip joist system still isn't competitive in terms of cost and ease of construction. Second, a steel system should be disqualified on the basis that it, too, is too large in depth. Also, cost of steel vs. a flat plate system is higher. Finally, a precast hollow core slab system and flat slab with drop panels system can be considered in the future. Both systems maintain a depth close to the existing 8". However, the precast hollow core slab system involves placing extra support beams throughout the floor. Each beam increases the depth of the floor by a substantial amount, and if architects and owner agree that this is a nuisance the system will be disqualified. In addition, a precast hollow core slab system may also be applied to much larger spans than currently exist. Therefore, if it is determined fewer beams than are currently presented in this report are acceptable, than the system will remain plausible. A flat slab system with drop panels, at least for now, appears to be the best alternative for a flat plate system. The reduction in slab depth from 8" to 6.5" will save concrete costs, and the additional formwork necessary to construct drop panels will not be nearly as significant as a skip joist system. Drop panels will add depth to the overall system, 8.75" in drop panel areas instead of 8", but this increase is probably acceptable. For these reasons, both the drop panel system and the precast hollow core slab system should be considered in the future.

Appendix A
Zoning Regulations



BUILDING CODE NOTES

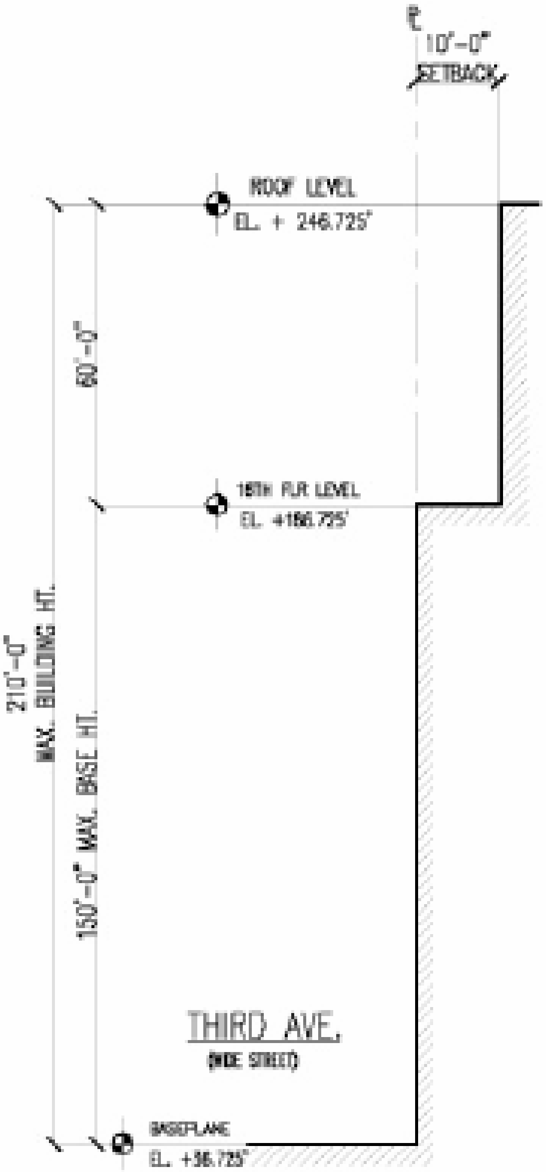
BUILDING OCCUPANCY CLASSIFICATION:	J-2 RESIDENTIAL (TABLE 3-2)
BUILDING CONSTRUCTION CLASSIFICATION:	GROUP I, CLASS I-C, NON COMBUSTIBLE, SPRINKLERED, LOCATION WITHIN FIRE DISTRICT (TABLE 3-4)
FIRE INDEX:	1 (TABLE 3-1)
BUILDING AREA LIMITATIONS:	NO LIMIT (TABLE 4-2)
BUILDING HEIGHT LIMITATIONS:	NO LIMIT (TABLE 4-2)

REQUIRED FIRE RESISTANCE RATINGS FOR CLASS I-C CONSTRUCTION (TABLE 3-4)

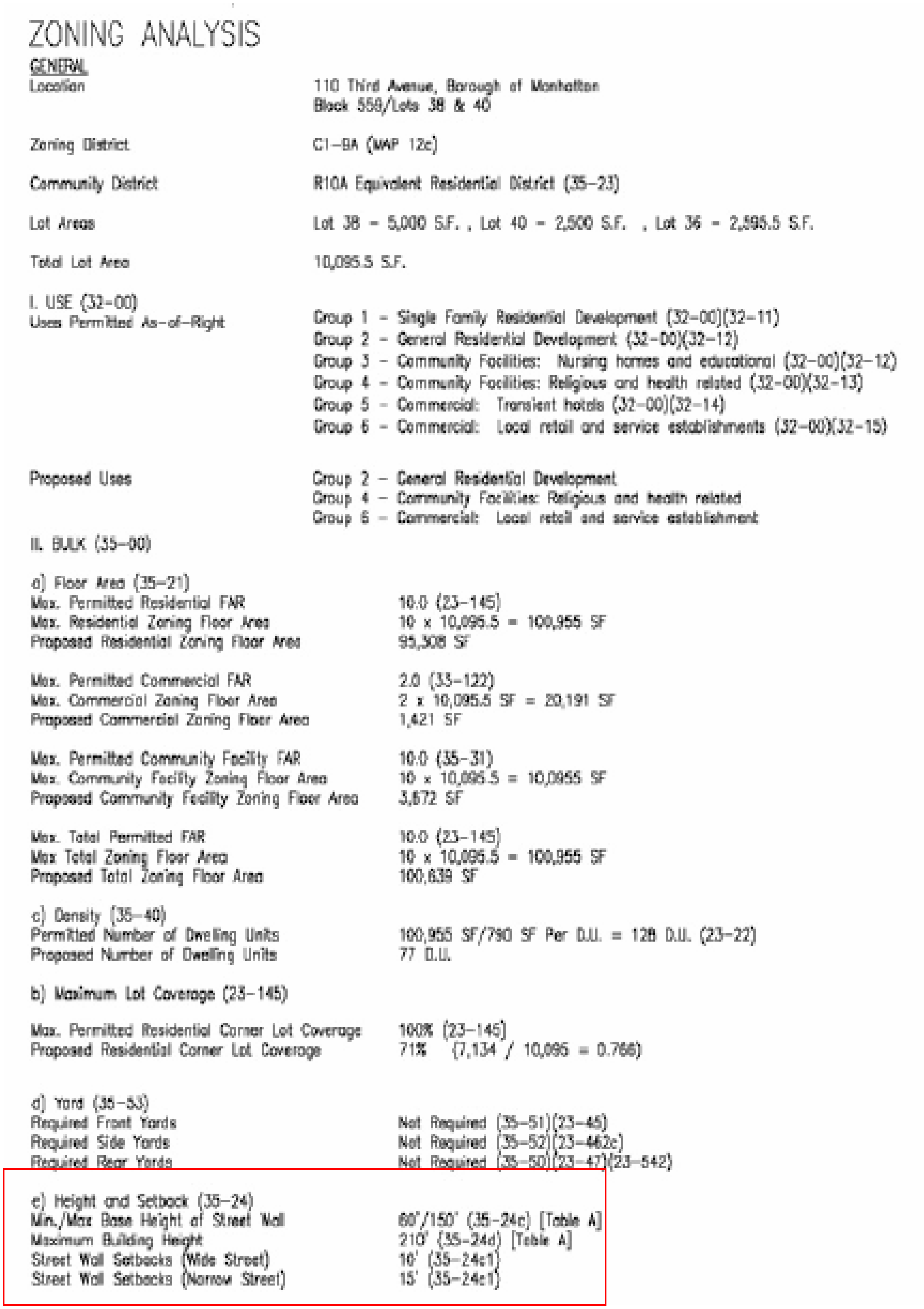
CONSTRUCTION ELEMENT			REQUIRED		PROVIDED
			RATING IN HRS	EXTERIOR OPNGS.	RATING IN HRS
EXTERIOR WALLS WITH AN EXTERIOR SEPARATION OF	3'-0" OR LESS	BEARING	2	N.P.	N/A
		NON-BEARING	2		
	MORE THAN 3'-0" BUT LESS THAN 15'-0"	BEARING	2	3 1/3% PRO-TECTED	N/A
		NON-BEARING	2		
	15'-0" OR MORE BUT LESS THAN 30'-0"	BEARING	2	3 1/3%	N/A
		NON-BEARING	1		
	30'-0" OR MORE	BEARING	2	N.L.	N/A
		NON-BEARING	0		
INTERIOR BEARING WALLS & BEARING PARTITIONS.			2		2
ENCLOSURE OF VERTICAL EXITS, EXIT PASSAGEWAYS, HOISTWAYS AND SHAFTS.			2		2
FIRE DISIONS AND FIRE SEPARATIONS			SEE ARTICLE 5		SEE TABLE 5-1/5-2
COLUMNS, GIRDERS, TRUSSES, OTHER THAN ROOF TRUSSES] AND FRAMING		SUPPORTING ONE FLOOR	1 1/2		1 1/2
		SUPPORTING MORE THAN ONE FLOOR	2		2
STRUCTURAL MEMBERS SUPPORTING A WALL			SAME AS REQ'D FIRE RESISTANCE OF WALL SUPPORT BUT NOT LESS THAN RATING REQUIRED FOR MEMBER BY THE CLASS OF CONSTRUCTION		
FLOOR CONSTRUCTION INCLUDING BEAMS			1 1/2		1 1/2
ROOF CONSTRUCTION INCLUDING BEAMS, TRUSSES AND FRAMING, INCLUDING ARCHES, DOMES, SHELLS, CABLE SUPPORTED ROOFS AND ROOF DECKS		15'-0" OR LESS IN HT. ABOVE FLOOR TO LOWEST MEMBER	1		1
		15'-0" TO 20'-0" IN HT. ABOVE FLOOR TO LOWEST MEMBER	1		1
		20'-0" OR MORE IN HT. ABOVE FLOOR TO LOWEST MEMBER	1 OR 0		0

1. ALL CONSTRUCTION SHALL CONFORM TO THE RULES AND REGULATIONS OF THE BUILDING CODE OF THE CITY OF NEW YORK.

2. CONTROLLED INSPECTIONS SHALL BE OBTAINED FOR THE FOLLOWING AREAS OF WORK. INSPECTIONS SHALL BE MADE AND WITNESSED BY OR UNDER THE DIRECT SUPERVISION OF AN ARCHITECT OR ENGINEER RETAINED BY THE OWNER AND ACCEPTABLE TO THE ARCHITECT OF RECORD. TEST REPORTS AND CERTIFICATES OF INSPECTION SHALL BE FILED WITH THE BUILDING DEPARTMENT.



3 FRONT SETBACK DIAGRAM
NTS



ZONING ANALYSIS

GENERAL

Location	110 Third Avenue, Borough of Manhattan Block 558/Lots 38 & 40
Zoning District	C1-9A (MAP 12c)
Community District	R10A Equivalent Residential District (35-23)
Lot Areas	Lot 38 - 5,000 S.F. , Lot 40 - 2,500 S.F. , Lot 36 - 2,595.5 S.F.
Total Lot Area	10,095.5 S.F.

I. USE (32-00)

Uses Permitted As-of-Right	Group 1 - Single Family Residential Development (32-00)(32-11) Group 2 - General Residential Development (32-00)(32-12) Group 3 - Community Facilities: Nursing homes and educational (32-00)(32-12) Group 4 - Community Facilities: Religious and health related (32-00)(32-13) Group 5 - Commercial: Transient hotels (32-00)(32-14) Group 6 - Commercial: Local retail and service establishments (32-00)(32-15)
Proposed Uses	Group 2 - General Residential Development Group 4 - Community Facilities: Religious and health related Group 6 - Commercial: Local retail and service establishment

II. BULK (35-00)

a) Floor Area (35-21)

Max. Permitted Residential FAR	10.0 (23-145)
Max. Residential Zoning Floor Area	10 x 10,095.5 = 100,955 SF
Proposed Residential Zoning Floor Area	95,308 SF
Max. Permitted Commercial FAR	2.0 (33-122)
Max. Commercial Zoning Floor Area	2 x 10,095.5 SF = 20,191 SF
Proposed Commercial Zoning Floor Area	1,421 SF
Max. Permitted Community Facility FAR	10.0 (35-31)
Max. Community Facility Zoning Floor Area	10 x 10,095.5 = 10,0955 SF
Proposed Community Facility Zoning Floor Area	3,672 SF
Max. Total Permitted FAR	10.0 (23-145)
Max Total Zoning Floor Area	10 x 10,095.5 = 100,955 SF
Proposed Total Zoning Floor Area	100,639 SF

c) Density (35-40)

Permitted Number of Dwelling Units	100,955 SF/790 SF Per D.U. = 128 D.U. (23-22)
Proposed Number of Dwelling Units	77 D.U.

b) Maximum Lot Coverage (23-145)

Max. Permitted Residential Corner Lot Coverage	100% (23-145)
Proposed Residential Corner Lot Coverage	71% (7,134 / 10,096 = 0.766)

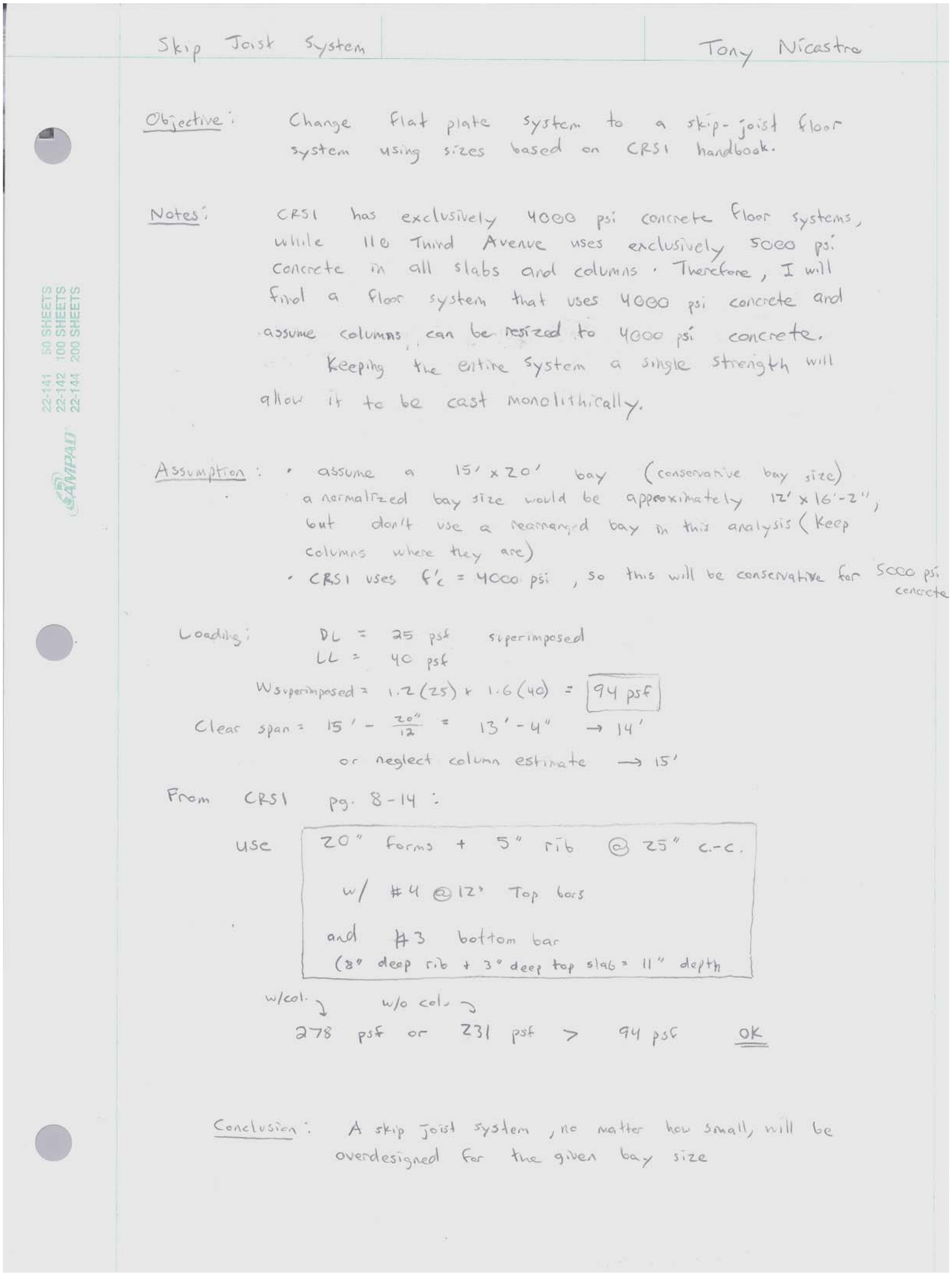
d) Yard (35-53)

Required Front Yards	Not Required (35-51)(23-45)
Required Side Yards	Not Required (35-52)(23-462c)
Required Rear Yards	Not Required (35-50)(23-47)(23-542)

e) Height and Setback (35-24)

Min./Max Base Height of Street Wall	60'/150' (35-24c) [Table A]
Maximum Building Height	210' (35-24d) [Table A]
Street Wall Setbacks (Wide Street)	10' (35-24e1)
Street Wall Setbacks (Narrow Street)	15' (35-24e1)

Appendix B
Skip Joist
Calculations



Skip Joist System

Tony Nicastro

Objective: Change flat plate system to a skip-joist floor system using sizes based on CRSI handbook.

Notes: CRSI has exclusively 4000 psi concrete floor systems, while 110 Third Avenue uses exclusively 5000 psi concrete in all slabs and columns. Therefore, I will find a floor system that uses 4000 psi concrete and assume columns can be resized to 4000 psi concrete.

Keeping the entire system a single strength will allow it to be cast monolithically.

Assumption:
- assume a 15' x 20' bay (conservative bay size) a normalized bay size would be approximately 12' x 16'-2", but don't use a rearranged bay in this analysis (Keep columns where they are)
- CRSI uses $f'_c = 4000$ psi, so this will be conservative for 5000 psi concrete

Loading:

DL = 25 psf superimposed

LL = 40 psf

$W_{superimposed} = 1.2(25) + 1.6(40) = \boxed{94 \text{ psf}}$

Clear span $= 15' - \frac{20''}{12} = 13'-4'' \rightarrow 14'$

or neglect column estimate → 15'

From CRSI pg. 8-14:

use

20" forms + 5" rib @ 25" c.-c.
w/ #4 @ 12" Top bars
and #3 bottom bar
(8" deep rib + 3" deep top slab = 11" depth

w/col. ↘ w/o col. ↘

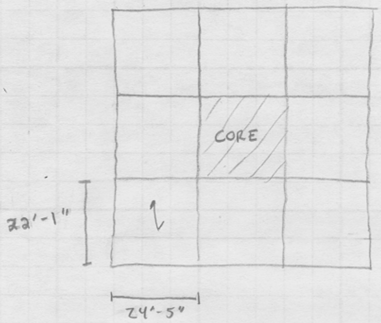
278 psf or 231 psf > 94 psf **OK**

Conclusion: A skip joist system, no matter how small, will be overdesigned for the given bay size

Notes: Replace current floor layout with a 9-bay layout and use a skip joist system

Assumptions:
- Architecture will allow for removal and redistribution of columns.
- bay sizes are $\frac{68' - 10'' \cdot 2}{3} \times \frac{75' - 10'' \cdot 2}{3}$ overhang

$\approx 22'-1'' \times 24'-5''$



Loading: DL = 25 psf
LL = 40 psf

$w_u = 1.2(25) + 1.6(40) = 94$ psf

Clear span = 22'-1" → 22' using column width deduction

From CRSI pg. 8-16

use

20" forms + 6" rib @ 26" c.-c.
w/ #4 @ 11" top bars
#4 bottom bar
(12" deep rib + 3" top slab = 15" total depth)

147 psf > 94 psf ∴ **OK**

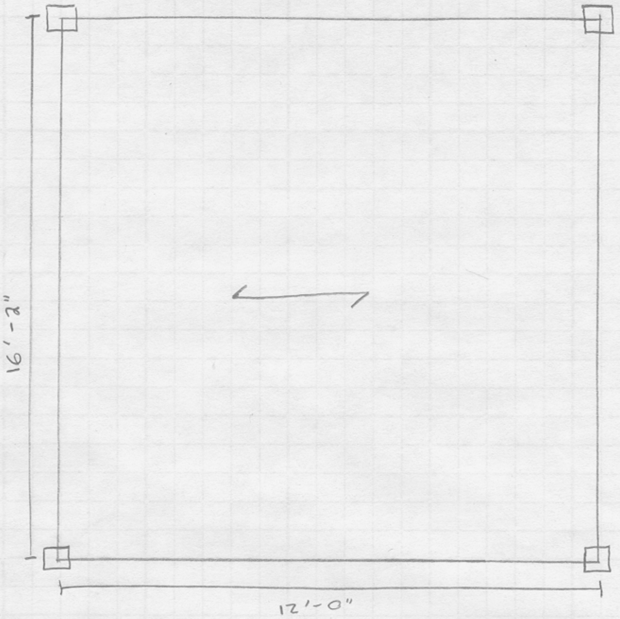
Conclusion: This system, although more practical because it uses larger bay sizes, is too deep for 110 Third Avenue. → lose floor due to height limitation

Appendix C
Precast Hollow Core Slab Calculations

1 Precast Hollow Core Planks Tony Nicastro

Objective : Replace the flat plate system with a regular grid for columns and uniform bay sizes to allow for placement of beams and hollow core slab.

Notes : A regular column grid is available elsewhere in the report, Typical bay size is 12'-0" x 16'-2", This analysis will design the hollow core slab using the PCI design handbook load tables for 6" hollow core slab



ASCE 7 T3.1
carp = 3 psf
tile = 16 psf
wood = 4 psf
p 2-26
6" + 2" topping

superimposed loads

DL = 25 psf } From dwg. S-001
LL = 40 psf }

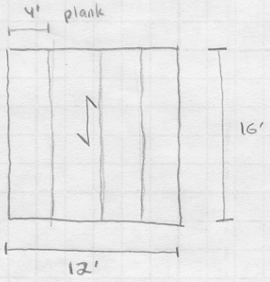
ASCE 7 approximates live load @ 40 psf
ASCE 7 approximates dead load :

Factored load : $w_u = 1.2(25) + 1.6(40) = 94$ psf

From PCI Handbook pg. 2-25:

Span = 12' ← too small for tables

Change span to 16':



Span = 16'

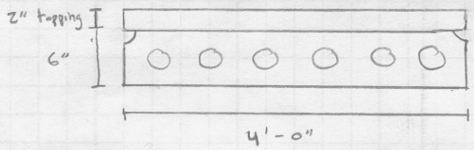
Use $\boxed{\text{Hollow-core 4'-0" × 6" Normal weight Conc. w/ 2" normal weight topping, 66-S strands (4HC6 + 2)}}$

.2" camber

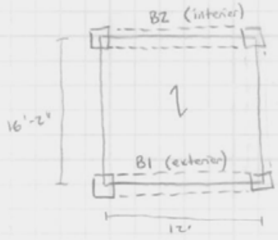
$f'_c = 5000$ psi

<u>Check:</u>

220 psf > 94 psf ∴ <u>OK</u>



Design of beams supporting planks:



Assume end span

B1 (end span)

Loading:

DL = 25 psf + 49 psf planks
LL = 40 psf

$w_u = 1.2(74 \text{ psf}) + 1.6(40 \text{ psf}) = 152.8 \text{ psf}$

Estimate beam stem: $(10 \times 12)(150 \text{ pcf} / 144)(1.2) = 150 \text{ plf}$

Area factored loads $152.8 \times 16.167' = 2470.3 \text{ plf}$

2620.267 plf
= 2.62 k/lf

- Enter End Span tables in CRSI (pg. 12-20)

Use $\boxed{\text{10 x 12 w/ 3 \#4 and 2 \#4 bottom bars in 2 rows and 2 \#7 top reinforcement}}$

Check 2.8 k/lf > 2.62 k/lf OK

B2 (interior)

Loading: Same as B1

pg. 12-50 for interior spans

Use $\boxed{\text{10 x 12 with 2 \#5 bottom bars and 2 \#6 top}}$

Check 2.7 k/lf > 2.62 k/lf OK

$\boxed{\text{B3}}$ (Not pictured) End span, corner

Loading Area factored loads $152.8 \times \frac{16.167'}{2} = 1235.15$ plf

Total load = 1235.15 plf + 150 plf = 1385.15 plf

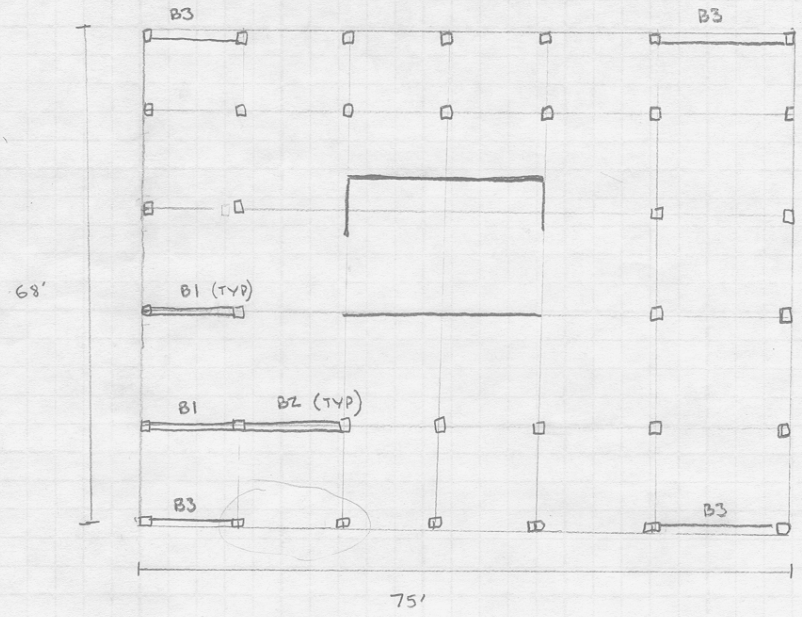
= 1.39 k/lf

- End span tables (pg. 12-20)

Use $\boxed{\text{10 x 12 w/ 2 \#5 Top \& bottom bars}}$

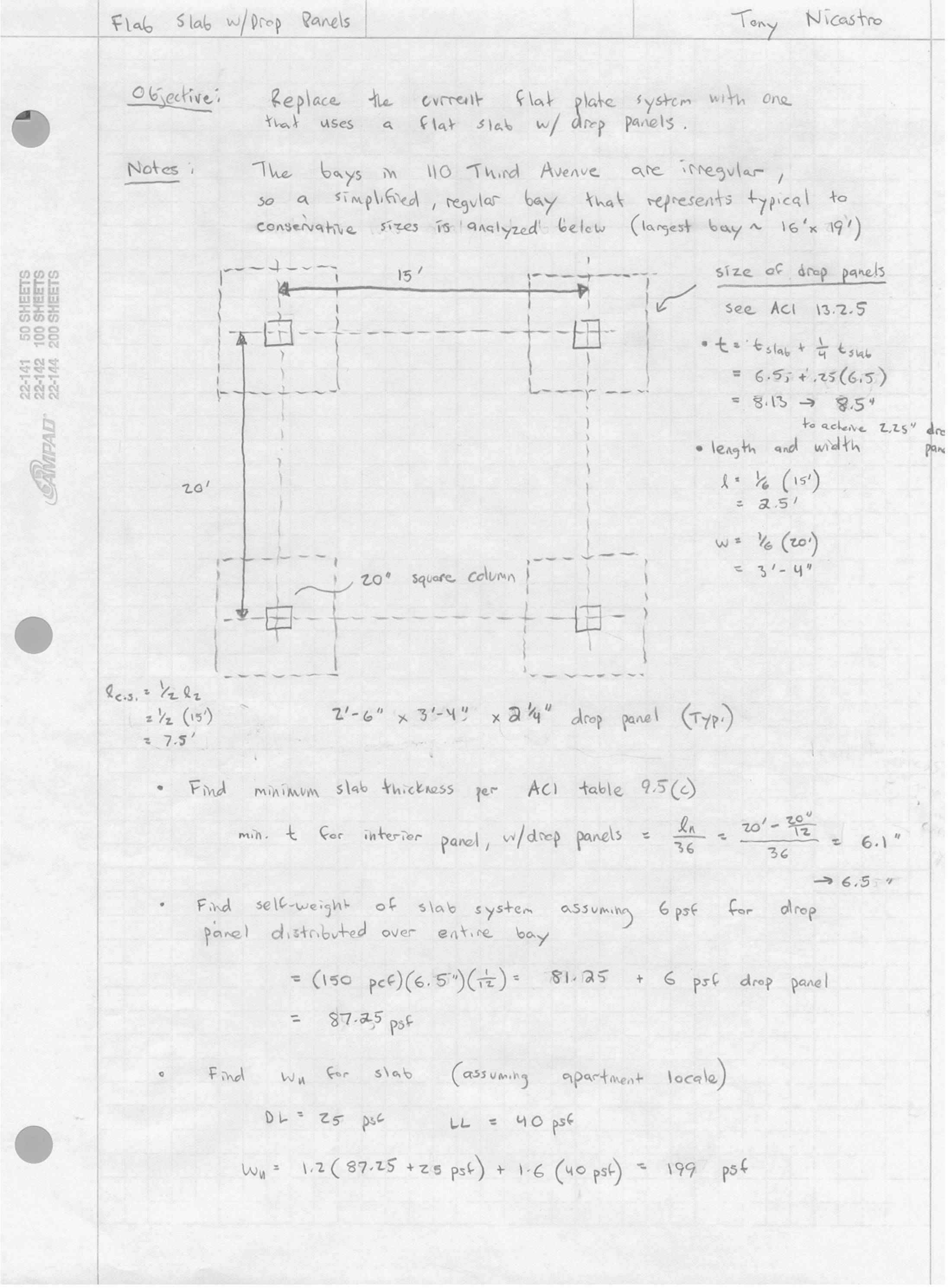
Check: 1.8 k/lf > 1.4 k/lf OK

Layout is approximately...



Note: Use of B2 at circled location will be a conservative design. It will use the same beam for half of the tributary width. Both beams would be 10x12, even with the reduction in tributary width. The same beam is being used for simplicity of design to avoid complications with reinforcing details.

Appendix D
Flat Slab with Drop Panels Calculations



Flab Slab w/Drop Panels — Tony Nicastro

Objective: Replace the current flat plate system with one that uses a flat slab w/ drop panels.

Notes: The bays in 110 Third Avenue are irregular, so a simplified, regular bay that represents typical to conservative sizes is analyzed below (largest bay ~ 16'x 19')

size of drop panels

see ACI 13.2.5

- $t = t_{slab} + \frac{1}{4} t_{slab}$
  $= 6.5 + .25(6.5)$
  $= 8.13 \rightarrow 8.5"$
  to acheive 2.25" dr
  pan
- length and width
  $l = 1/6\,(15')$
  $= 2.5'$
  $w = 1/6\,(20')$
  $= 3'-4"$

$l_{c.s.} = 1/2\, l_2$
$= 1/2\,(15')$
$= 7.5'$

2'-6" x 3'-4" x 2 1/4" drop panel (Typ.)

- Find minimum slab thickness per ACI table 9.5(c)

  $$\text{min. } t \text{ for interior panel, w/drop panels} = \frac{l_n}{36} = \frac{20' - \frac{20"}{12}}{36} = 6.1" \rightarrow 6.5"$$

- Find self-weight of slab system assuming 6 psf for drop panel distributed over entire bay

  $$= (150\text{ pcf})(6.5")\left(\tfrac{1}{12}\right) = 81.25 + 6\text{ psf drop panel}$$
  $$= 87.25\text{ psf}$$

- Find w_u for slab (assuming apartment locale)

  DL = 25 psf LL = 40 psf

  $$w_u = 1.2(87.25 + 25\text{ psf}) + 1.6(40\text{ psf}) = 199\text{ psf}$$

- Find the static moment, M_o for the long span direction

$$M_o = \frac{w_u l_2 l_n^2}{8} = \frac{(.1991 \text{ ksf})(15')(20' - 20''/12)^2}{8} = 126 \text{ 'k}$$

- Analyze as an exterior bay w/o edge beams, edge unrestrained

ACI 13.6.3.2

		Total Mu	Total width	Moment / ft. of width
Interior support (-) 75 %	Col. Strip (78%)	74.1 'k	7.5'	9.88 'k/ft
	Mid. strip (22%)	20.9 'k	12.5'	1.67
Midspan (+) 63 %	C.S. (68%)	54.3 'k	7.5'	7.24
	M.S. (32%)	25.5 'k	12.5'	2.04
Exterior neg. factored moment (-) 0%	C.S. (100%)	0	0	0
	M.S (0%)	0	0	0

interior

$$\alpha = \frac{\cancel{E_{cb}} I_b}{\cancel{E_{cs}} I_s} = \frac{\cancel{1/12} (3.33')(8.5'')^3}{\cancel{1/12} (15')(6.5'')^3} = .496 \qquad \frac{l_2}{l_1} = \frac{15}{20} = .75$$

$$\frac{\alpha l_2}{l_1} = \frac{.496 (15')}{20'} = .372 \leq 1$$

from Design of Concrete Structures pg. 755 design aid,

C.S. moment = .78

midspan C.S. moment = .68

Exterior Negative Moment

$\beta_t = 0$ (ACI 13.6.4.2 and R13.6.4.2)

C.S. moment = 100%

Reinforcement

Middle strip

min. reinf. : $.0018 A_g = .0018 (6.5''\text{ thick})(12''/\text{ft}) = .14 \text{ in}^2/\text{ft}$

use #4 @ 12" min. reinforcing for $A \leq .2 \text{ in}^2/\text{ft.}$

$$d = 6.5'' - \overset{\text{cover}}{.75''} - \overset{\text{stirrup}}{.5''} - \overset{\phi}{\frac{.5''}{2}} = 5''$$

3

$$a = \frac{A_s f_y}{.85 f'_c b} = \frac{.2(60)}{.85(5)(12)} = .235 \text{ in.}$$

$$\phi M_n = .9\left[.2(60)\left(5'' - \frac{.235}{2}\right)\right] = 4.4 \ 'k/ft.$$

$$\phi M_n > M_u$$

$$4.4 \ 'k/ft > 2.04 \ 'k/ft > 1.67 \ 'k/ft$$

$\therefore$ $\boxed{\text{use \#4 @ 12'' for midspan \& support M.S.}}$

Column Strips

min. reinforcing: $.0018 A_g = .0018(6.5'')(12''/ft) = .14 ''$

Try #4 @ 12'' min. reinforcing for $A \leq .2 \ in^2/ft$

$$d = 8.5'' \text{ total} - .75 - .5 - \frac{.5''}{2} = 7''$$

$$a = \frac{A_s f_y}{.85 f'_c b} = \frac{.2(60)}{.85(5)(12)} = .235 \text{ in.}$$

$$\phi M_n = .9(.2)(60 \text{ ksi})\left(7'' - \frac{.235}{2}\right)/12 = 6.19 \ 'k/ft.$$

fails

- Try #4 @ 6''

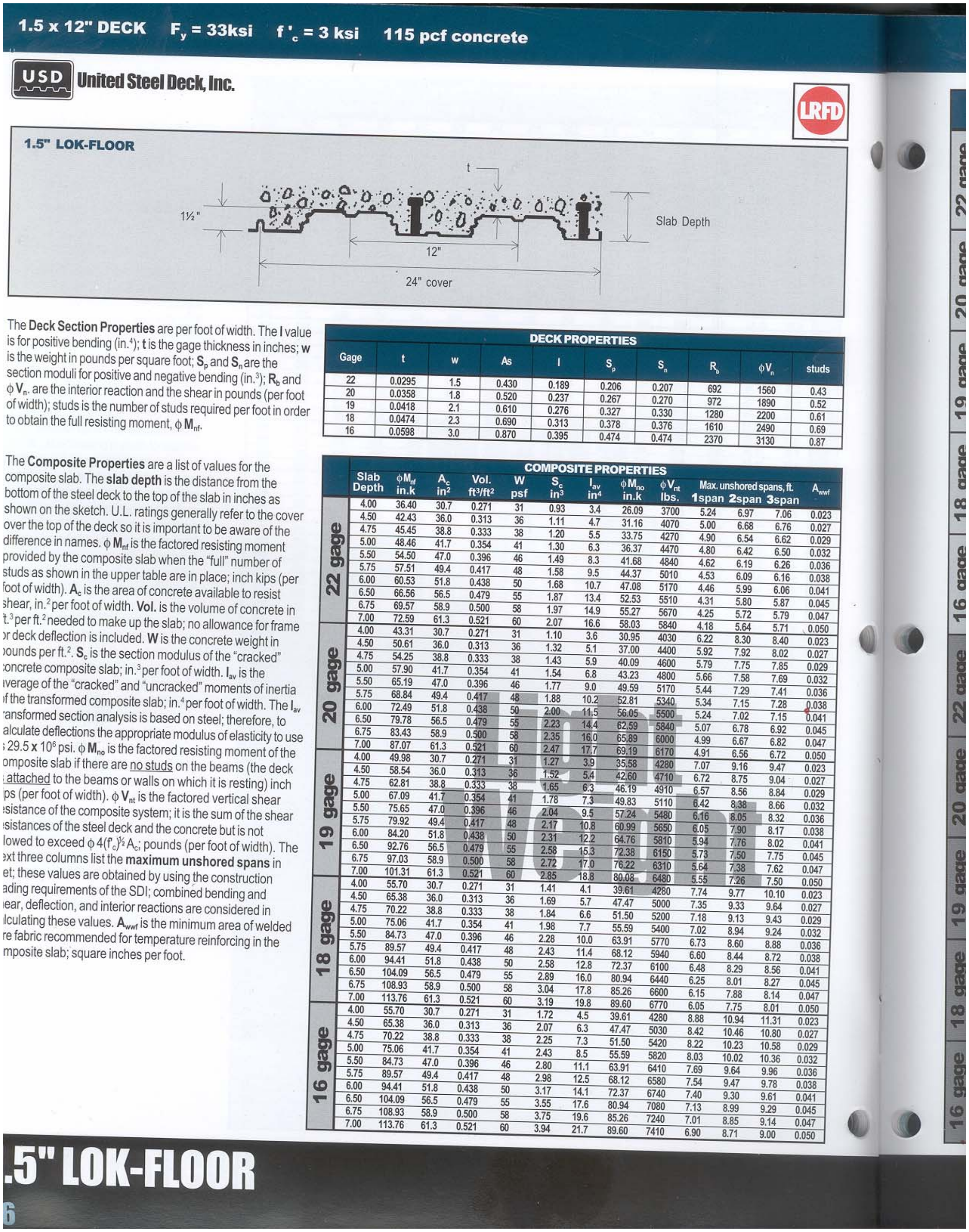
$$\phi M_n = 2(6.19) = 12.38 \ 'k$$

$$\phi M_n > M_u$$

$$12.38 \ 'k/ft > 9.88 \ 'k/ft > 7.24 \ 'k/ft.$$

$\therefore$ $\boxed{\text{use \#4 @ 6'' for midspan + support C.S.}}$

Appendix E
Alternate Floor System References



1.5 x 12" DECK F_y = 33ksi f'_c = 3 ksi 115 pcf concrete

USD United Steel Deck, Inc.

LRFD

1.5" LOK-FLOOR

The **Deck Section Properties** are per foot of width. The **I** value is for positive bending (in.^{4}); **t** is the gage thickness in inches; **w** is the weight in pounds per square foot; S_p and S_n are the section moduli for positive and negative bending (in.^{3}); R_b and ϕV_n. are the interior reaction and the shear in pounds (per foot of width); studs is the number of studs required per foot in order to obtain the full resisting moment, ϕM_{nf}.

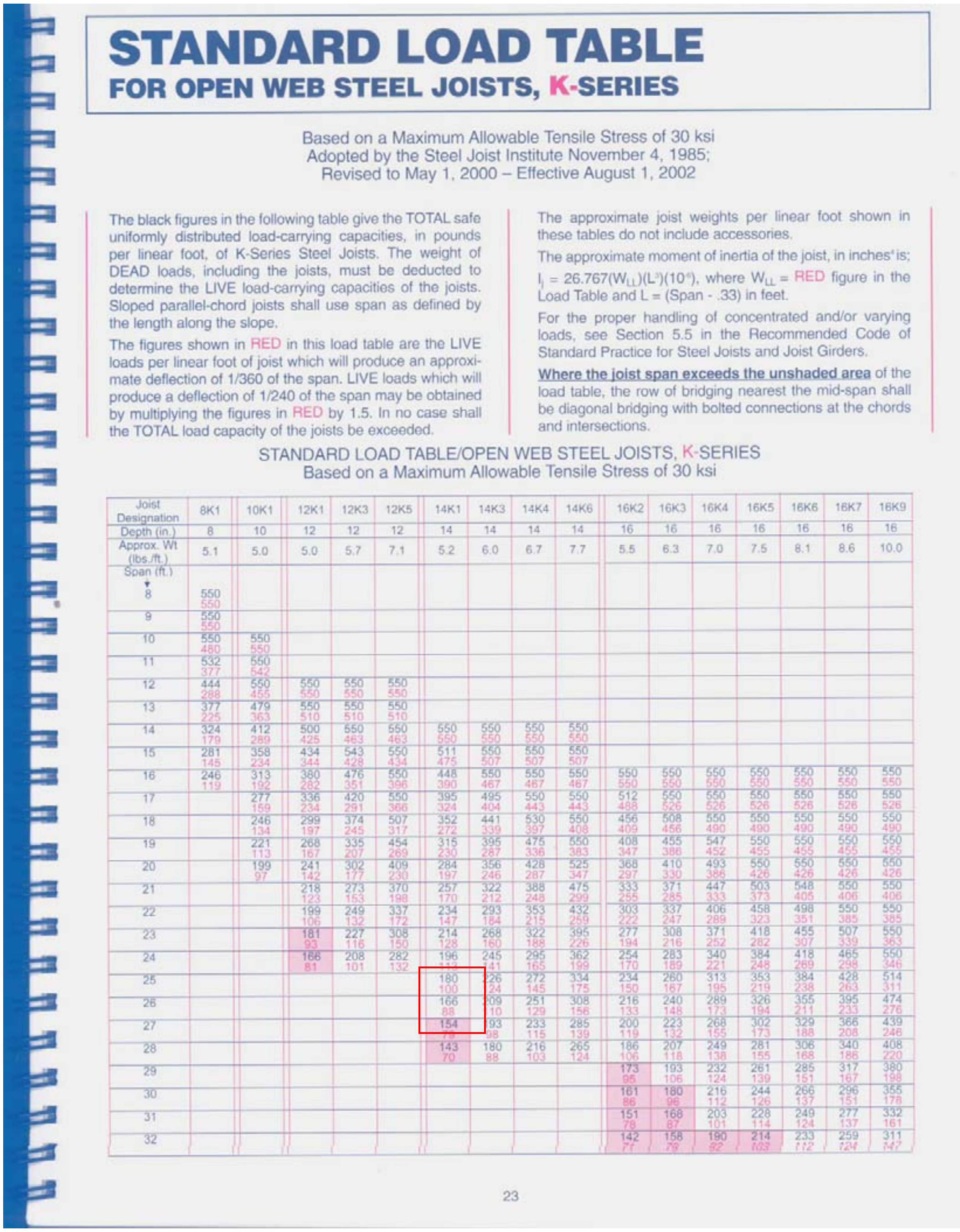
DECK PROPERTIES									
Gage	t	w	As	I	S_p	S_n	R_b	ϕV_n	studs
22	0.0295	1.5	0.430	0.189	0.206	0.207	692	1560	0.43
20	0.0358	1.8	0.520	0.237	0.267	0.270	972	1890	0.52
19	0.0418	2.1	0.610	0.276	0.327	0.330	1280	2200	0.61
18	0.0474	2.3	0.690	0.313	0.378	0.376	1610	2490	0.69
16	0.0598	3.0	0.870	0.395	0.474	0.474	2370	3130	0.87

The **Composite Properties** are a list of values for the composite slab. The **slab depth** is the distance from the bottom of the steel deck to the top of the slab in inches as shown on the sketch. U.L. ratings generally refer to the cover over the top of the deck so it is important to be aware of the difference in names. ϕM_{nf} is the factored resisting moment provided by the composite slab when the "full" number of studs as shown in the upper table are in place; inch kips (per foot of width). A_c is the area of concrete available to resist shear, in.^{2} per foot of width. **Vol.** is the volume of concrete in t.^{3} per ft.^{2} needed to make up the slab; no allowance for frame r deck deflection is included. **W** is the concrete weight in ounds per ft.^{2}. S_c is the section modulus of the "cracked" oncrete composite slab; in.^{3} per foot of width. I_{av} is the verage of the "cracked" and "uncracked" moments of inertia f the transformed composite slab; in.^{4} per foot of width. The I_{av} ansformed section analysis is based on steel; therefore, to alculate deflections the appropriate modulus of elasticity to use 29.5 x 10^6 psi. ϕM_{no} is the factored resisting moment of the omposite slab if there are no studs on the beams (the deck attached to the beams or walls on which it is resting) inch ps (per foot of width). ϕV_{nt} is the factored vertical shear sistance of the composite system; it is the sum of the shear sistances of the steel deck and the concrete but is not lowed to exceed $\phi 4(f'_c)^{1/2} A_c$; pounds (per foot of width). The xt three columns list the **maximum unshored spans** in et; these values are obtained by using the construction ading requirements of the SDI; combined bending and ear, deflection, and interior reactions are considered in lculating these values. A_{wwf} is the minimum area of welded re fabric recommended for temperature reinforcing in the mposite slab; square inches per foot.

	COMPOSITE PROPERTIES												
	Slab Depth	ϕM_{nf} in.k	A_c in^2	Vol. ft^3/ft^2	W psf	S_c in^3	I_{av} in^4	ϕM_{no} in.k	ϕV_{nt} lbs.	Max. unshored spans, ft. 1span	2span	3span	A_{wwf}
22 gage	4.00	36.40	30.7	0.271	31	0.93	3.4	26.09	3700	5.24	6.97	7.06	0.023
	4.50	42.43	36.0	0.313	36	1.11	4.7	31.16	4070	5.00	6.68	6.76	0.027
	4.75	45.45	38.8	0.333	38	1.20	5.5	33.75	4270	4.90	6.54	6.62	0.029
	5.00	48.46	41.7	0.354	41	1.30	6.3	36.37	4470	4.80	6.42	6.50	0.032
	5.50	54.50	47.0	0.396	46	1.49	8.3	41.68	4840	4.62	6.19	6.26	0.036
	5.75	57.51	49.4	0.417	48	1.58	9.5	44.37	5010	4.53	6.09	6.16	0.038
	6.00	60.53	51.8	0.438	50	1.68	10.7	47.08	5170	4.46	5.99	6.06	0.041
	6.50	66.56	56.5	0.479	55	1.87	13.4	52.53	5510	4.31	5.80	5.87	0.045
	6.75	69.57	58.9	0.500	58	1.97	14.9	55.27	5670	4.25	5.72	5.79	0.047
	7.00	72.59	61.3	0.521	60	2.07	16.6	58.03	5840	4.18	5.64	5.71	0.050
20 gage	4.00	43.31	30.7	0.271	31	1.10	3.6	30.95	4030	6.22	8.30	8.40	0.023
	4.50	50.61	36.0	0.313	36	1.32	5.1	37.00	4400	5.92	7.92	8.02	0.027
	4.75	54.25	38.8	0.333	38	1.43	5.9	40.09	4600	5.79	7.75	7.85	0.029
	5.00	57.90	41.7	0.354	41	1.54	6.8	43.23	4800	5.66	7.58	7.69	0.032
	5.50	65.19	47.0	0.396	46	1.77	9.0	49.59	5170	5.44	7.29	7.41	0.036
	5.75	68.84	49.4	0.417	48	1.88	10.2	52.81	5340	5.34	7.15	7.28	0.038
	6.00	72.49	51.8	0.438	50	2.00	11.5	56.05	5500	5.24	7.02	7.15	0.041
	6.50	79.78	56.5	0.479	55	2.23	14.4	62.59	5840	5.07	6.78	6.92	0.045
	6.75	83.43	58.9	0.500	58	2.35	16.0	65.89	6000	4.99	6.67	6.82	0.047
	7.00	87.07	61.3	0.521	60	2.47	17.7	69.19	6170	4.91	6.56	6.72	0.050
19 gage	4.00	49.98	30.7	0.271	31	1.27	3.9	35.58	4280	7.07	9.16	9.47	0.023
	4.50	58.54	36.0	0.313	36	1.52	5.4	42.60	4710	6.72	8.75	9.04	0.027
	4.75	62.81	38.8	0.333	38	1.65	6.3	46.19	4910	6.57	8.56	8.84	0.029
	5.00	67.09	41.7	0.354	41	1.78	7.3	49.83	5110	6.42	8.38	8.66	0.032
	5.50	75.65	47.0	0.396	46	2.04	9.5	57.24	5480	6.16	8.05	8.32	0.036
	5.75	79.92	49.4	0.417	48	2.17	10.8	60.99	5650	6.05	7.90	8.17	0.038
	6.00	84.20	51.8	0.438	50	2.31	12.2	64.76	5810	5.94	7.76	8.02	0.041
	6.50	92.76	56.5	0.479	55	2.58	15.3	72.38	6150	5.73	7.50	7.75	0.045
	6.75	97.03	58.9	0.500	58	2.72	17.0	76.22	6310	5.64	7.38	7.62	0.047
	7.00	101.31	61.3	0.521	60	2.85	18.8	80.08	6480	5.55	7.26	7.50	0.050
18 gage	4.00	55.70	30.7	0.271	31	1.41	4.1	39.61	4280	7.74	9.77	10.10	0.023
	4.50	65.38	36.0	0.313	36	1.69	5.7	47.47	5000	7.35	9.33	9.64	0.027
	4.75	70.22	38.8	0.333	38	1.84	6.6	51.50	5200	7.18	9.13	9.43	0.029
	5.00	75.06	41.7	0.354	41	1.98	7.7	55.59	5400	7.02	8.94	9.24	0.032
	5.50	84.73	47.0	0.396	46	2.28	10.0	63.91	5770	6.73	8.60	8.88	0.036
	5.75	89.57	49.4	0.417	48	2.43	11.4	68.12	5940	6.60	8.44	8.72	0.038
	6.00	94.41	51.8	0.438	50	2.58	12.8	72.37	6100	6.48	8.29	8.56	0.041
	6.50	104.09	56.5	0.479	55	2.89	16.0	80.94	6440	6.25	8.01	8.27	0.045
	6.75	108.93	58.9	0.500	58	3.04	17.8	85.26	6600	6.15	7.88	8.14	0.047
	7.00	113.76	61.3	0.521	60	3.19	19.8	89.60	6770	6.05	7.75	8.01	0.050
16 gage	4.00	55.70	30.7	0.271	31	1.72	4.5	39.61	4280	8.88	10.94	11.31	0.023
	4.50	65.38	36.0	0.313	36	2.07	6.3	47.47	5030	8.42	10.46	10.80	0.027
	4.75	70.22	38.8	0.333	38	2.25	7.3	51.50	5420	8.22	10.23	10.58	0.029
	5.00	75.06	41.7	0.354	41	2.43	8.5	55.59	5820	8.03	10.02	10.36	0.032
	5.50	84.73	47.0	0.396	46	2.80	11.1	63.91	6410	7.69	9.64	9.96	0.036
	5.75	89.57	49.4	0.417	48	2.98	12.5	68.12	6580	7.54	9.47	9.78	0.038
	6.00	94.41	51.8	0.438	50	3.17	14.1	72.37	6740	7.40	9.30	9.61	0.041
	6.50	104.09	56.5	0.479	55	3.55	17.6	80.94	7080	7.13	8.99	9.29	0.045
	6.75	108.93	58.9	0.500	58	3.75	19.6	85.26	7240	7.01	8.85	9.14	0.047
	7.00	113.76	61.3	0.521	60	3.94	21.7	89.60	7410	6.90	8.71	9.00	0.050

.5" LOK-FLOOR

Basis of choosing a 1.5” Lok-Floor



STANDARD LOAD TABLE
FOR OPEN WEB STEEL JOISTS, K-SERIES

Based on a Maximum Allowable Tensile Stress of 30 ksi
Adopted by the Steel Joist Institute November 4, 1985;
Revised to May 1, 2000 – Effective August 1, 2002

The black figures in the following table give the TOTAL safe uniformly distributed load-carrying capacities, in pounds per linear foot, of K-Series Steel Joists. The weight of DEAD loads, including the joists, must be deducted to determine the LIVE load-carrying capacities of the joists. Sloped parallel-chord joists shall use span as defined by the length along the slope.

The figures shown in RED in this load table are the LIVE loads per linear foot of joist which will produce an approximate deflection of 1/360 of the span. LIVE loads which will produce a deflection of 1/240 of the span may be obtained by multiplying the figures in RED by 1.5. In no case shall the TOTAL load capacity of the joists be exceeded.

The approximate joist weights per linear foot shown in these tables do not include accessories.

The approximate moment of inertia of the joist, in inches^4 is;

$I_j = 26.767(W_{LL})(L^3)(10^{-6})$, where W_{LL} = RED figure in the Load Table and L = (Span - .33) in feet.

For the proper handling of concentrated and/or varying loads, see Section 5.5 in the Recommended Code of Standard Practice for Steel Joists and Joist Girders.

Where the joist span exceeds the unshaded area of the load table, the row of bridging nearest the mid-span shall be diagonal bridging with bolted connections at the chords and intersections.

STANDARD LOAD TABLE/OPEN WEB STEEL JOISTS, K-SERIES
Based on a Maximum Allowable Tensile Stress of 30 ksi

Joist Designation	8K1	10K1	12K1	12K3	12K5	14K1	14K3	14K4	14K6	16K2	16K3	16K4	16K5	16K6	16K7	16K9
Depth (in.)	8	10	12	12	12	14	14	14	14	16	16	16	16	16	16	16
Approx. Wt (lbs./ft.)	5.1	5.0	5.0	5.7	7.1	5.2	6.0	6.7	7.7	5.5	6.3	7.0	7.5	8.1	8.6	10.0
Span (ft.) ↓																
8	550 550															
9	550 550															
10	550 480	550 550														
11	532 377	550 542														
12	444 288	550 455	550 550	550 550	550 550											
13	377 225	479 363	550 510	550 510	550 510											
14	324 179	412 289	500 425	550 463	550 463	550 550	550 550	550 550	550 550							
15	281 145	358 234	434 344	543 428	550 434	511 475	550 507	550 507	550 507							
16	246 119	313 192	380 282	476 351	550 396	448 390	550 467	550 467	550 467	550 550	550 550	550 550	550 550	550 550	550 550	550 550
17		277 159	336 234	420 291	550 366	395 324	495 404	550 443	550 443	512 488	550 526	550 526	550 526	550 526	550 526	550 526
18		246 134	299 197	374 245	507 317	352 272	441 339	530 397	550 408	456 409	508 456	550 490	550 490	550 490	550 490	550 490
19		221 113	268 167	335 207	454 269	315 230	395 287	475 336	550 383	408 347	455 386	547 452	550 455	550 455	550 455	550 455
20		199 97	241 142	302 177	409 230	284 197	356 246	428 287	525 347	368 297	410 330	493 386	550 426	550 426	550 426	550 426
21			218 123	273 153	370 198	257 170	322 212	388 248	475 299	333 255	371 285	447 333	503 373	548 405	550 406	550 406
22			199 106	249 132	337 172	234 147	293 184	353 215	432 259	303 222	337 247	406 289	458 323	498 351	550 385	550 385
23			181 93	227 116	308 150	214 128	268 160	322 188	395 226	277 194	308 216	371 252	418 282	455 307	507 339	550 363
24			166 81	208 101	282 132	196 113	245 141	295 165	362 199	254 170	283 189	340 221	384 248	418 269	465 298	550 346
25						180 100	226 124	272 145	334 175	234 150	260 167	313 195	353 219	384 238	428 263	514 311
26						166 88	209 110	251 129	308 156	216 133	240 148	289 173	326 194	355 211	395 233	474 276
27						154 79	193 98	233 115	285 139	200 119	223 132	268 155	302 173	329 188	366 208	439 246
28						143 70	180 88	216 103	265 124	186 106	207 118	249 138	281 155	306 168	340 186	408 220
29										173 95	193 106	232 124	261 139	285 151	317 167	380 198
30										161 86	180 96	216 112	244 126	266 137	296 151	355 178
31										151 78	168 87	203 101	228 114	249 124	277 137	332 161
32										142 71	158 79	190 92	214 103	233 112	259 124	311 147

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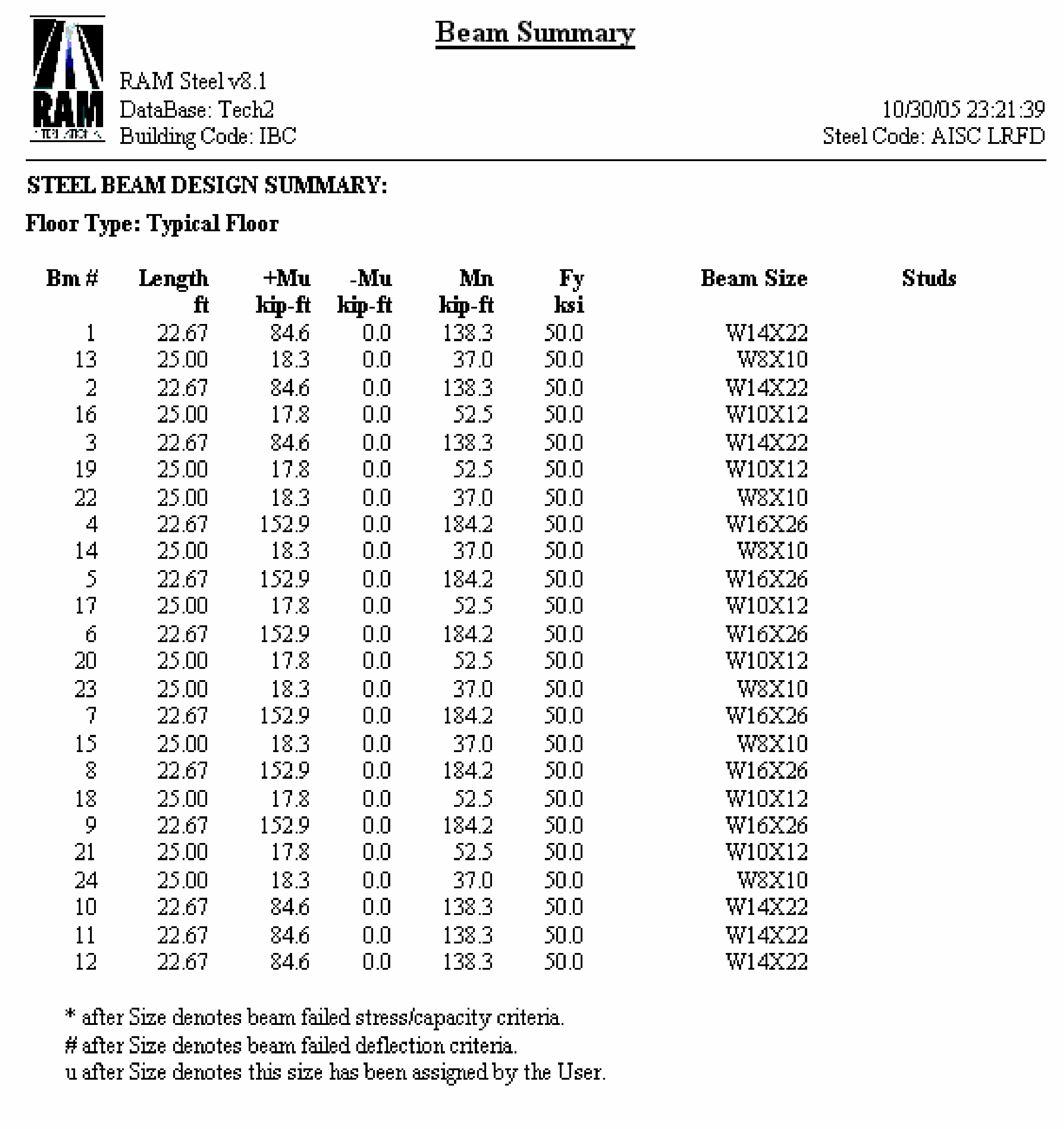
Spot check of joists



Beam Summary

RAM Steel v8.1
DataBase: Tech2
Building Code: IBC

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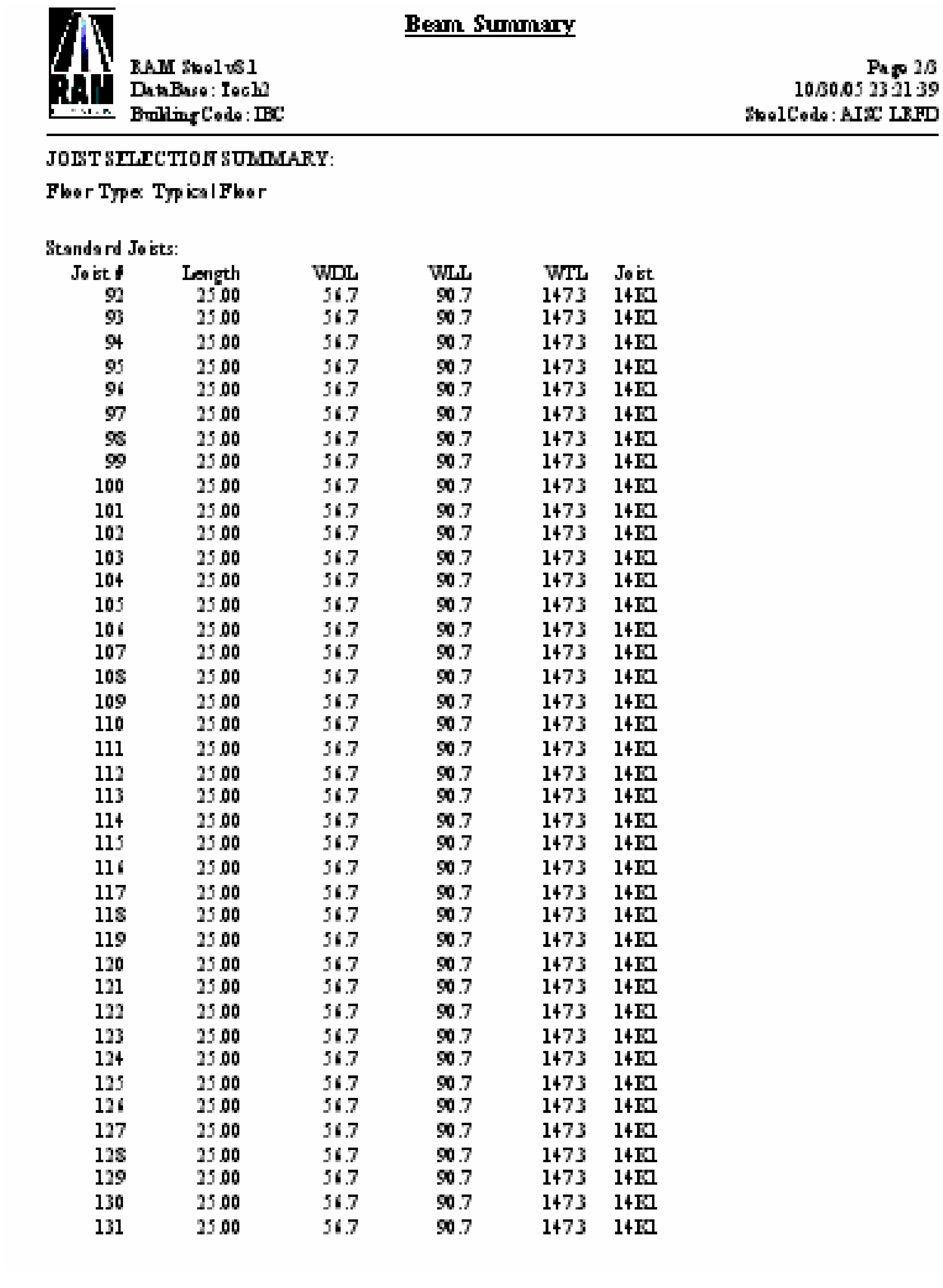
Steel Code: AISC LRFD

STEEL BEAM DESIGN SUMMARY:

Floor Type: Typical Floor

Bm #	Length ft	+Mu kip-ft	-Mu kip-ft	Mn kip-ft	Fy ksi	Beam Size	Studs
1	22.67	84.6	0.0	138.3	50.0	W14X22	
13	25.00	18.3	0.0	37.0	50.0	W8X10	
2	22.67	84.6	0.0	138.3	50.0	W14X22	
16	25.00	17.8	0.0	52.5	50.0	W10X12	
3	22.67	84.6	0.0	138.3	50.0	W14X22	
19	25.00	17.8	0.0	52.5	50.0	W10X12	
22	25.00	18.3	0.0	37.0	50.0	W8X10	
4	22.67	152.9	0.0	184.2	50.0	W16X26	
14	25.00	18.3	0.0	37.0	50.0	W8X10	
5	22.67	152.9	0.0	184.2	50.0	W16X26	
17	25.00	17.8	0.0	52.5	50.0	W10X12	
6	22.67	152.9	0.0	184.2	50.0	W16X26	
20	25.00	17.8	0.0	52.5	50.0	W10X12	
23	25.00	18.3	0.0	37.0	50.0	W8X10	
7	22.67	152.9	0.0	184.2	50.0	W16X26	
15	25.00	18.3	0.0	37.0	50.0	W8X10	
8	22.67	152.9	0.0	184.2	50.0	W16X26	
18	25.00	17.8	0.0	52.5	50.0	W10X12	
9	22.67	152.9	0.0	184.2	50.0	W16X26	
21	25.00	17.8	0.0	52.5	50.0	W10X12	
24	25.00	18.3	0.0	37.0	50.0	W8X10	
10	22.67	84.6	0.0	138.3	50.0	W14X22	
11	22.67	84.6	0.0	138.3	50.0	W14X22	
12	22.67	84.6	0.0	138.3	50.0	W14X22	

* after Size denotes beam failed stress/capacity criteria.
\# after Size denotes beam failed deflection criteria.
u after Size denotes this size has been assigned by the User.



Beam Summary

RAM Steel v8.1
DataBase: Tech2
Building Code: IBC

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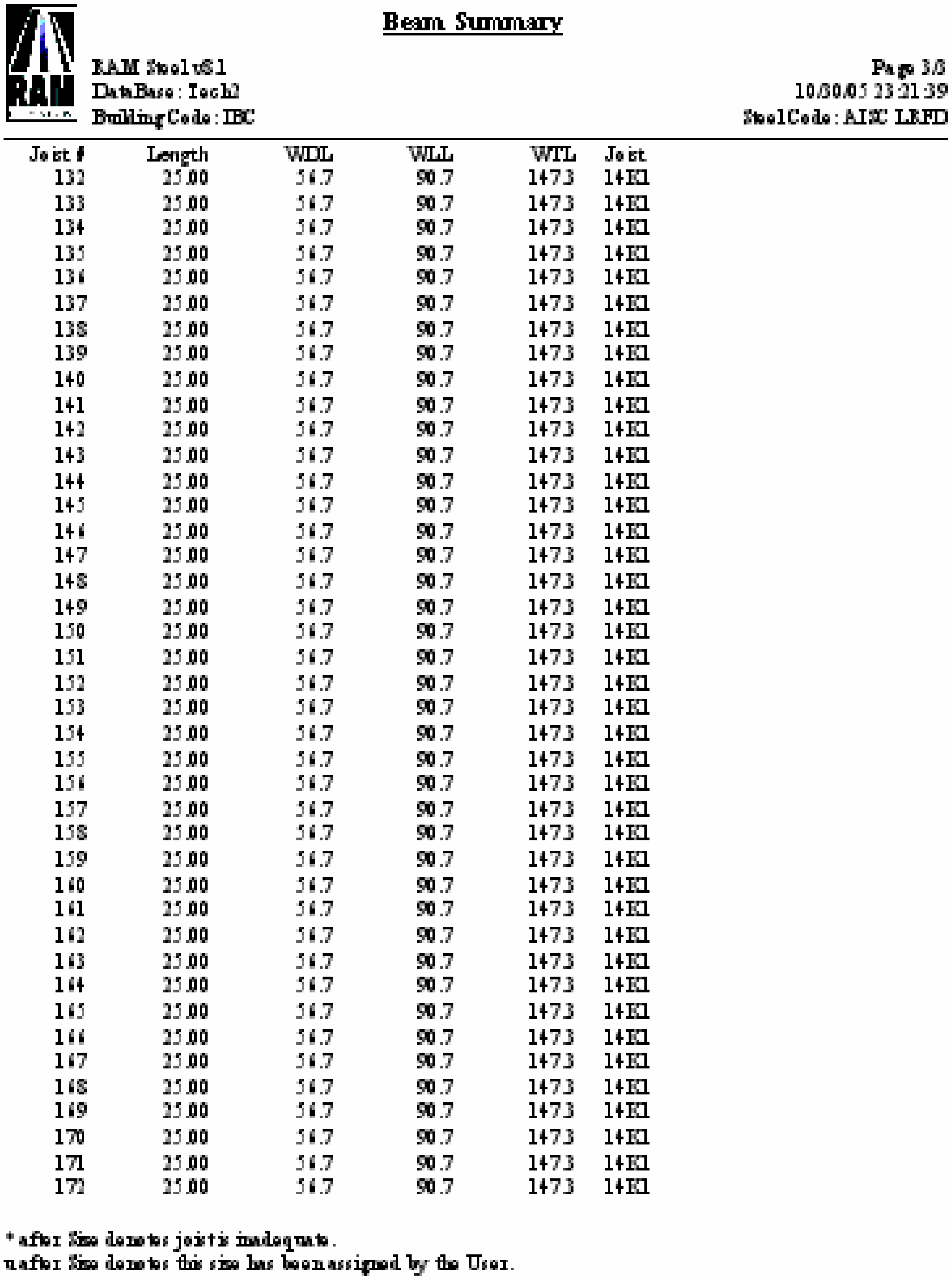
Steel Code: AISC LRFD

JOIST SELECTION SUMMARY:

Floor Type: Typical Floor

Standard Joists:

Joist #	Length	WDL	WLL	WTL	Joist
92	25.00	56.7	90.7	147.3	14K1
93	25.00	56.7	90.7	147.3	14K1
94	25.00	56.7	90.7	147.3	14K1
95	25.00	56.7	90.7	147.3	14K1
96	25.00	56.7	90.7	147.3	14K1
97	25.00	56.7	90.7	147.3	14K1
98	25.00	56.7	90.7	147.3	14K1
99	25.00	56.7	90.7	147.3	14K1
100	25.00	56.7	90.7	147.3	14K1
101	25.00	56.7	90.7	147.3	14K1
102	25.00	56.7	90.7	147.3	14K1
103	25.00	56.7	90.7	147.3	14K1
104	25.00	56.7	90.7	147.3	14K1
105	25.00	56.7	90.7	147.3	14K1
106	25.00	56.7	90.7	147.3	14K1
107	25.00	56.7	90.7	147.3	14K1
108	25.00	56.7	90.7	147.3	14K1
109	25.00	56.7	90.7	147.3	14K1
110	25.00	56.7	90.7	147.3	14K1
111	25.00	56.7	90.7	147.3	14K1
112	25.00	56.7	90.7	147.3	14K1
113	25.00	56.7	90.7	147.3	14K1
114	25.00	56.7	90.7	147.3	14K1
115	25.00	56.7	90.7	147.3	14K1
116	25.00	56.7	90.7	147.3	14K1
117	25.00	56.7	90.7	147.3	14K1
118	25.00	56.7	90.7	147.3	14K1
119	25.00	56.7	90.7	147.3	14K1
120	25.00	56.7	90.7	147.3	14K1
121	25.00	56.7	90.7	147.3	14K1
122	25.00	56.7	90.7	147.3	14K1
123	25.00	56.7	90.7	147.3	14K1
124	25.00	56.7	90.7	147.3	14K1
125	25.00	56.7	90.7	147.3	14K1
126	25.00	56.7	90.7	147.3	14K1
127	25.00	56.7	90.7	147.3	14K1
128	25.00	56.7	90.7	147.3	14K1
129	25.00	56.7	90.7	147.3	14K1
130	25.00	56.7	90.7	147.3	14K1
131	25.00	56.7	90.7	147.3	14K1



Beam Summary

RAM Steel v8.1
DataBase: Tech2
Building Code: IBC

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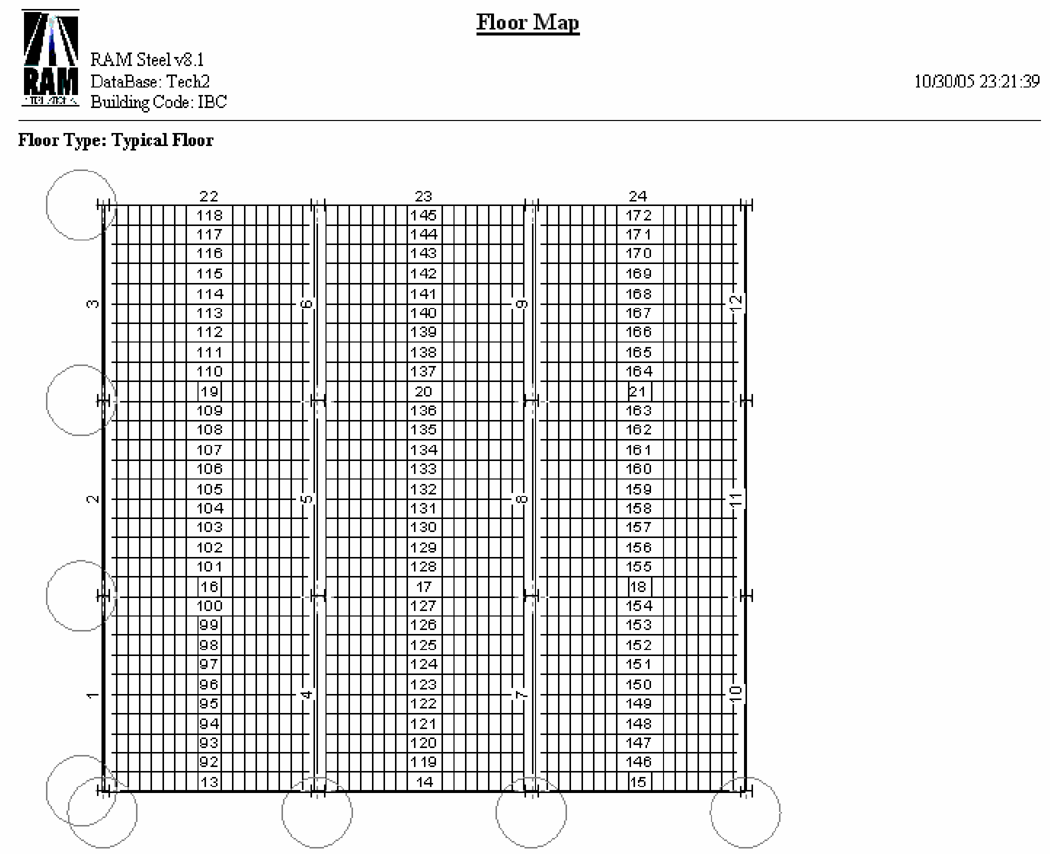
Steel Code: AISC LRFD

Joist #	Length	WDL	WLL	WTL	Joist
132	25.00	56.7	90.7	147.3	14K1
133	25.00	56.7	90.7	147.3	14K1
134	25.00	56.7	90.7	147.3	14K1
135	25.00	56.7	90.7	147.3	14K1
136	25.00	56.7	90.7	147.3	14K1
137	25.00	56.7	90.7	147.3	14K1
138	25.00	56.7	90.7	147.3	14K1
139	25.00	56.7	90.7	147.3	14K1
140	25.00	56.7	90.7	147.3	14K1
141	25.00	56.7	90.7	147.3	14K1
142	25.00	56.7	90.7	147.3	14K1
143	25.00	56.7	90.7	147.3	14K1
144	25.00	56.7	90.7	147.3	14K1
145	25.00	56.7	90.7	147.3	14K1
146	25.00	56.7	90.7	147.3	14K1
147	25.00	56.7	90.7	147.3	14K1
148	25.00	56.7	90.7	147.3	14K1
149	25.00	56.7	90.7	147.3	14K1
150	25.00	56.7	90.7	147.3	14K1
151	25.00	56.7	90.7	147.3	14K1
152	25.00	56.7	90.7	147.3	14K1
153	25.00	56.7	90.7	147.3	14K1
154	25.00	56.7	90.7	147.3	14K1
155	25.00	56.7	90.7	147.3	14K1
156	25.00	56.7	90.7	147.3	14K1
157	25.00	56.7	90.7	147.3	14K1
158	25.00	56.7	90.7	147.3	14K1
159	25.00	56.7	90.7	147.3	14K1
160	25.00	56.7	90.7	147.3	14K1
161	25.00	56.7	90.7	147.3	14K1
162	25.00	56.7	90.7	147.3	14K1
163	25.00	56.7	90.7	147.3	14K1
164	25.00	56.7	90.7	147.3	14K1
165	25.00	56.7	90.7	147.3	14K1
166	25.00	56.7	90.7	147.3	14K1
167	25.00	56.7	90.7	147.3	14K1
168	25.00	56.7	90.7	147.3	14K1
169	25.00	56.7	90.7	147.3	14K1
170	25.00	56.7	90.7	147.3	14K1
171	25.00	56.7	90.7	147.3	14K1
172	25.00	56.7	90.7	147.3	14K1

* after Size denotes joist is inadequate.
u after Size denotes this size has been assigned by the User.

Typical Floor and Beam Loading Diagram:



Floor Map

RAM Steel v8.1
DataBase: Tech2
Building Code: IBC

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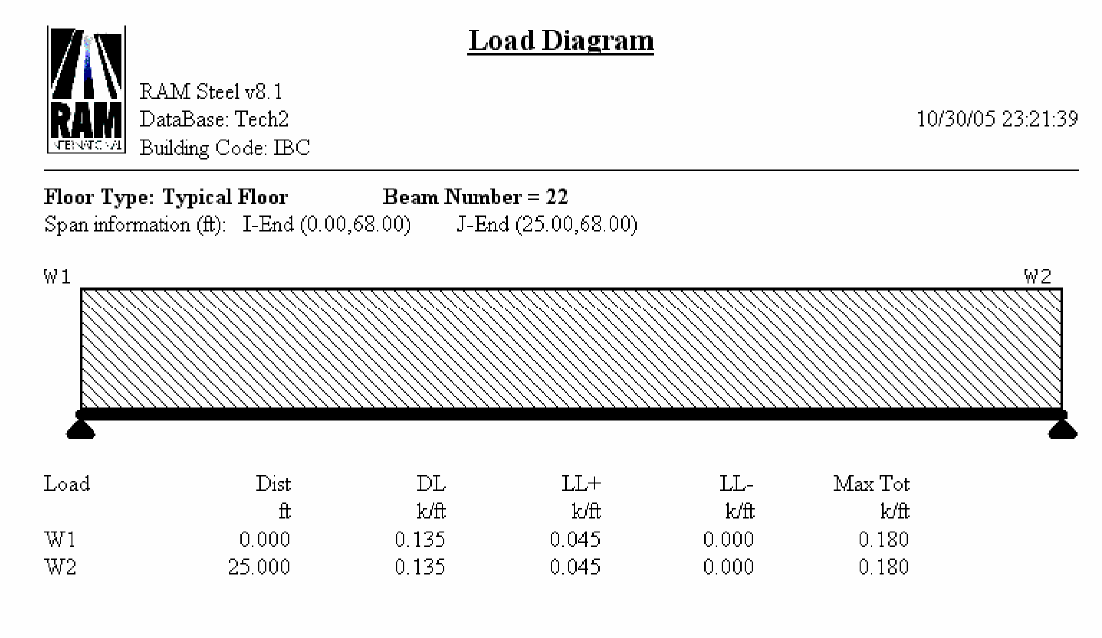
Floor Type: Typical Floor



Load Diagram

RAM Steel v8.1
DataBase: Tech2
Building Code: IBC

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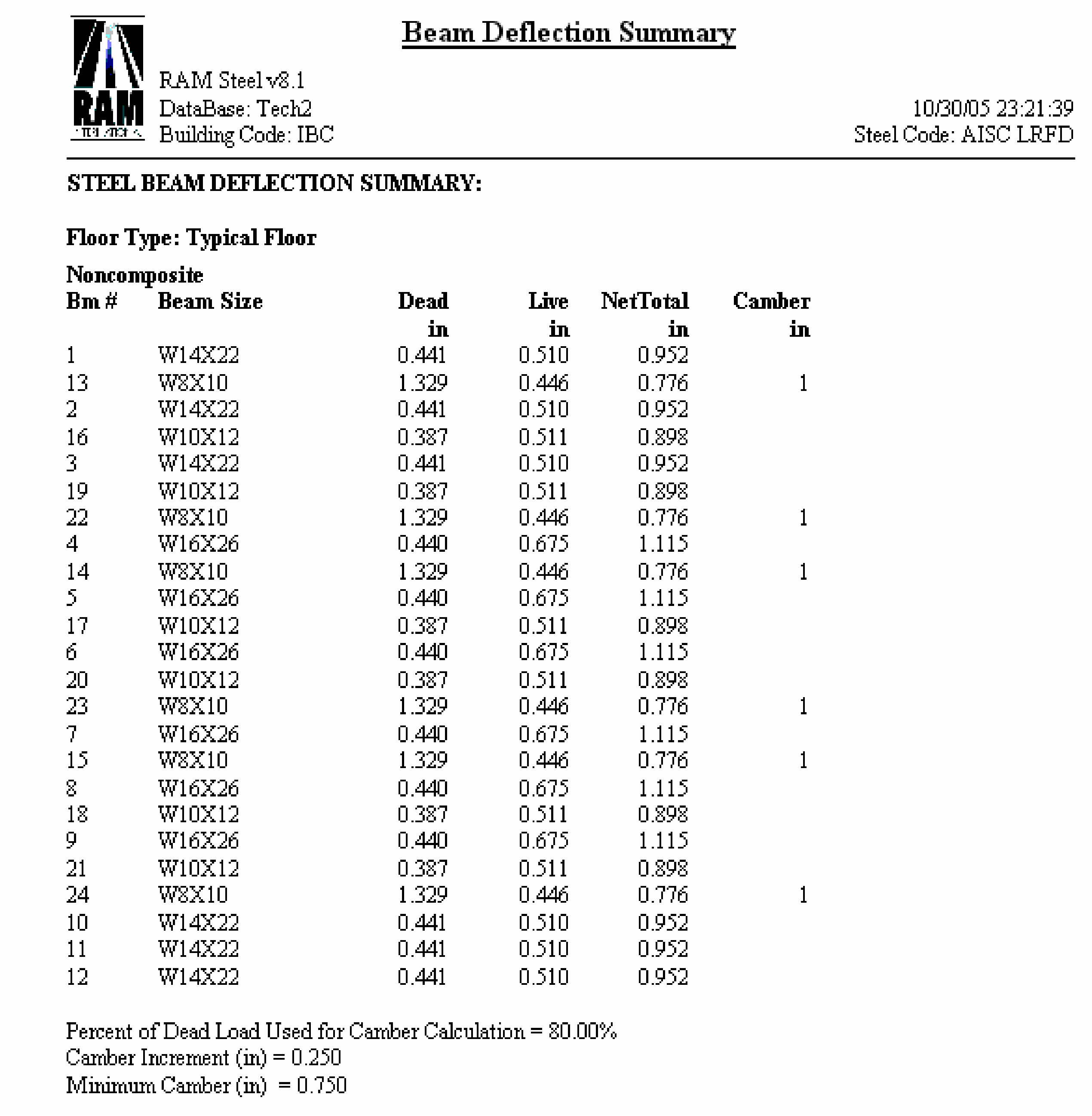
Floor Type: Typical Floor **Beam Number = 22**
Span information (ft): I-End (0.00,68.00) J-End (25.00,68.00)

Load	Dist ft	DL k/ft	LL+ k/ft	LL- k/ft	Max Tot k/ft
W1	0.000	0.135	0.045	0.000	0.180
W2	25.000	0.135	0.045	0.000	0.180



Beam Deflection Summary

RAM Steel v8.1
DataBase: Tech2
Building Code: IBC

10/30/05 23:21:39
Steel Code: AISC LRFD

STEEL BEAM DEFLECTION SUMMARY:

Floor Type: Typical Floor

Noncomposite

Bm #	Beam Size	Dead in	Live in	NetTotal in	Camber in
1	W14X22	0.441	0.510	0.952	
13	W8X10	1.329	0.446	0.776	1
2	W14X22	0.441	0.510	0.952	
16	W10X12	0.387	0.511	0.898	
3	W14X22	0.441	0.510	0.952	
19	W10X12	0.387	0.511	0.898	
22	W8X10	1.329	0.446	0.776	1
4	W16X26	0.440	0.675	1.115	
14	W8X10	1.329	0.446	0.776	1
5	W16X26	0.440	0.675	1.115	
17	W10X12	0.387	0.511	0.898	
6	W16X26	0.440	0.675	1.115	
20	W10X12	0.387	0.511	0.898	
23	W8X10	1.329	0.446	0.776	1
7	W16X26	0.440	0.675	1.115	
15	W8X10	1.329	0.446	0.776	1
8	W16X26	0.440	0.675	1.115	
18	W10X12	0.387	0.511	0.898	
9	W16X26	0.440	0.675	1.115	
21	W10X12	0.387	0.511	0.898	
24	W8X10	1.329	0.446	0.776	1
10	W14X22	0.441	0.510	0.952	
11	W14X22	0.441	0.510	0.952	
12	W14X22	0.441	0.510	0.952	

Percent of Dead Load Used for Camber Calculation = 80.00%
Camber Increment (in) = 0.250
Minimum Camber (in) = 0.750