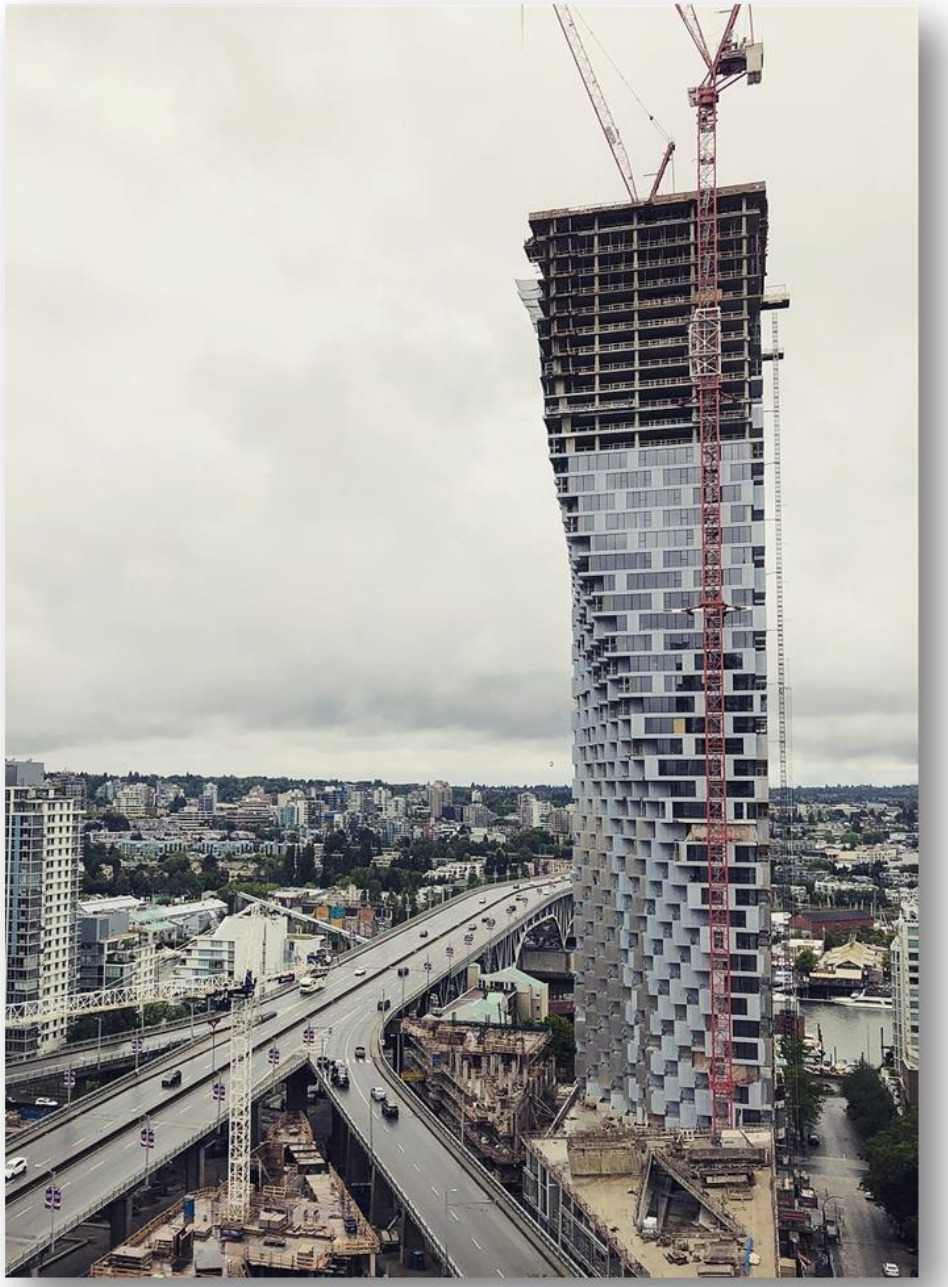
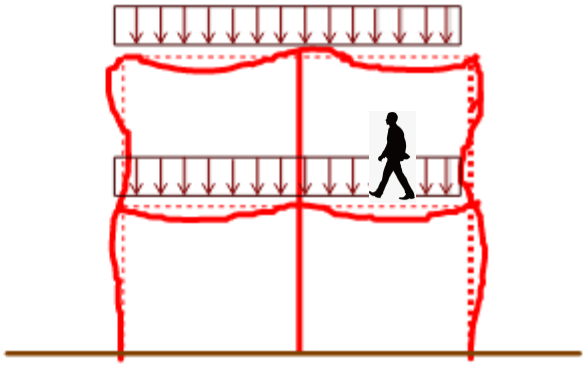
NBCC 2020 CODE CHANGES

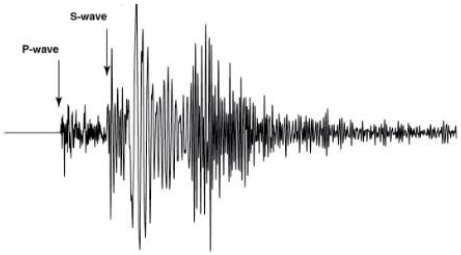
2023-11-22

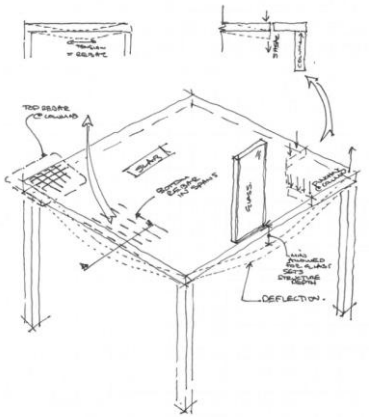
Harrison Glotman

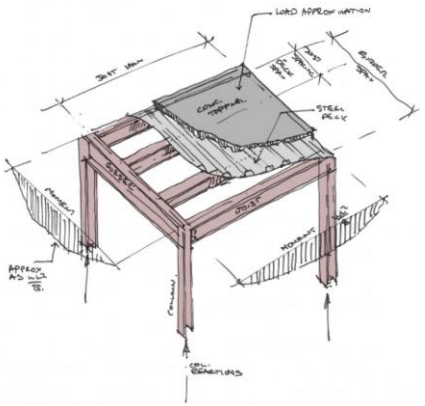


THE FUNDAMENTALS



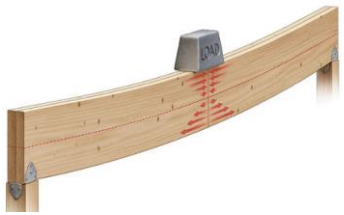


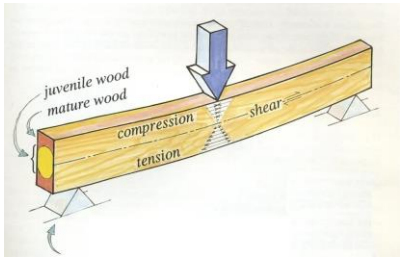


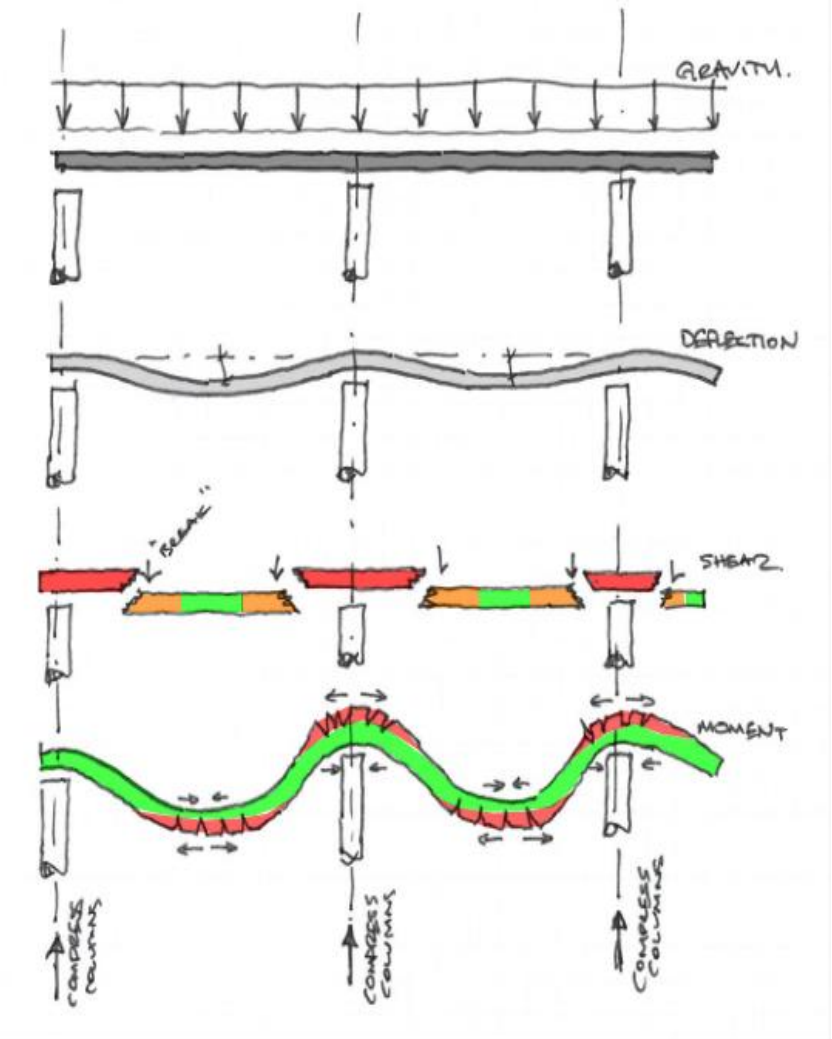


THE FUNDAMENTALS

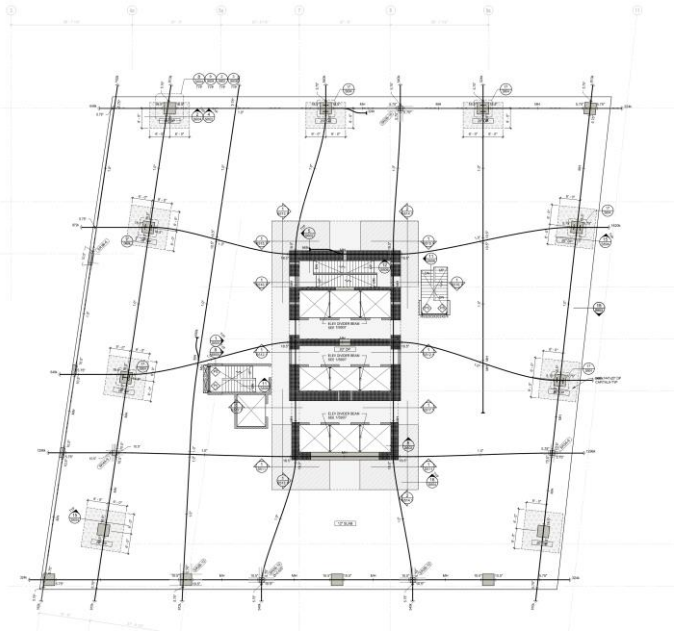
- Gravity only pushes down- Spans are gravity's **nemesis,** Columns are gravity's **friend**.
- Spanning elements Bend, Compress, Shear and Pull on materials
  - All materials have unique strength and stiffness properties prescribed by code, and are optimal for different applications.
- Analysis of each element is broken down into axial, shear, deflection and bending moment plots

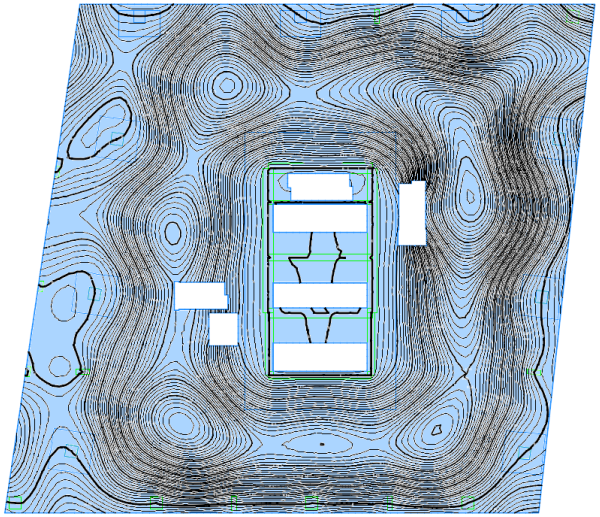


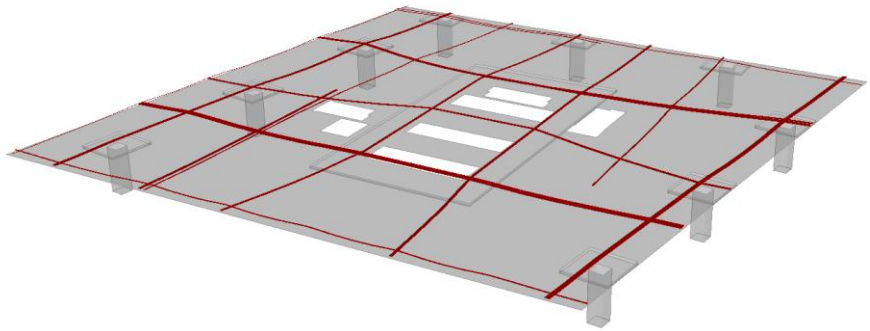




DETAILING THE GRAVITY SYSTEM

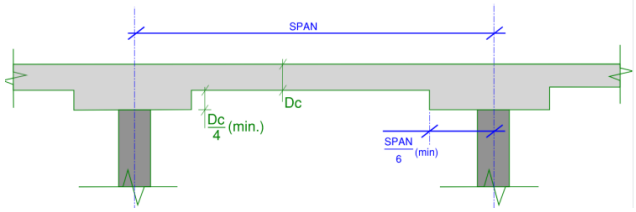






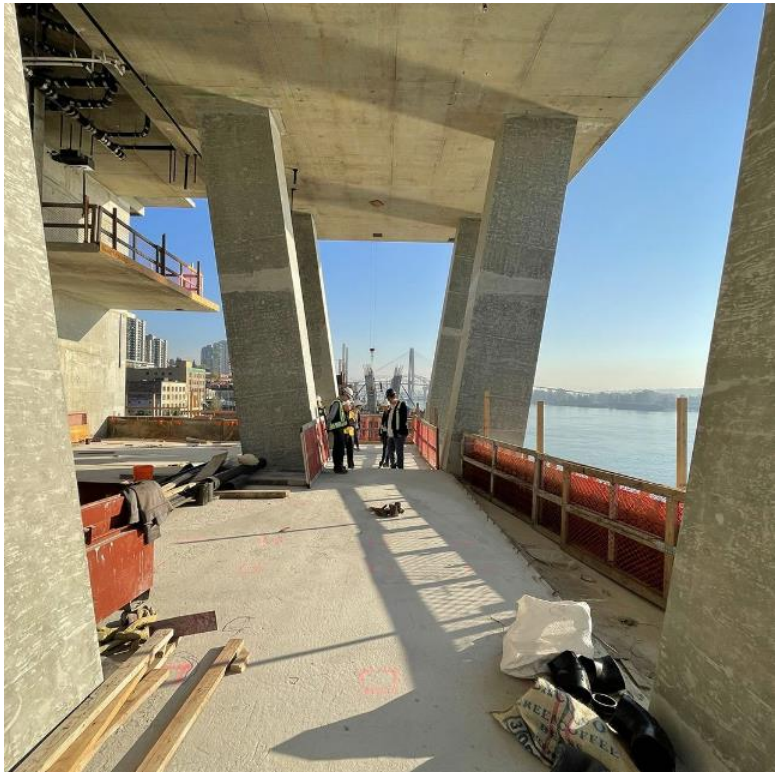
ROUGH SLAB THICKNESS ESTIMATES

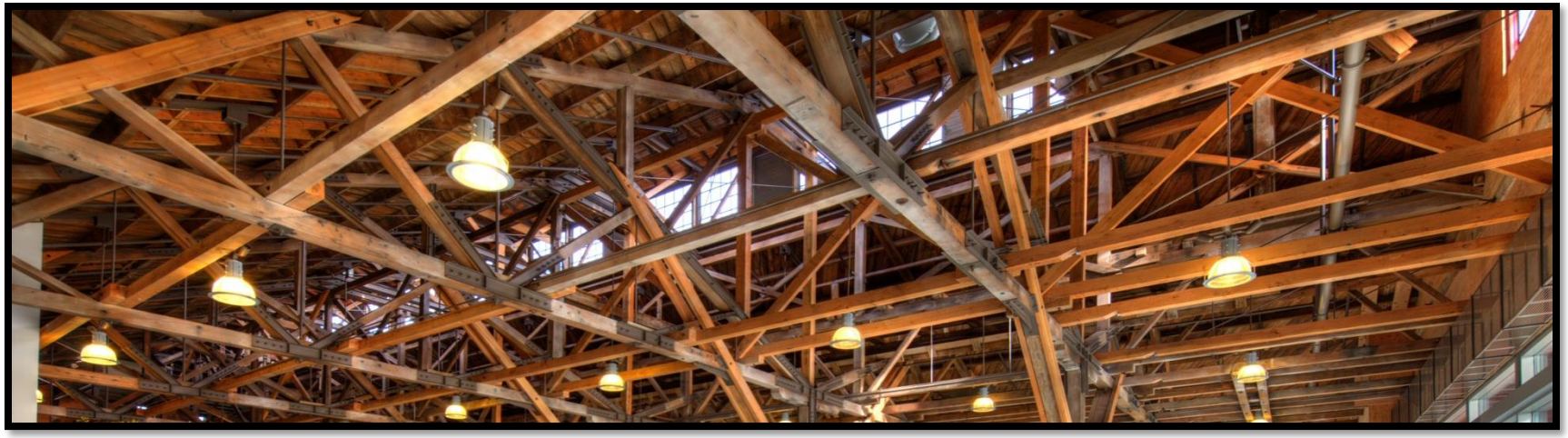
FLAT SLAB CONSTRUCTION GUIDELINES												
Span (m)		Conventional Slab			Post-Tensioned Slab			Slabs with Drop Panels			Drop Panel	
		Interior	End	Cantilever	Interior	End	Cantilever	Interior	End	Cantilever	Depth	Extent
Thickness (mm)	6.0	200	225	2000	175	200	2400	150	175	2400	300	1200
	6.5	200	225	2175	175	200	2600	175	200	2600	350	1300
	7.0	225	250	2325	200	225	2800	175	200	2800	350	1400
	7.5	225	275	2500	200	225	3000	200	225	3000	400	1500
	8.0	250	275	2675	225	250	3200	200	225	3200	400	1600
	8.5	275	300	2825	225	275	3400	225	250	3400	450	1700
	9.0	275	325	3000	250	275	3600	225	275	3600	450	1800
	9.5	300	350	3175	275	300	3800	250	275	3800	500	1900
	10.0	325	350	3325	275	325	4000	275	300	4000	550	2000
	10.5	325	375	3500	300	325	4200	275	300	4200	550	2100
	11.0	350	400	3675	300	350	4400	300	325	4400	600	2200
	11.5	350	400	3825	325	350	4600	300	350	4600	600	2300
	12.0	375	425	4000	325	375	4800	325	350	4800	650	2400

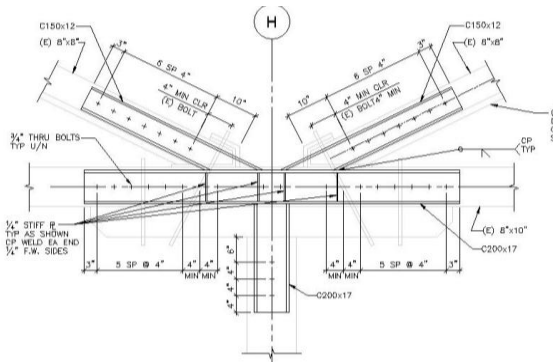


SIZING THE COLUMNS

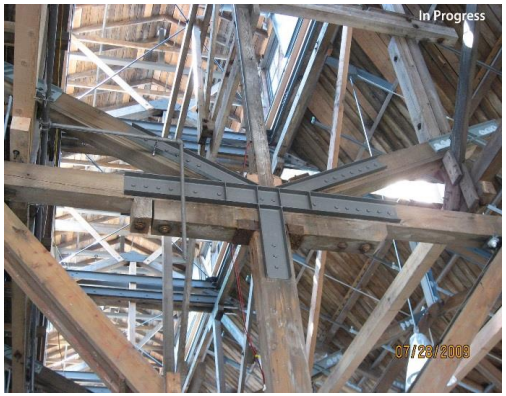
Height	Span	Column
12 Story	18'0"	14" X 48"
	24'6"	18" X 48"
	30'0"	20" X 48"
	36'0"	26" X 48"
8 Story	18'0"	12" X 36"
	24'6"	12" X 48"
	30'0"	16" X 48"
	36'0"	20" X 48"
4 Story	18'0"	12" X 24"
	24'6"	12" X 30"
	30'0"	12" X 36"
	36'0"	12" X 48"



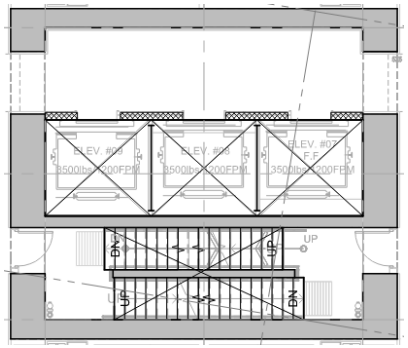


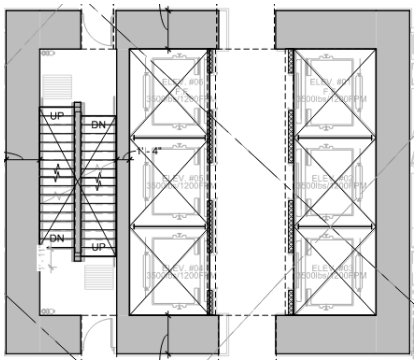


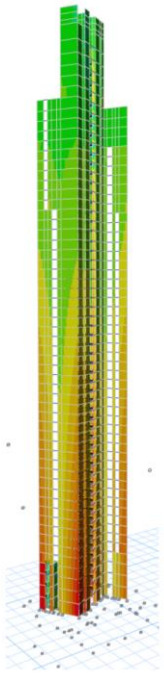
4 **TRUSS CONNECTION SUPPORT DETAIL**
SCALE: 3/4"=1'-0"

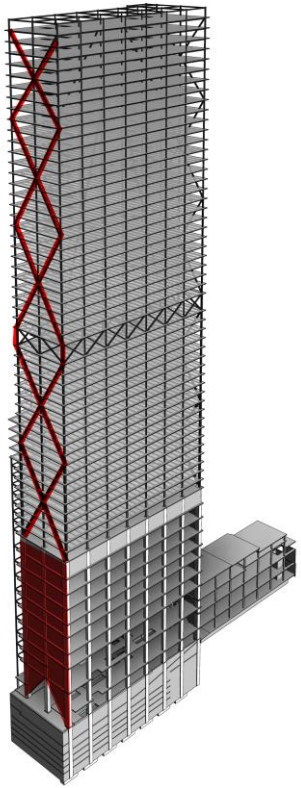


DETAILING THE SEISMIC SYSTEM

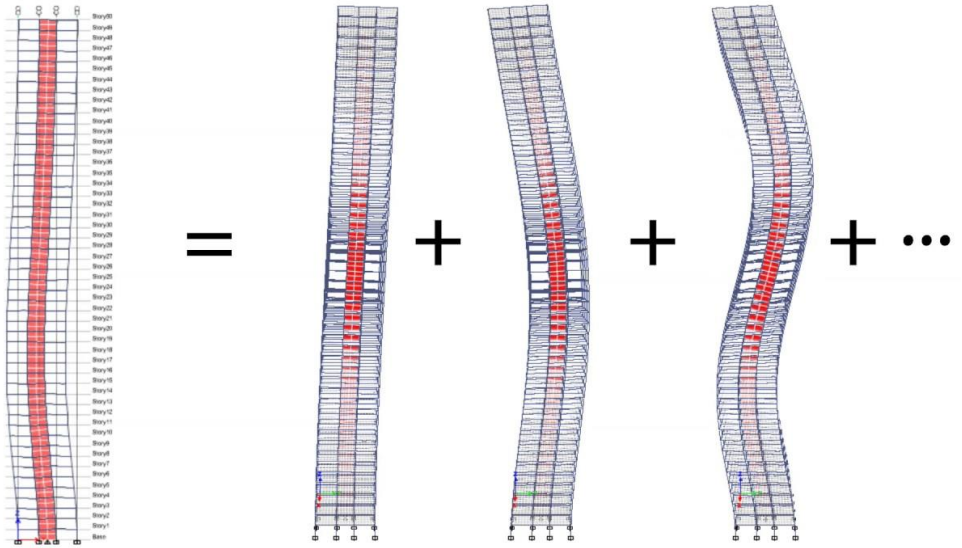




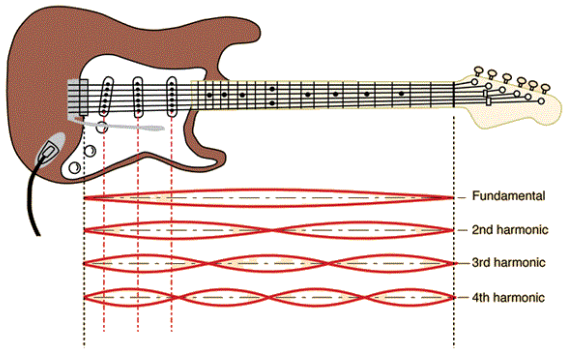




‘GOOD’ VIBRATIONS

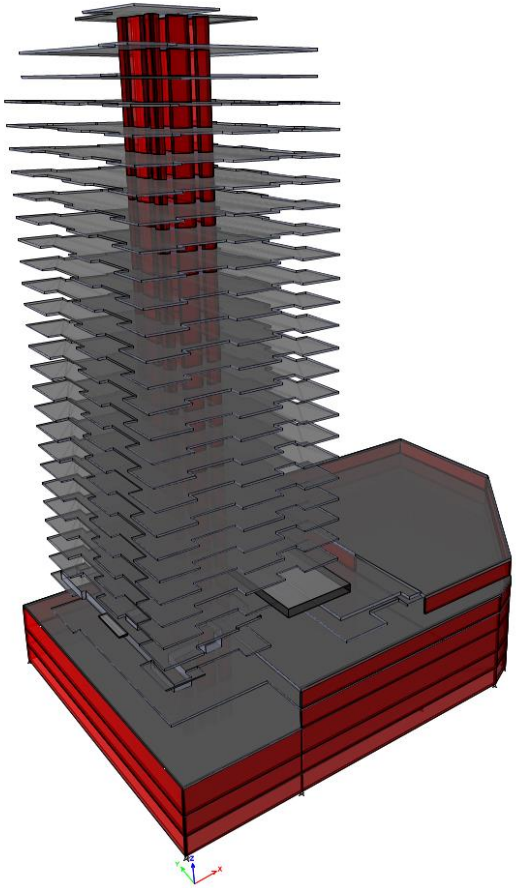


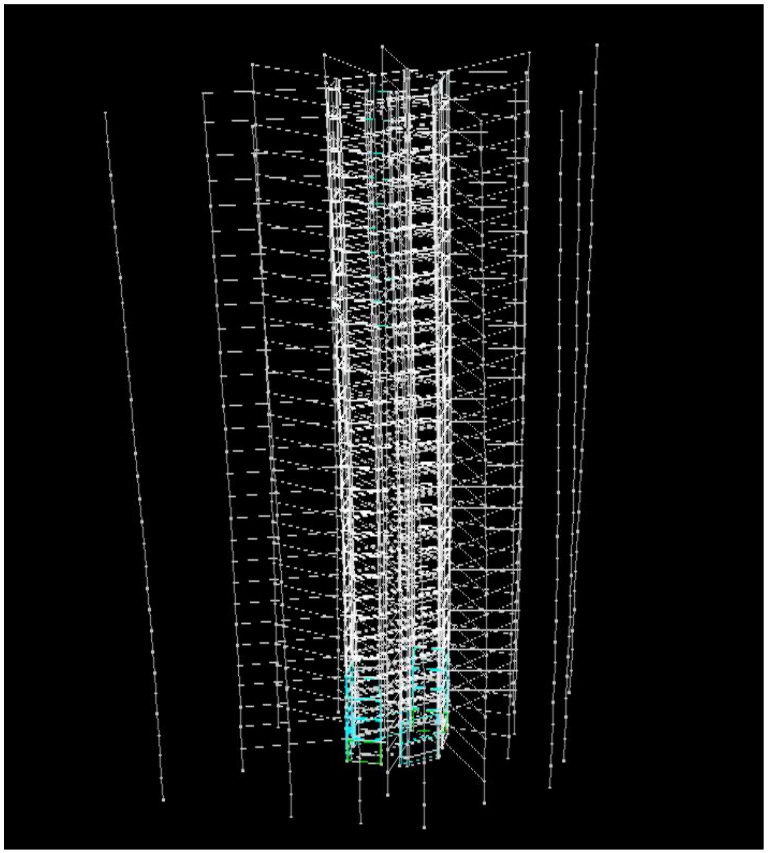
This is “The Period”



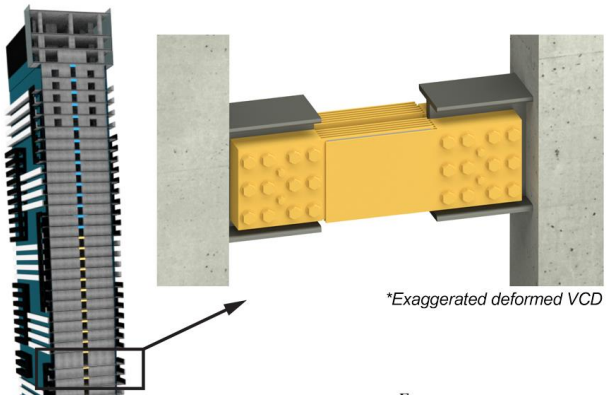
Modes on a String - YouTube

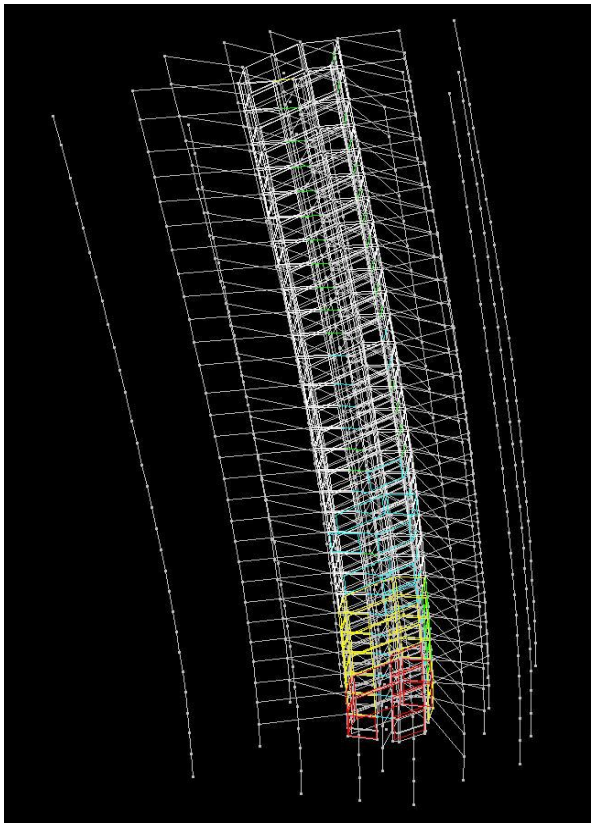
‘GOOD’ VIBRATIONS





DETAILING FOR DUCTILITY



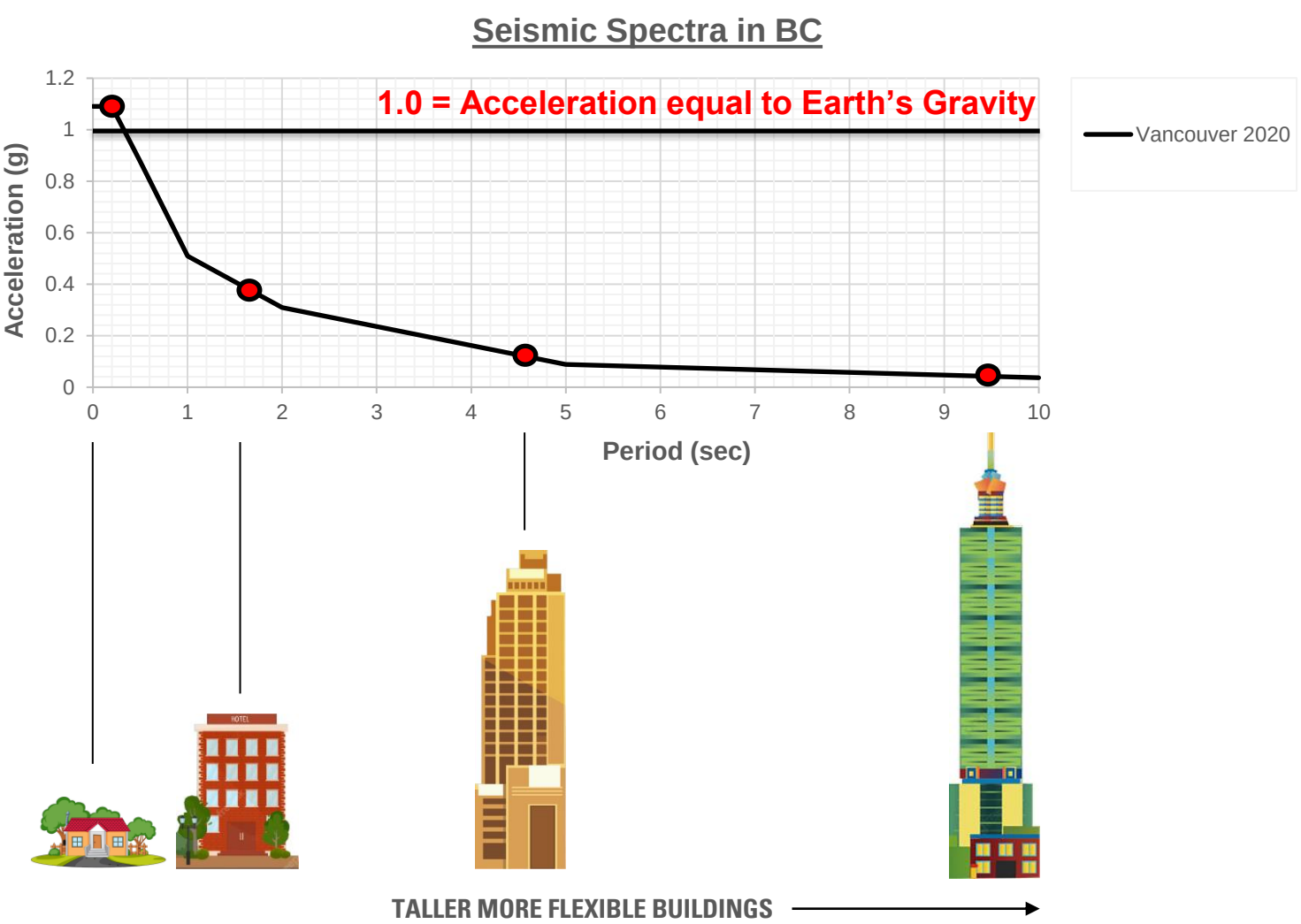


[Testing of a Full-Scale Steel Braced Frame Equipped with CAST CONNEX® High Strength Connectors™ - YouTube]

1 ELEVATION ALONG GRID 5

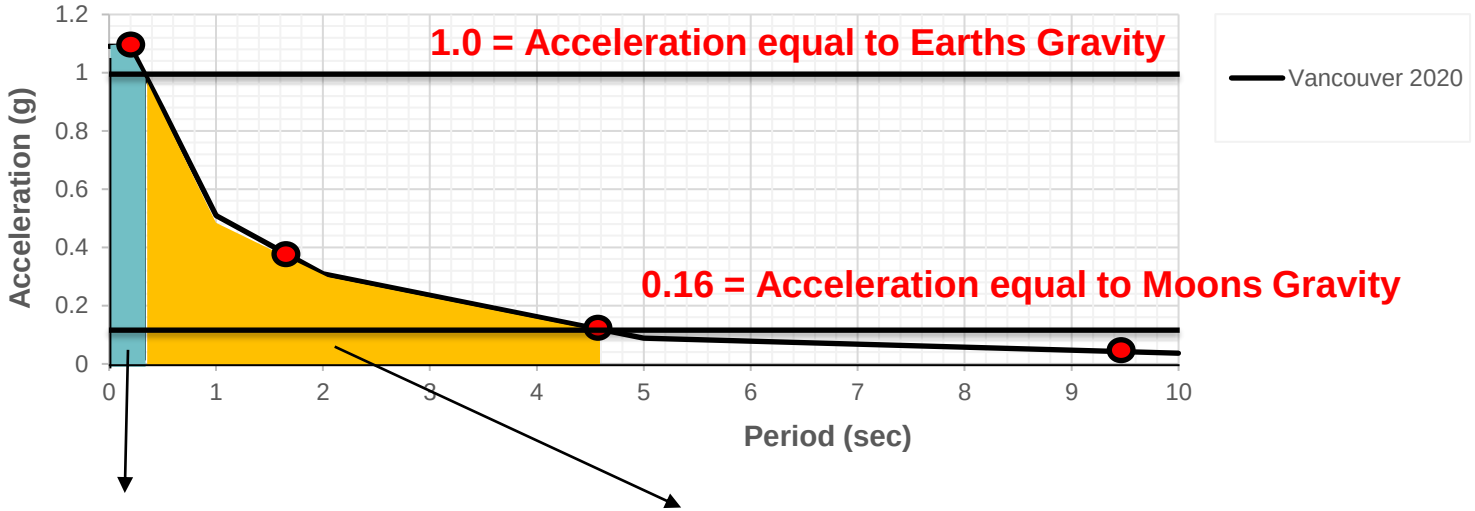
BASICS OF EARTHQUAKE FORCES

MORE SEISMIC LOAD

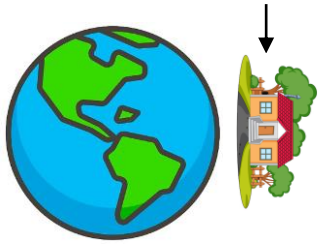


BASICS OF EARTHQUAKE FORCES

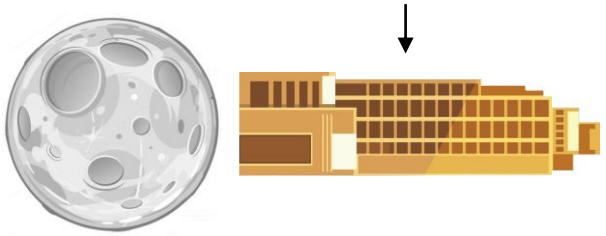
MORE SEISMIC LOAD



Building designed in this region– Can be tipped sideways and remain stable

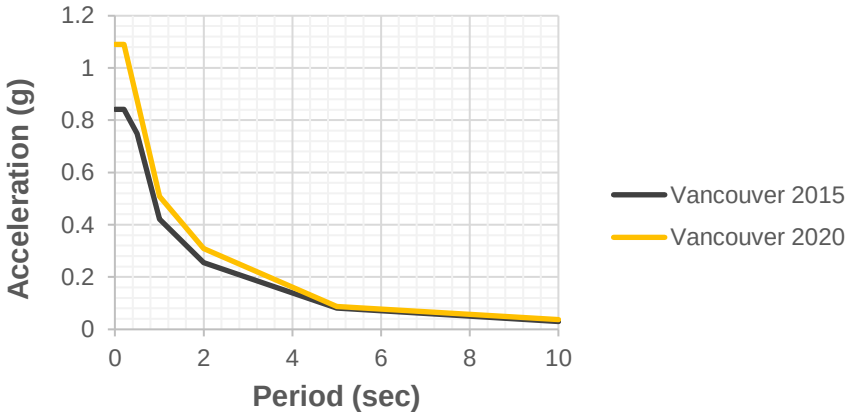


Building that fall in this region – Could be tipped sideways and remain stable on the moon

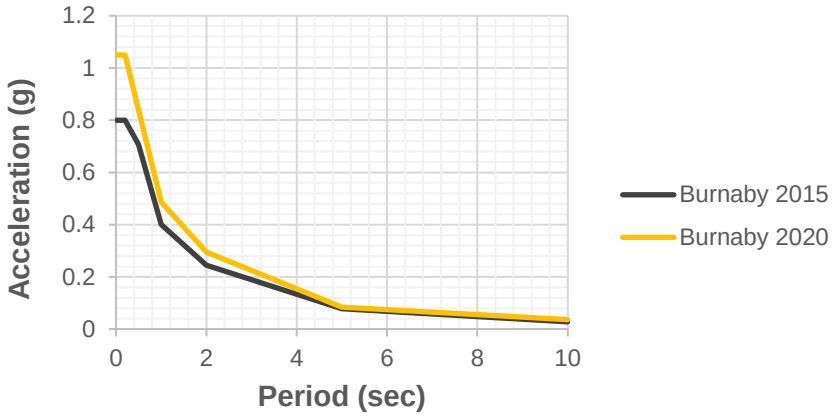


NEW SEISMIC DESIGN LOADS

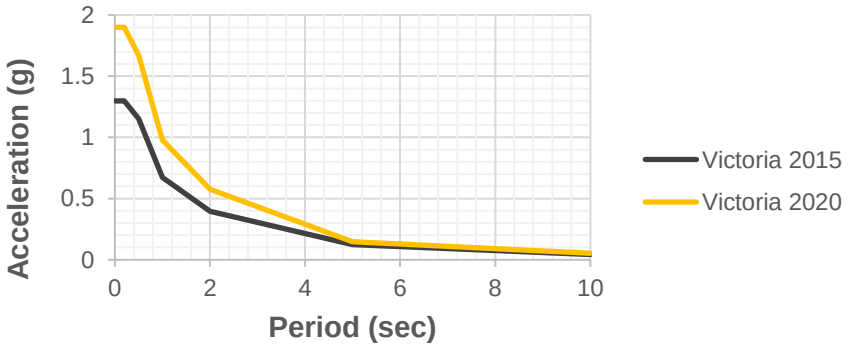
Vancouver City Hall (Site Class C)



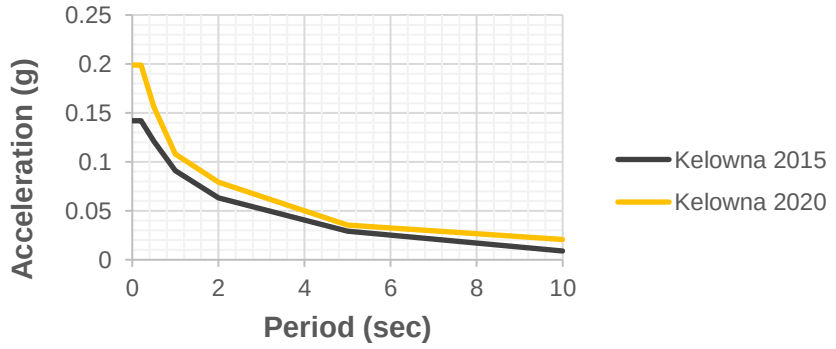
Burnaby Brentwood (Site Class C)



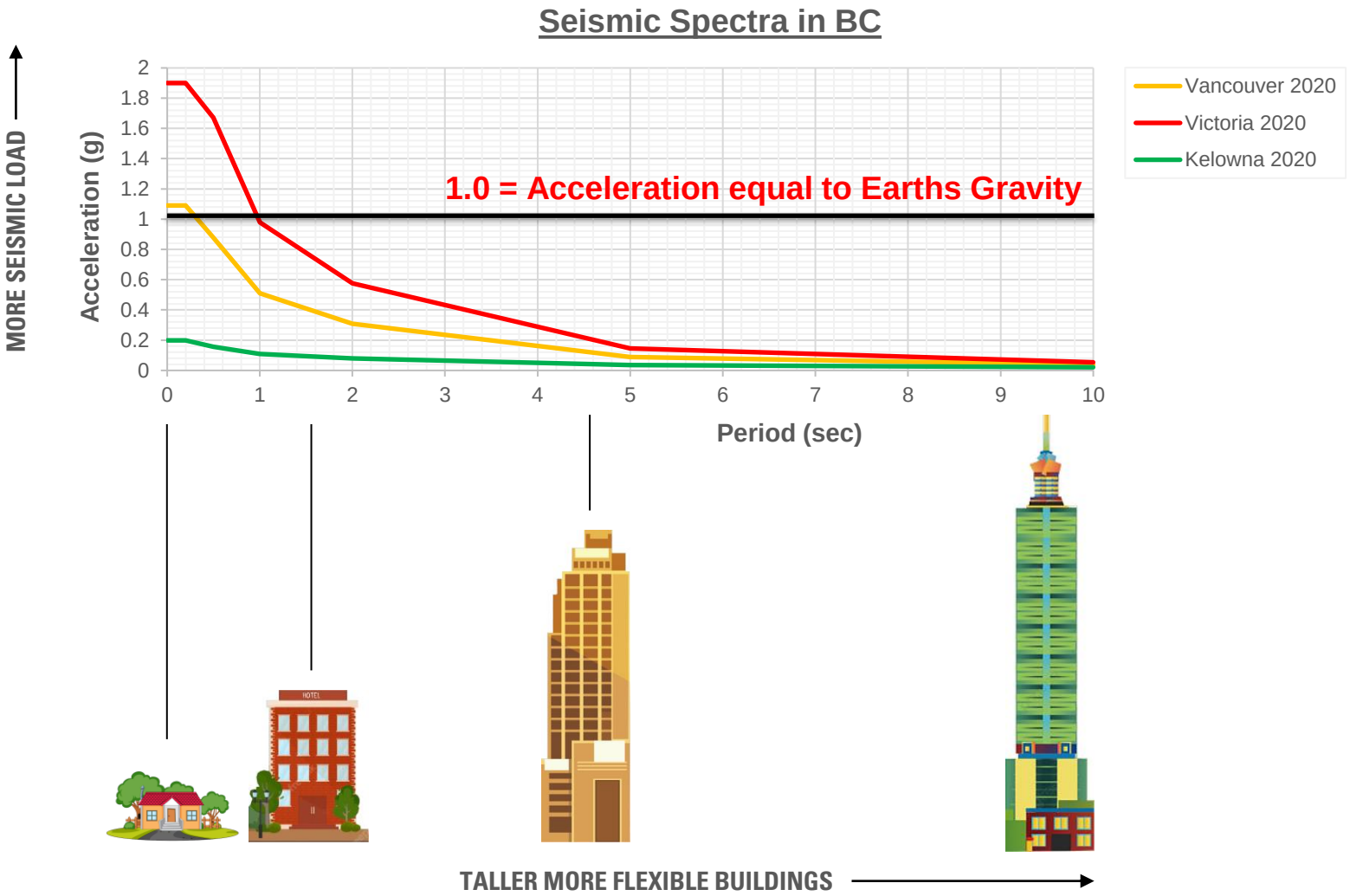
Victoria City Hall (Site Class C)



Kelowna Downtown (Site Class C)

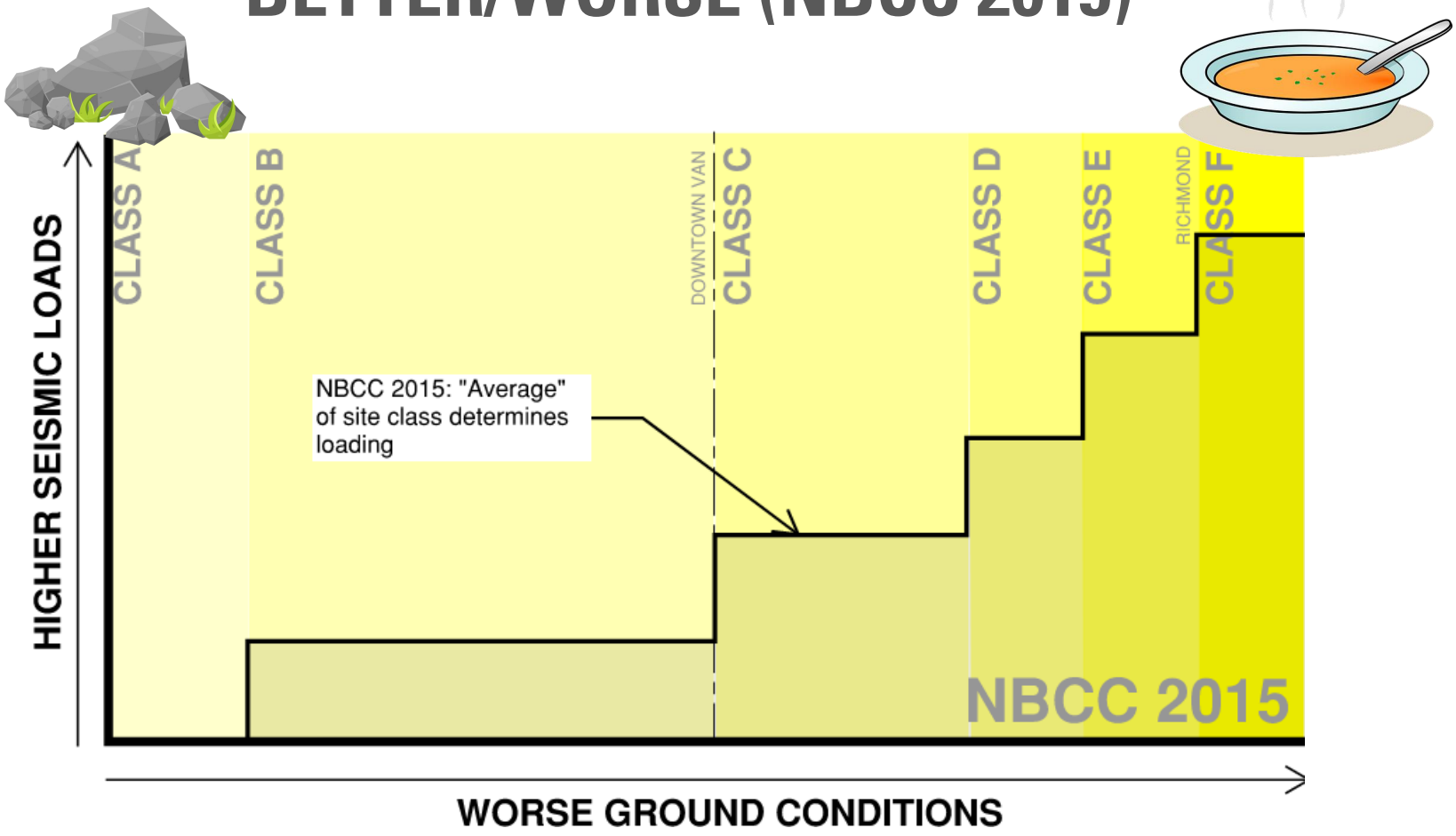


WAIT…HOW MUCH HIGHER IN VICTORIA!?

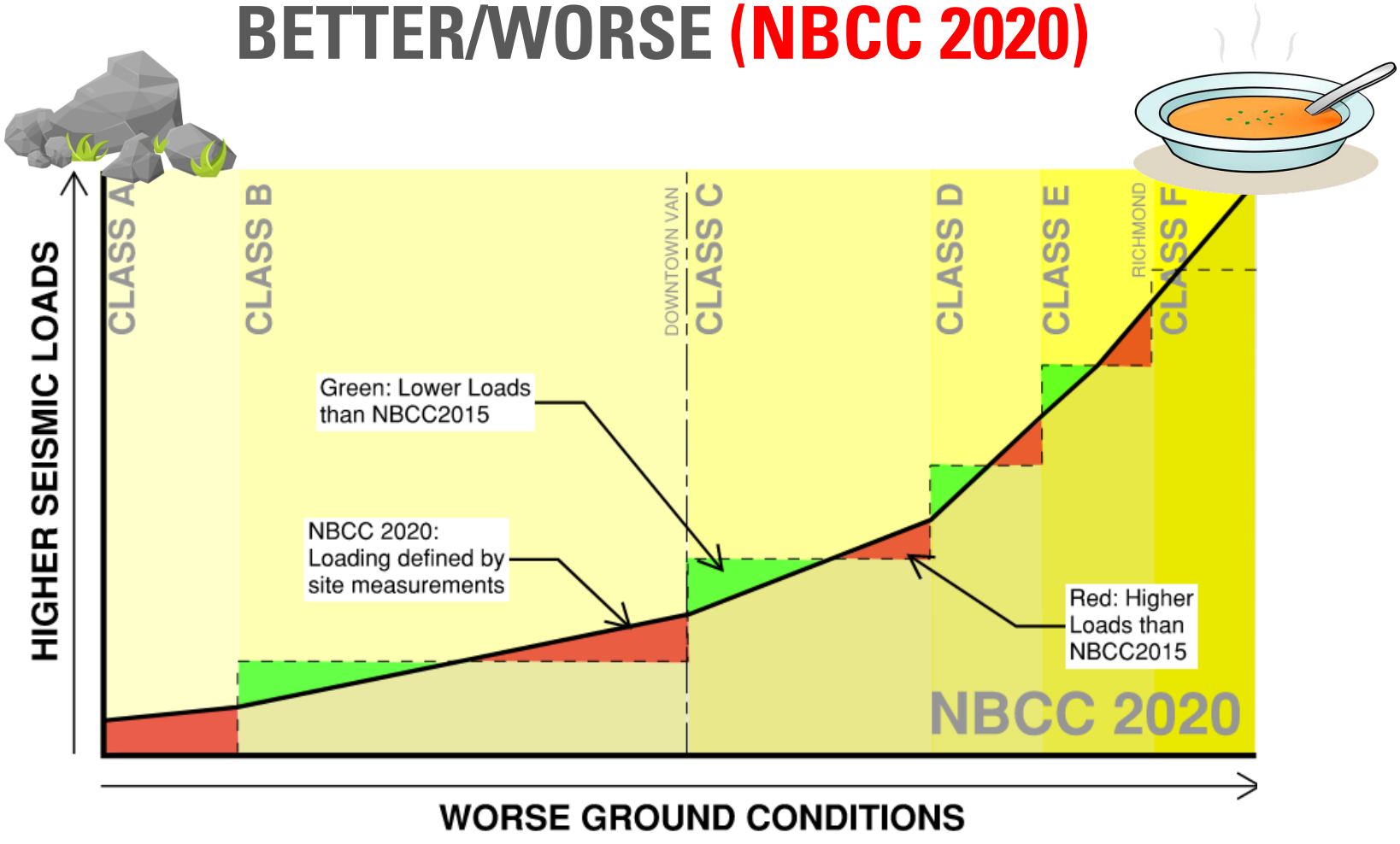


HOW DOES MY SOIL MAKE THIS BETTER/WORSE (NBCC 2015)

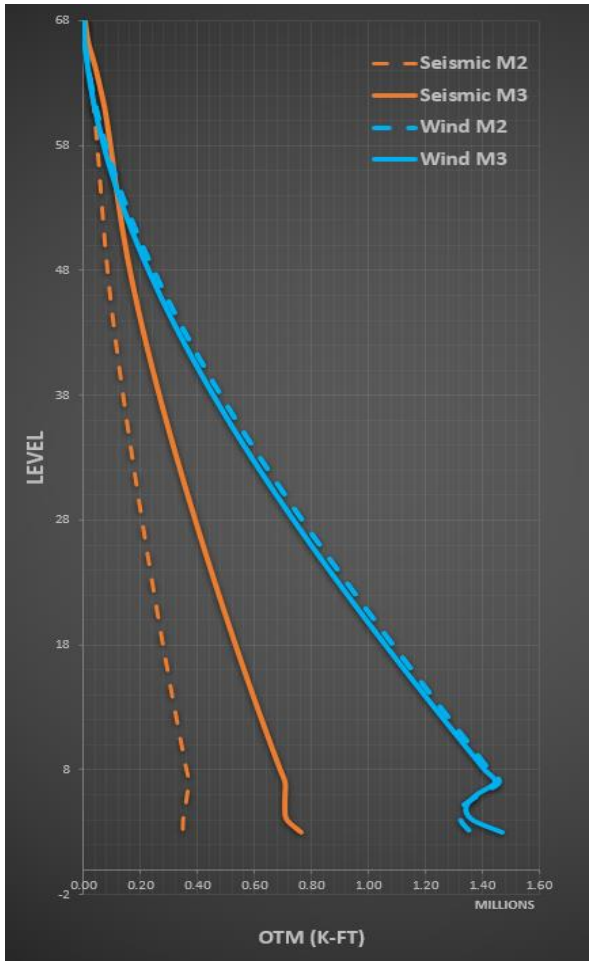
HOW DOES MY SOIL MAKE THIS BETTER/WORSE (NBCC 2015)

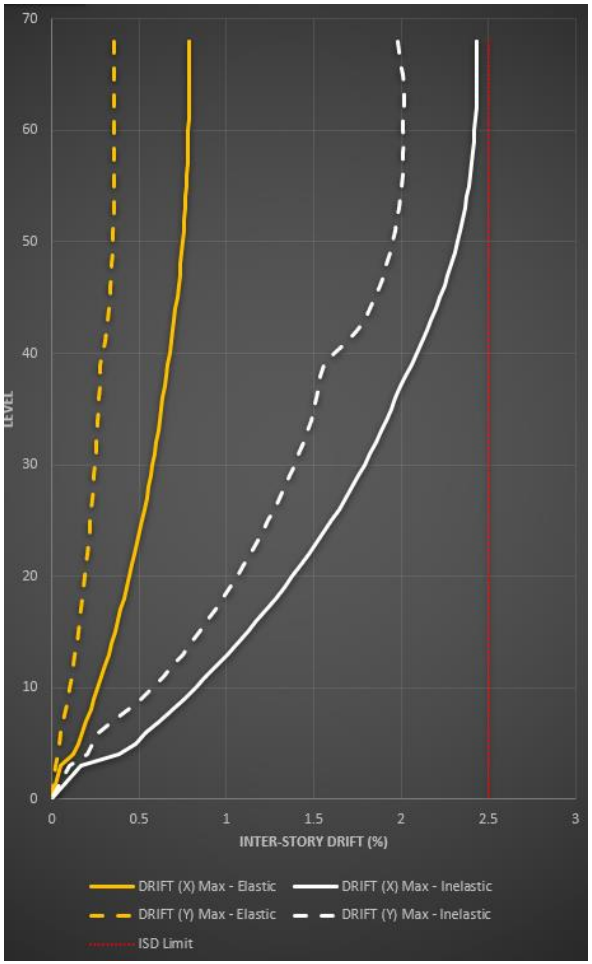


HOW DOES MY SOIL MAKE THIS BETTER/WORSE (NBCC 2020)



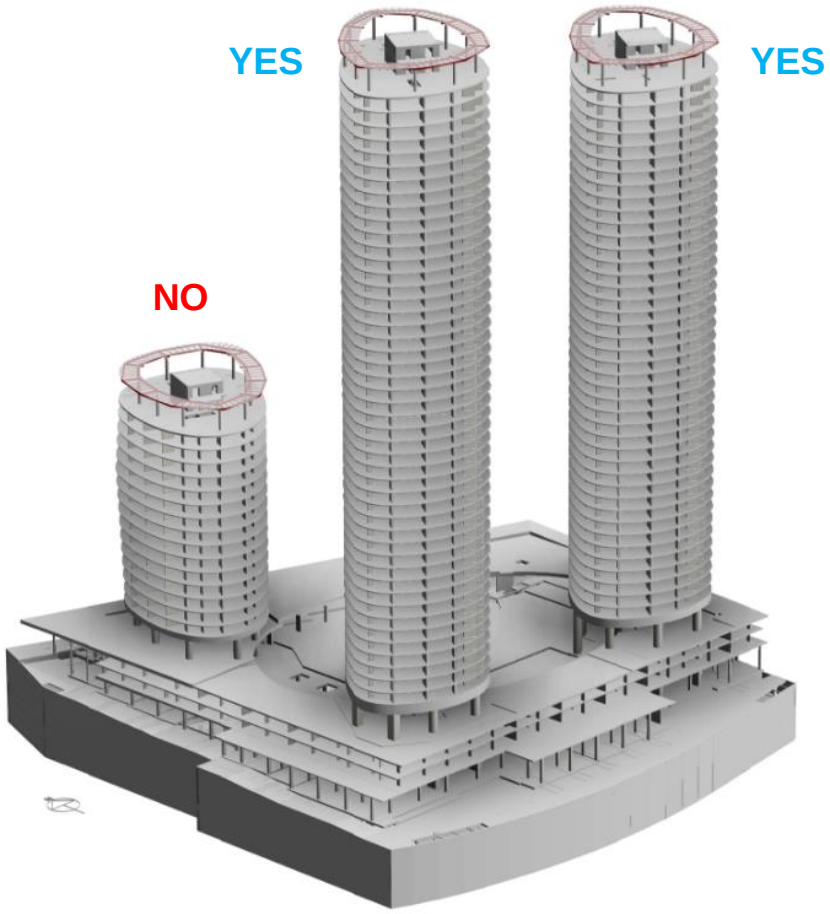
SEISMIC VS. WIND



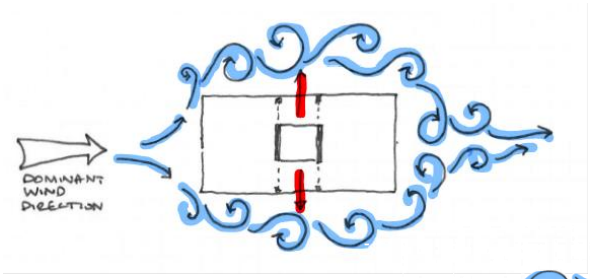


WHEN TO GET A WIND STUDY?

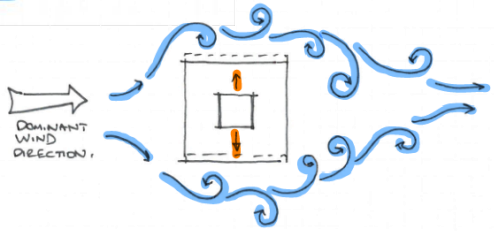
- Code requires a wind-tunnel test for structures with a period > 4.0 sec
- Generally, this applies for 40-storey tower +/-
- Depending on the seismic site classification (B or better), a wind-tunnel test may help realizing great savings for 30-40 storey range.
- Façade system could be a driver.

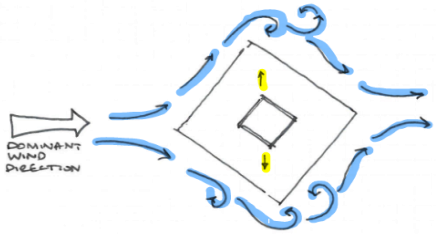


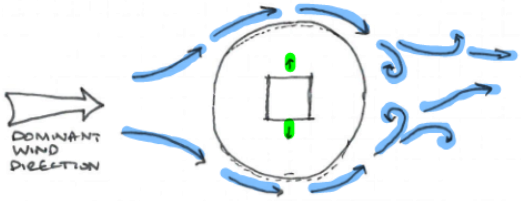
WHAT IF WE JUST HIDE FROM THE WIND



HIGH FORCE/
HIGH ACCELERATION

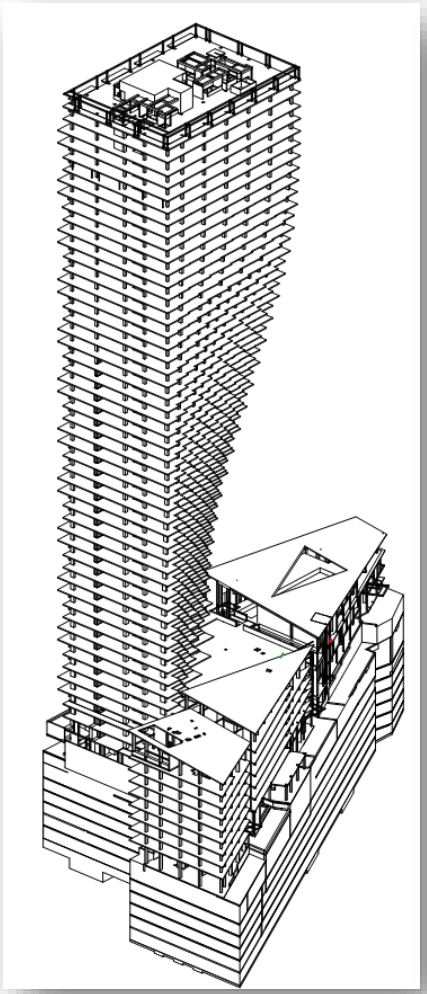


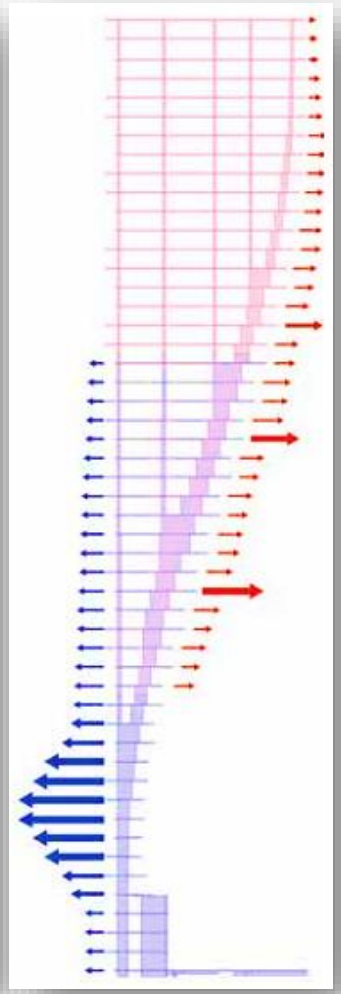




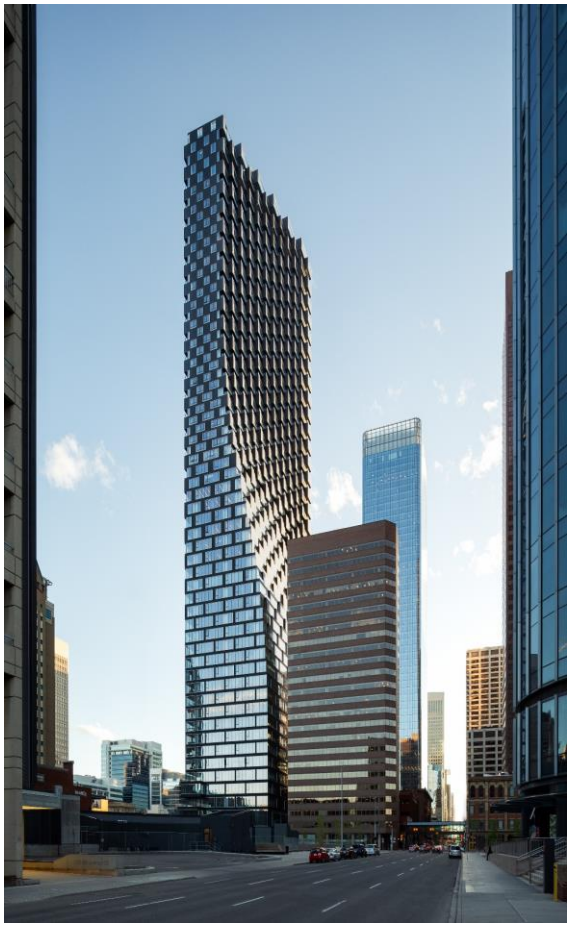
LOW FORCE/
LOW ACCELERATION

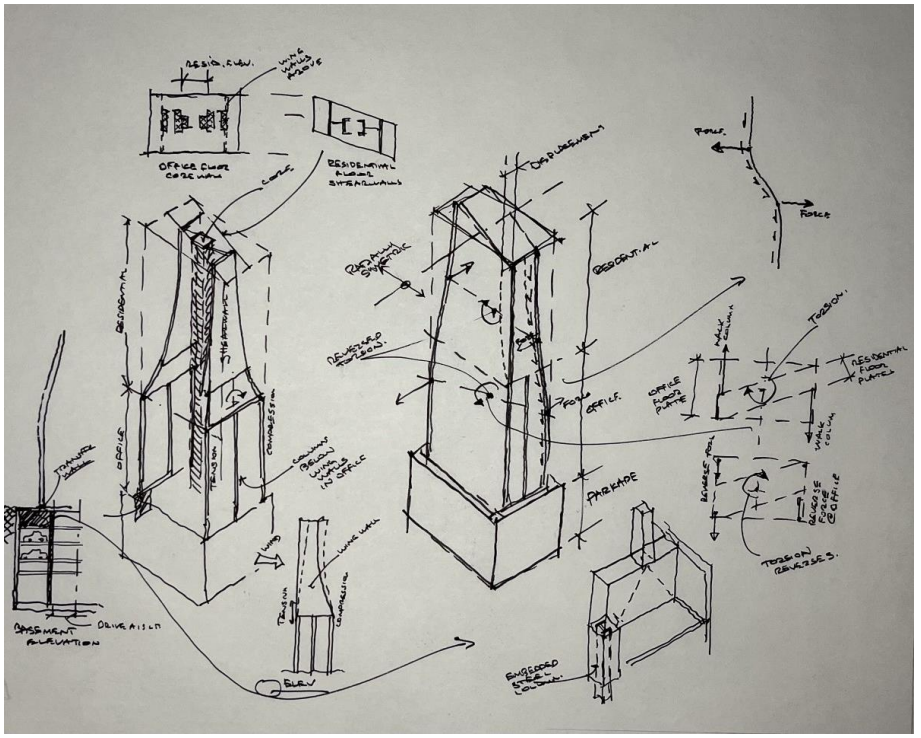
IS IT JUST WIND & EARTHQUAKES?





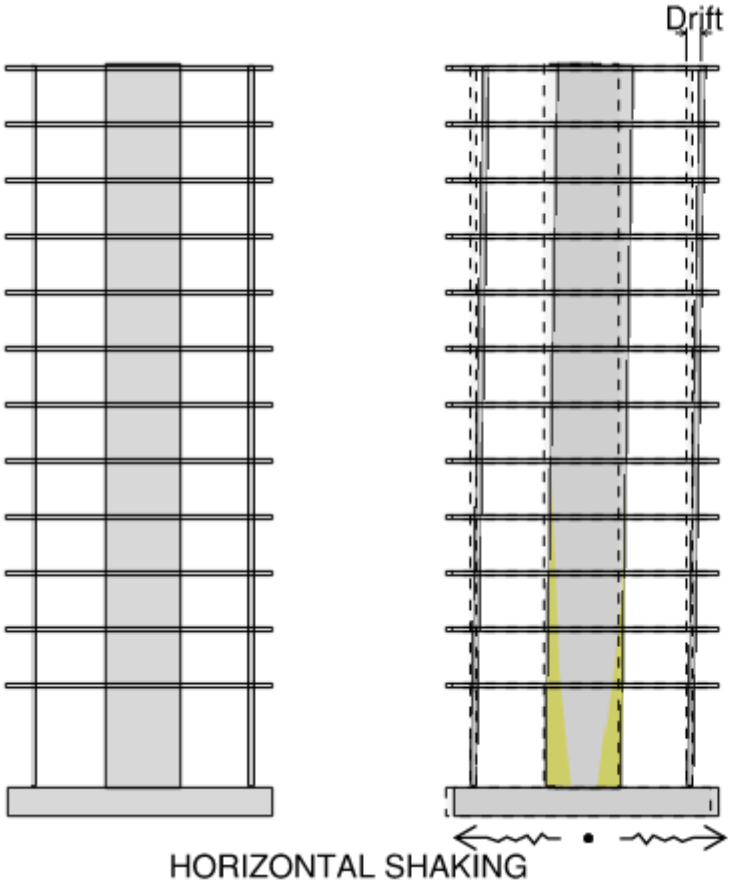
IS IT JUST WIND & EARTHQUAKES?





https://www.youtube.com/watch?v=1JZk95fa5SA

SLOPED COLUMNS ARE COOL (NBCC 2010)

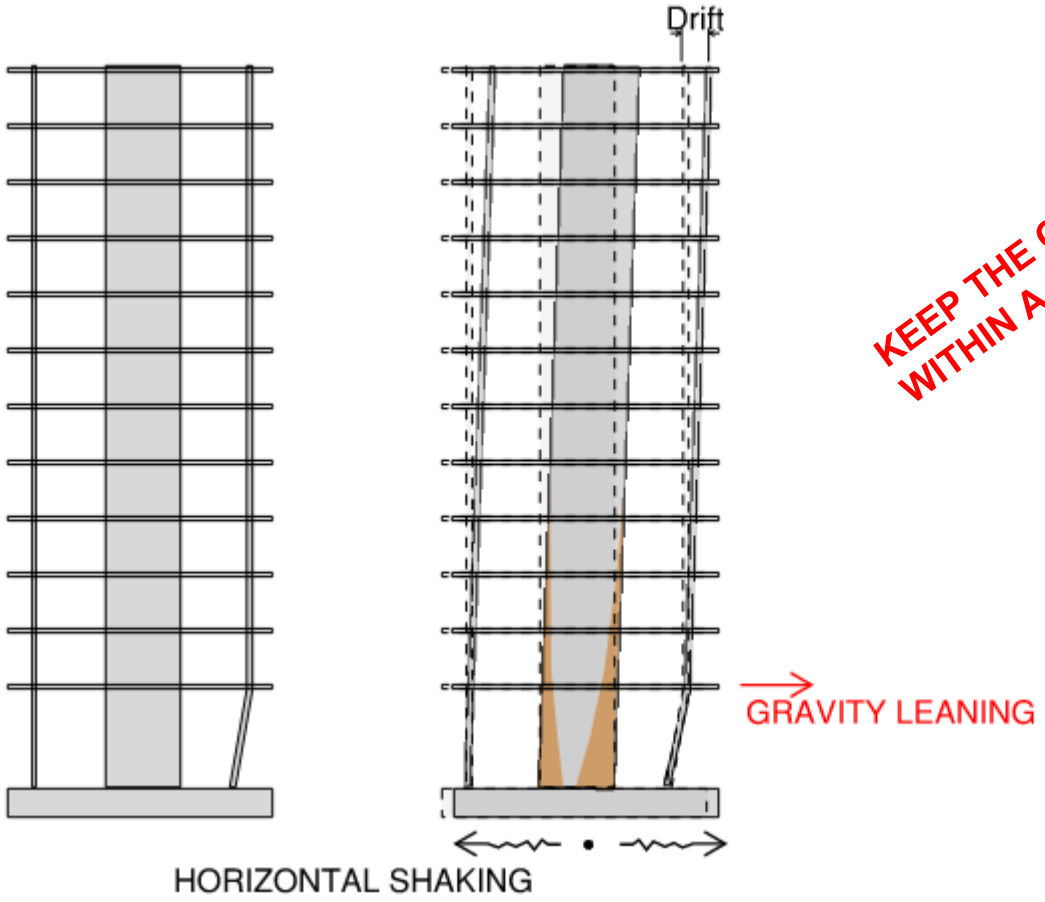


DESIGN THE CORE WITH LITTLE CONSIDERATION OF COLUMNS

NBCC 2010

Gravity Leaning forces not explicitly addressed.

SLOPED COLUMNS ~~ARE~~ WERE COOL (NBCC 2015)

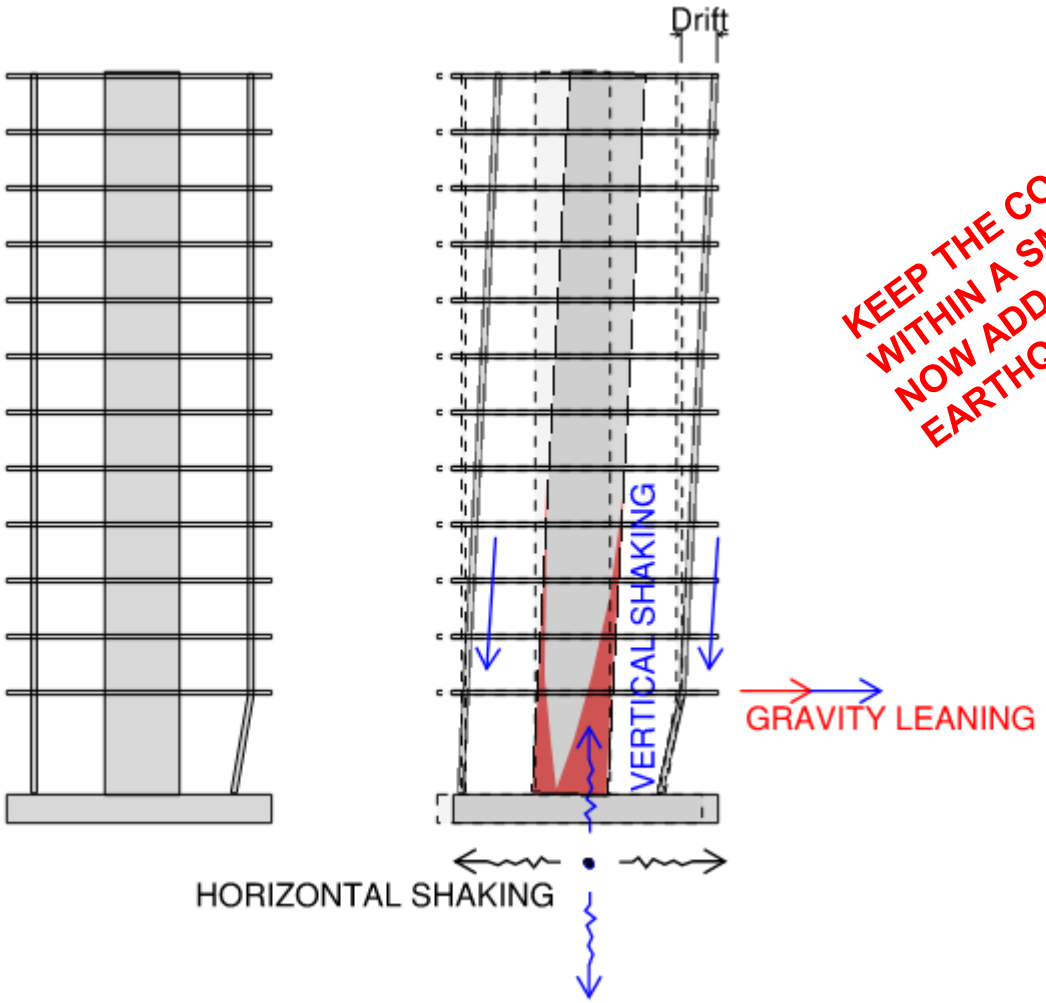


KEEP THE COLUMN LEANING WITHIN A SMALL LIMIT!!

NBCC 2015

Peer review for high gravity leaning forces

SLOPED COLUMNS ARE DIFFICULT (NBCC 2020)



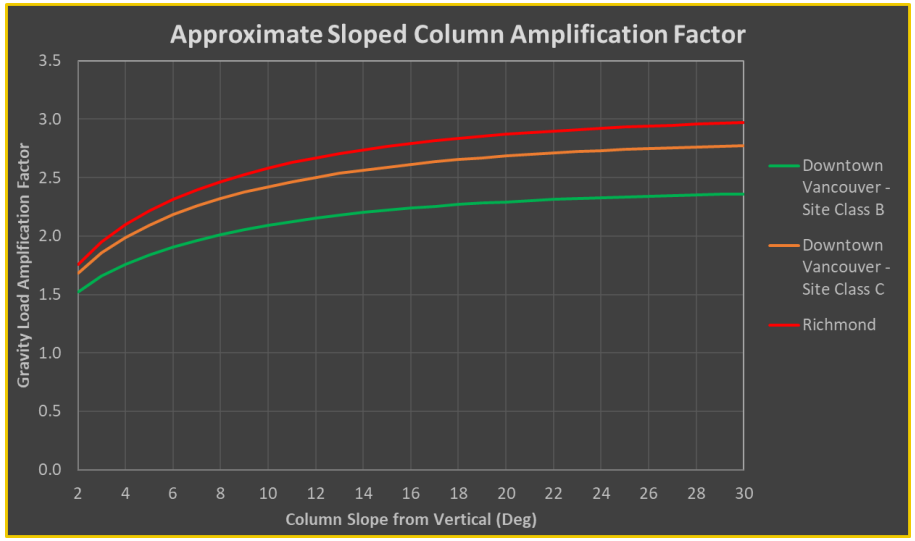
KEEP THE COLUMN LEANING WITHIN A SMALL LIMIT!! NOW ADD VERTICAL EARTHQUAKE LOADS.

NBCC 2020

More demand on core, columns and diaphragms from vertical accelerations.

Peer review for high gravity leaning forces

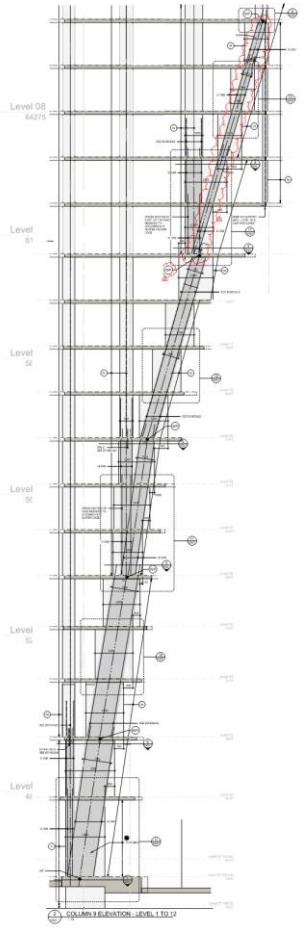
MY PROJECT HAS SLOPED COLUMNS…
WHAT CAN I EXPECT



Columns Get **Bigger**

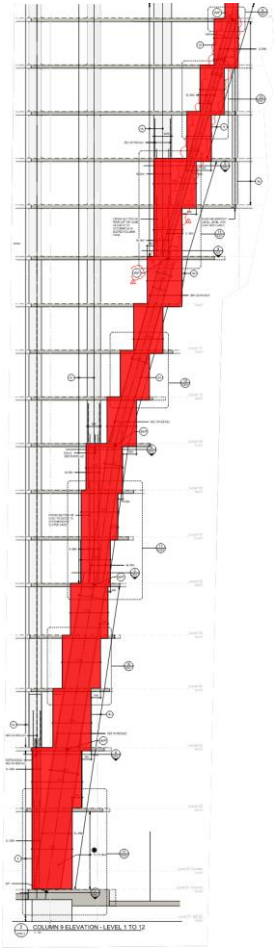
- Anything sloping more than 2% triggers a code clause that amplifies the column loads.
- Larger slope- larger column BUT, also adds more load to core. **UP TO 3x the LOAD!**
- **Peer Review** for nnbalanced sloped Structures

DO WALKING COLUMNS COUNT?

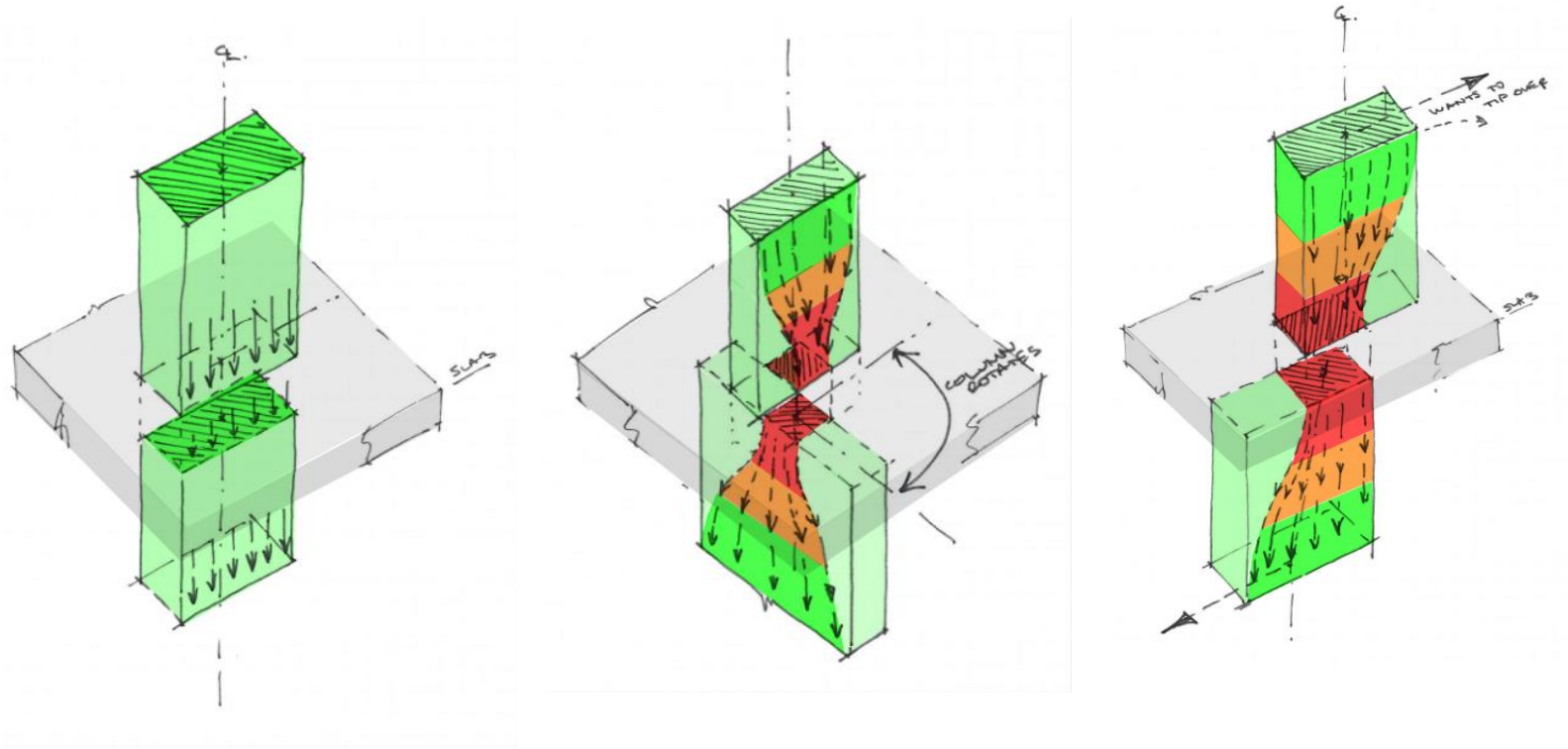


Any column that has a base offset from its position further up has an inherent **sloped load path**.

Walking columns = Sloped Columns

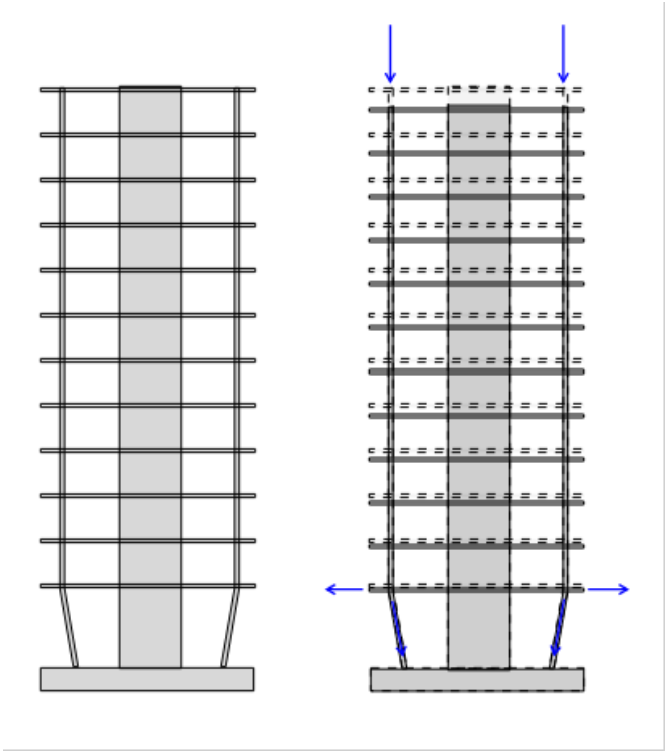


MY COLUMNS TOTALLY ALIGN



MY ARCHITECT NEEDS SLOPED/WALKING COLUMNS.

WHAT SHOULD I DO?



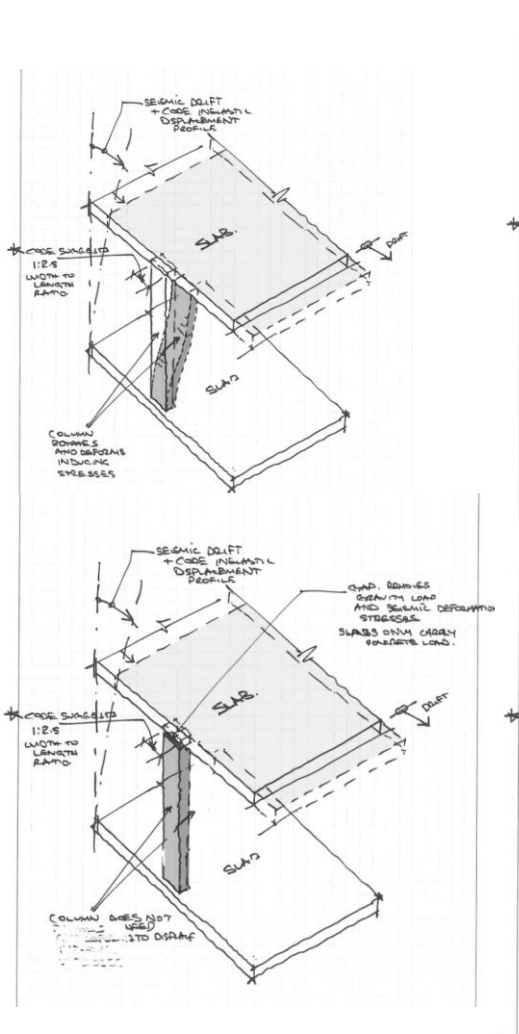
Engage us to review as soon as possible, can suggest how to:

-Balance the loads
-Proportion the core
-Road map to minimize the impacts (Cost, Space inefficiency, Construction complexity, Avoid peer review etc.)

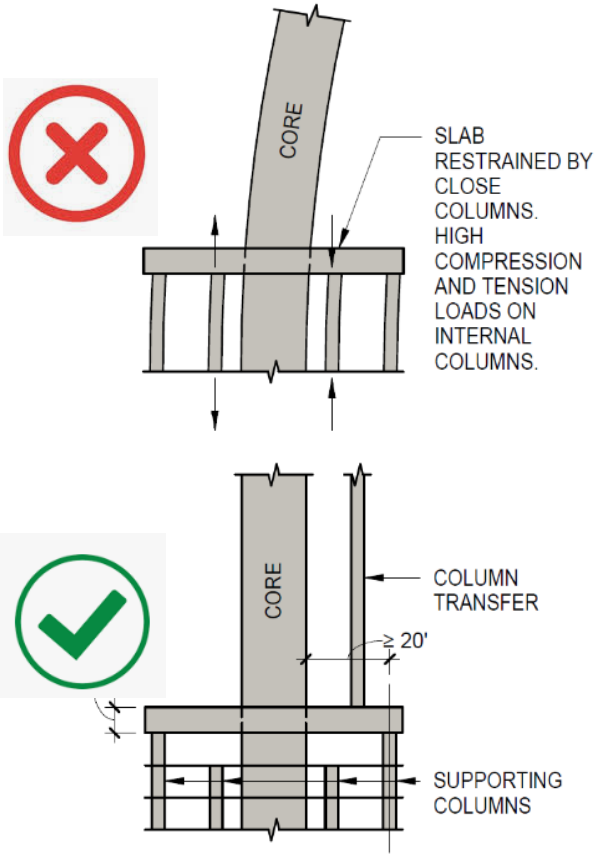
What's the Cheapest Thing to do?

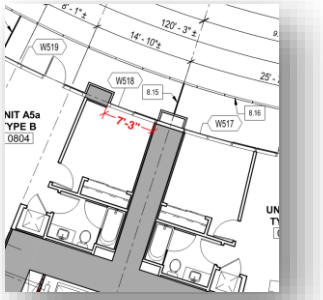
Limit Slopes, offsets, walking, rotating columns, and transfers

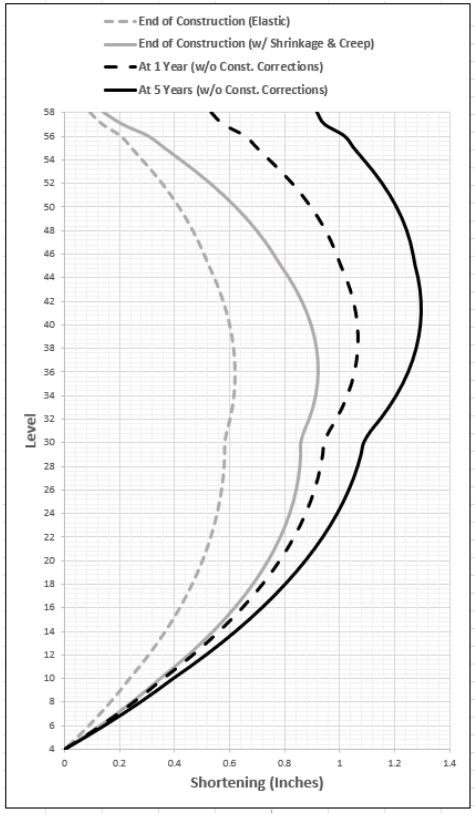
WHAT HAPPENS TO MY COLUMNS AND WALLS?



AVOID COLUMNS CLOSE TO THE CORE







Also, more costly core and foundations!

COLUMNS SHRINK

IS IT ALL BAD NEWS?

WHAT DO WE DO ABOUT IT?

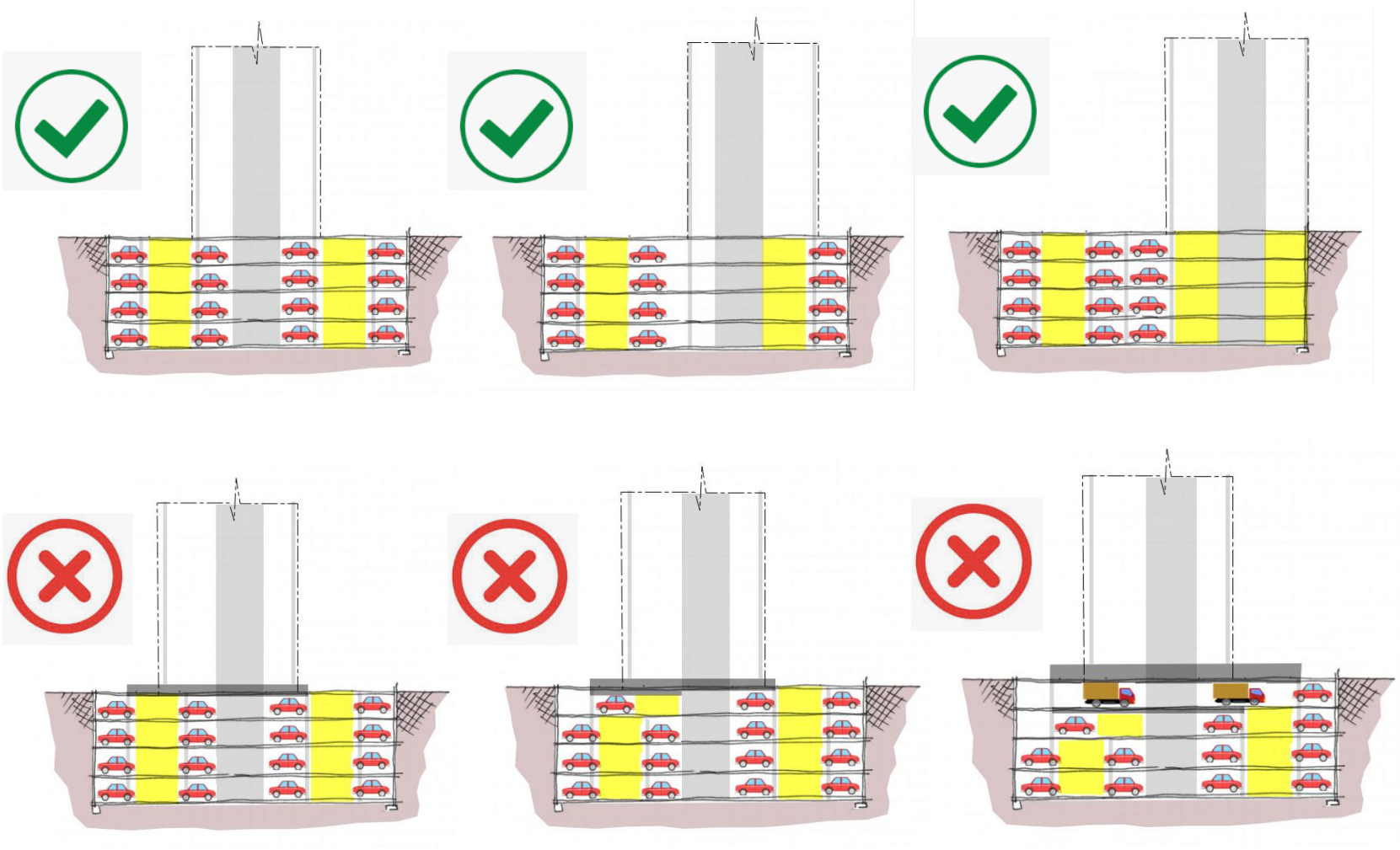
K.I.S.S.
-Limit Slopes, offsets, walking, rotating columns, and transfers

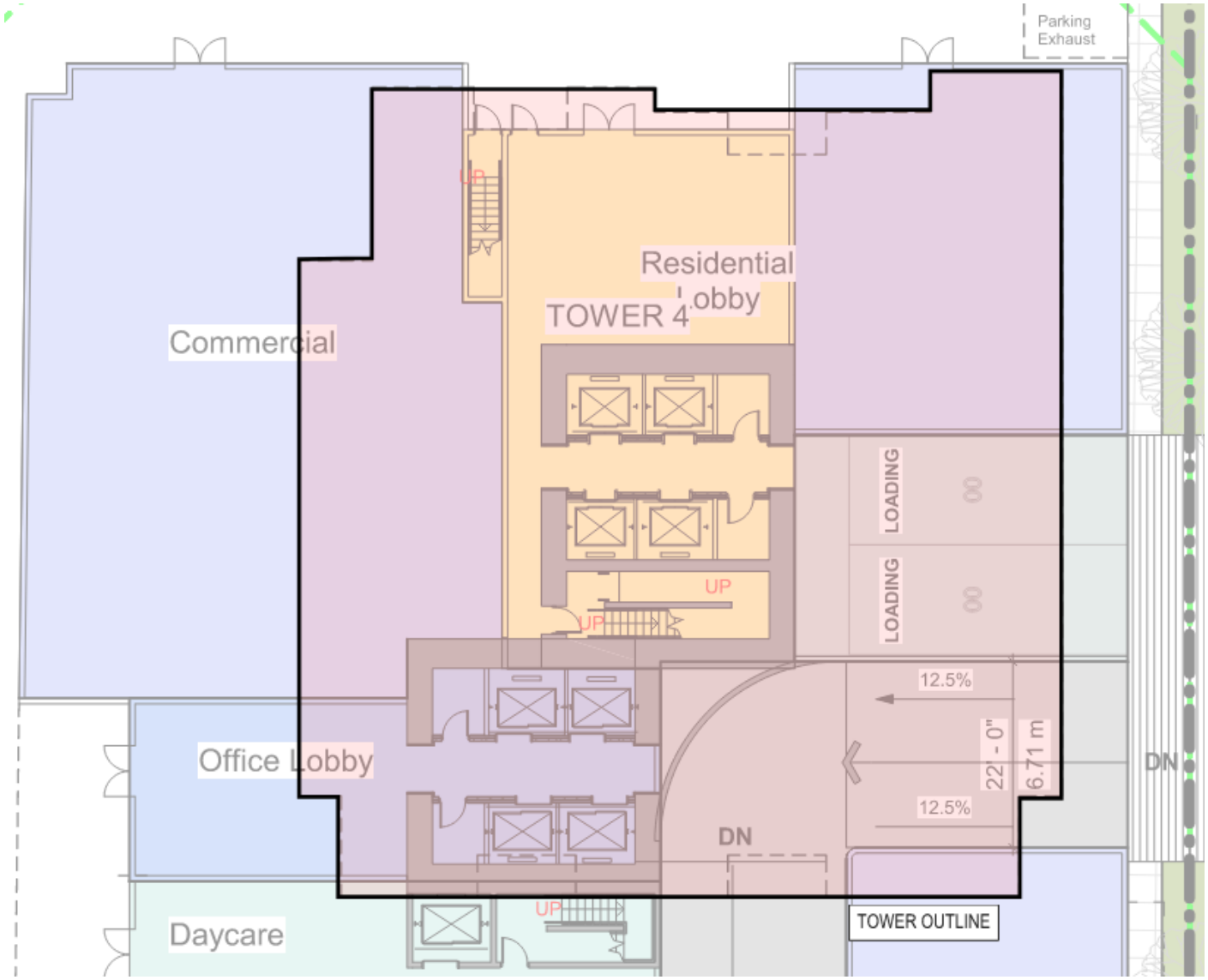
If we want to keep it exciting… we are well-equipped to run a peer review and non-linear analysis. We've been doing it for many years in the United States.

Good news is the simpler the structure, the better it performs from an embodied carbon and cost standpoint.

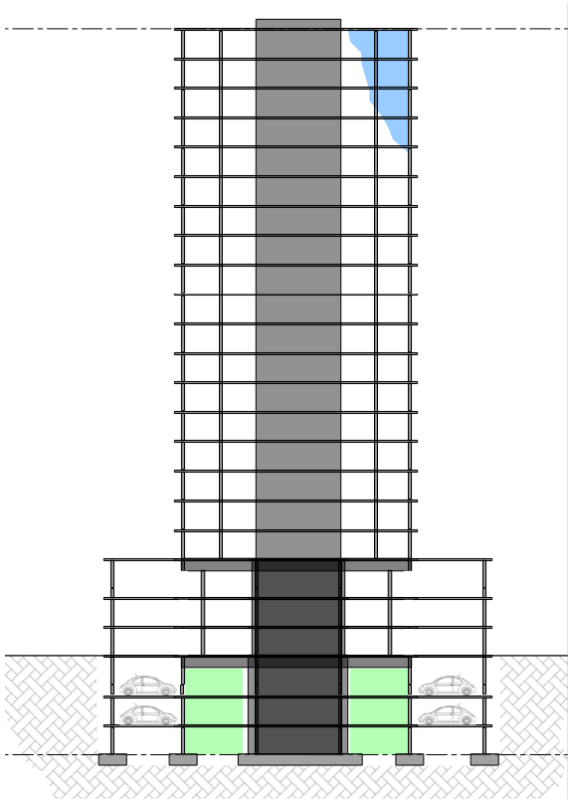
While conventional means of construction are getting more restrictive, advances are being made in mass timber and sustainability.

ALIGNMENT – ALL ABOUT THE MASSING

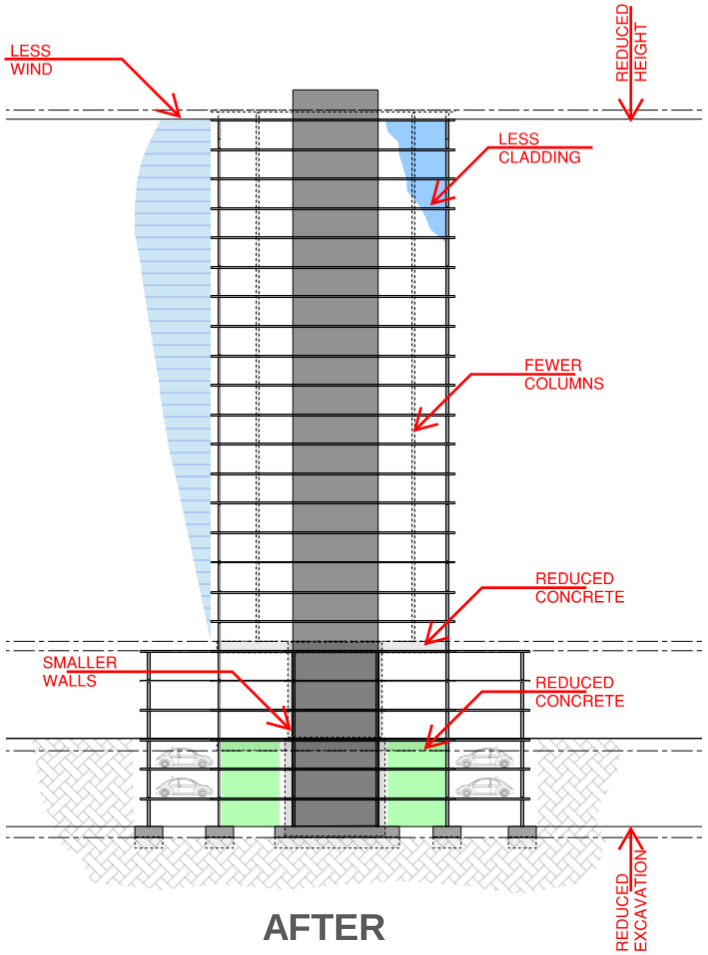



Parking Exhaust
Residential Lobby
TOWER 4
Commercial
UP
UP
UP
LOADING
LOADING
12.5%
22' - 0"
6.71 m
12.5%
DN
DN
Office Lobby
Daycare
UP
TOWER OUTLINE

ALIGNMENT – ALL ABOUT THE MASSING



BEFORE

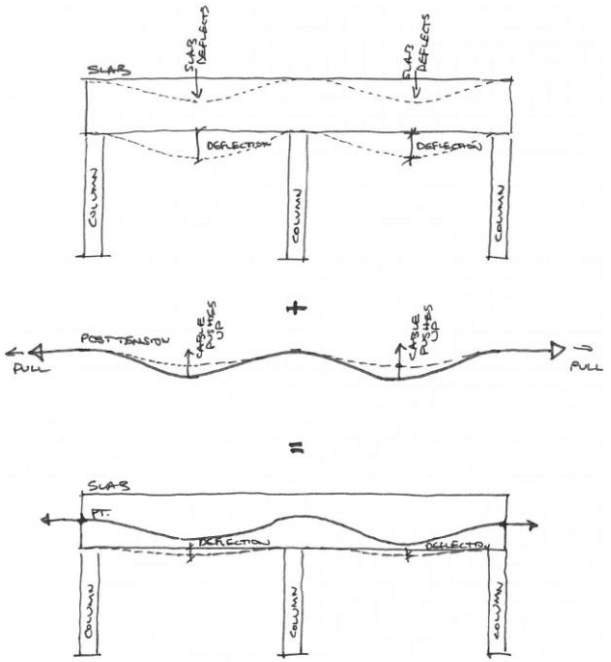


AFTER

UNLOCKING THE POTENTIAL OF PT

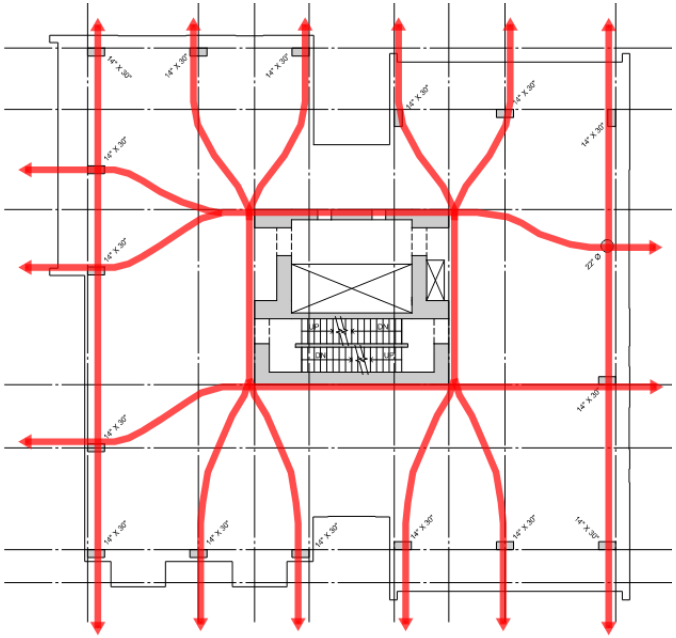
- **ADVANTAGES**
  - Longer spans with thinner assembly
  - Potential elimination of transfers
  - PT is about 3x stronger than rebar, but also 3x the price

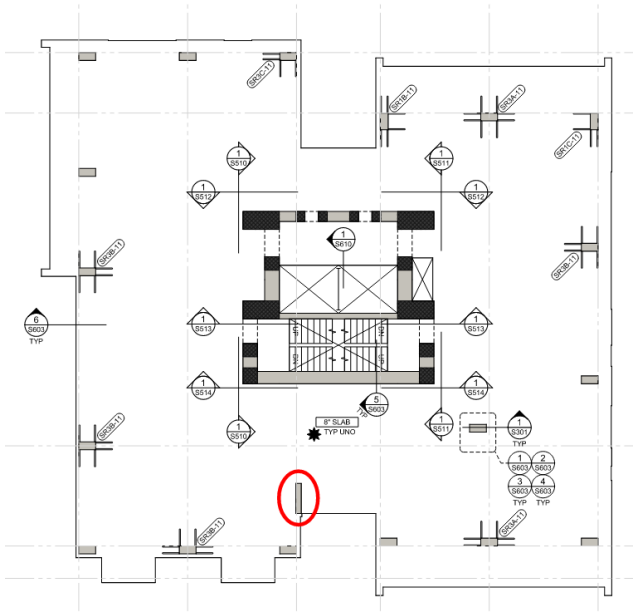
- **DISADVANTAGES**
  - Future flexibility for office/commercial tenants
  - In-slab duct coordination for residential
  - Potentially adds a day to the schedule



TO **PT** OR NOT TO **PT**

Case Study (1)



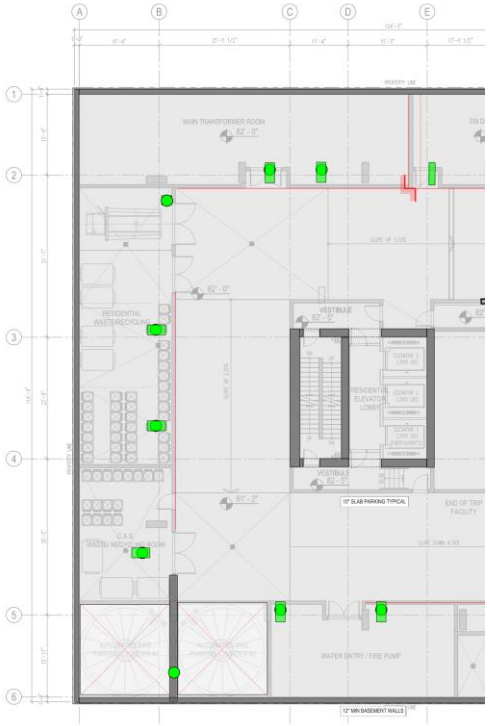


DOES PT MAKE SENSE IN THIS CASE?

- All tower columns had to transfer due to architectural constraints.
- Only 1 extra column was required to control deflection (no impact on the unit layout)
- Extra construction time, in-slab duct conflicts, increased risks (cost, installation, etc.)

TO **PT** OR NOT TO **PT**

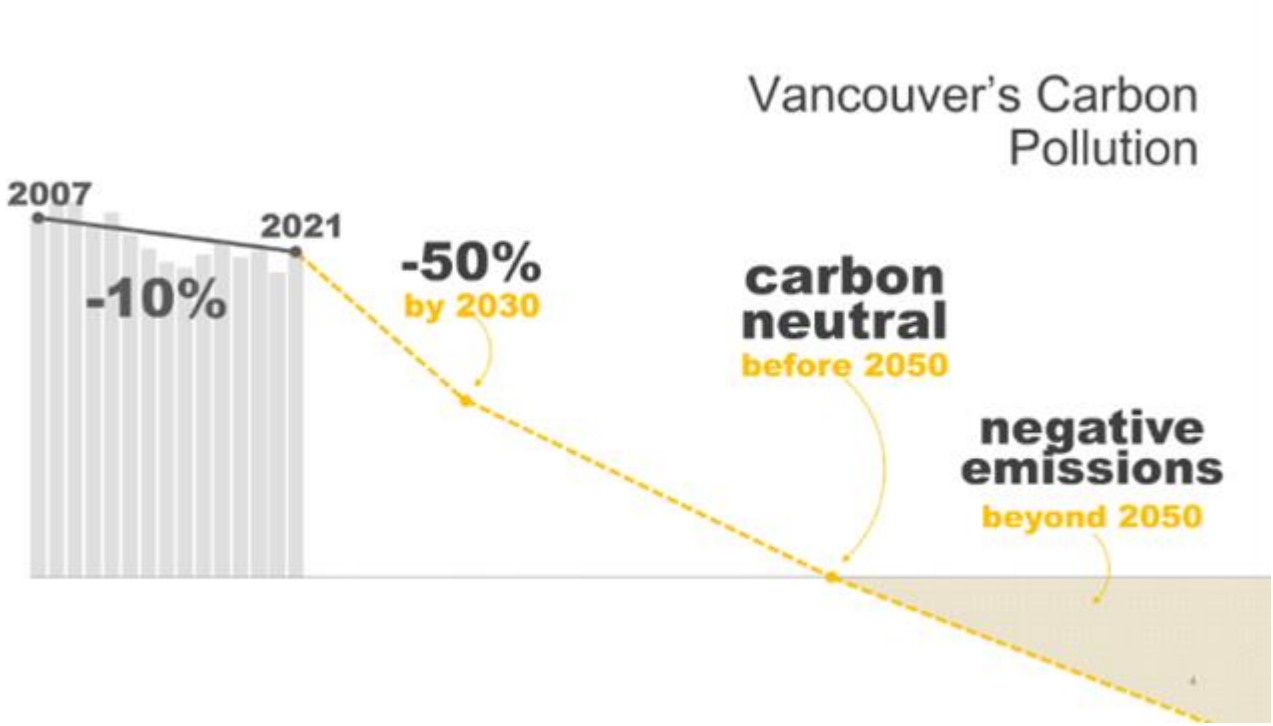
Case Study (2)



DOES PT MAKE SENSE IN THIS CASE?

- Most transfers were eliminated.
- More space flexibility for unit planning.
- Additional construction time on the typical floors offset by the savings in transfers.

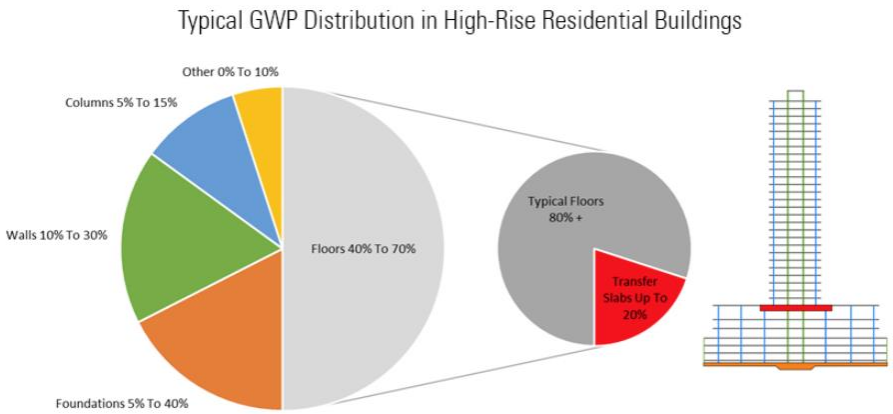
GETTING TO NET ZERO



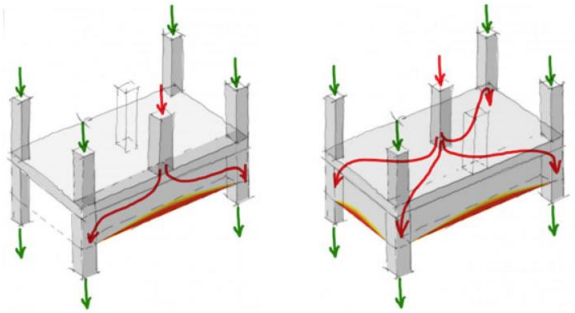
On Track: Policy and Embodied Carbon - Glotman Simpson

GETTING TO NET ZERO

BUT HOW?



Distribution of embodied building emissions (Global Warming Potential)
(above data for a single tower development over 20-storeys)

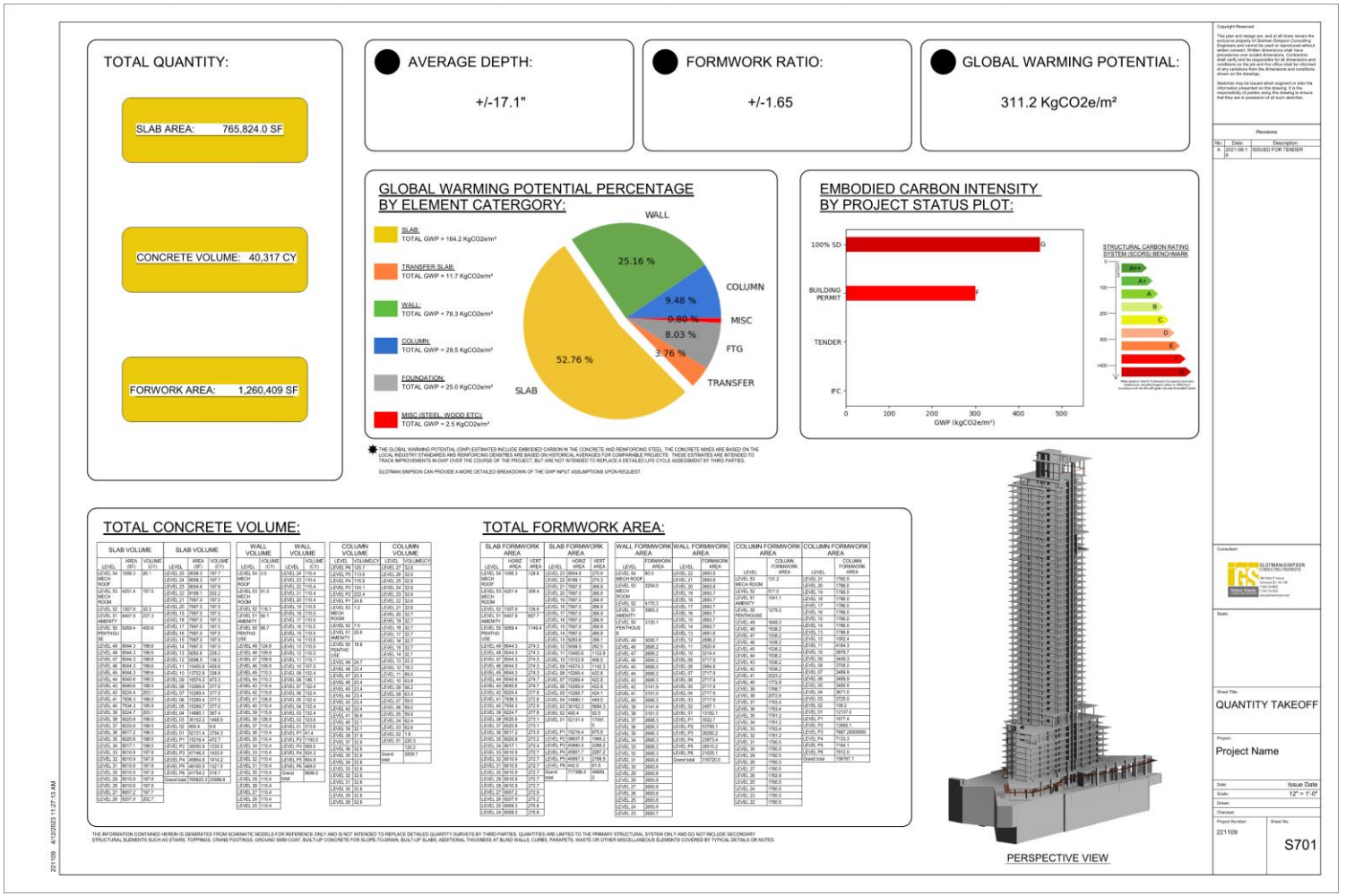


Layout of a one-way beam transfer (left) vs. a two-way slab transfer (right)

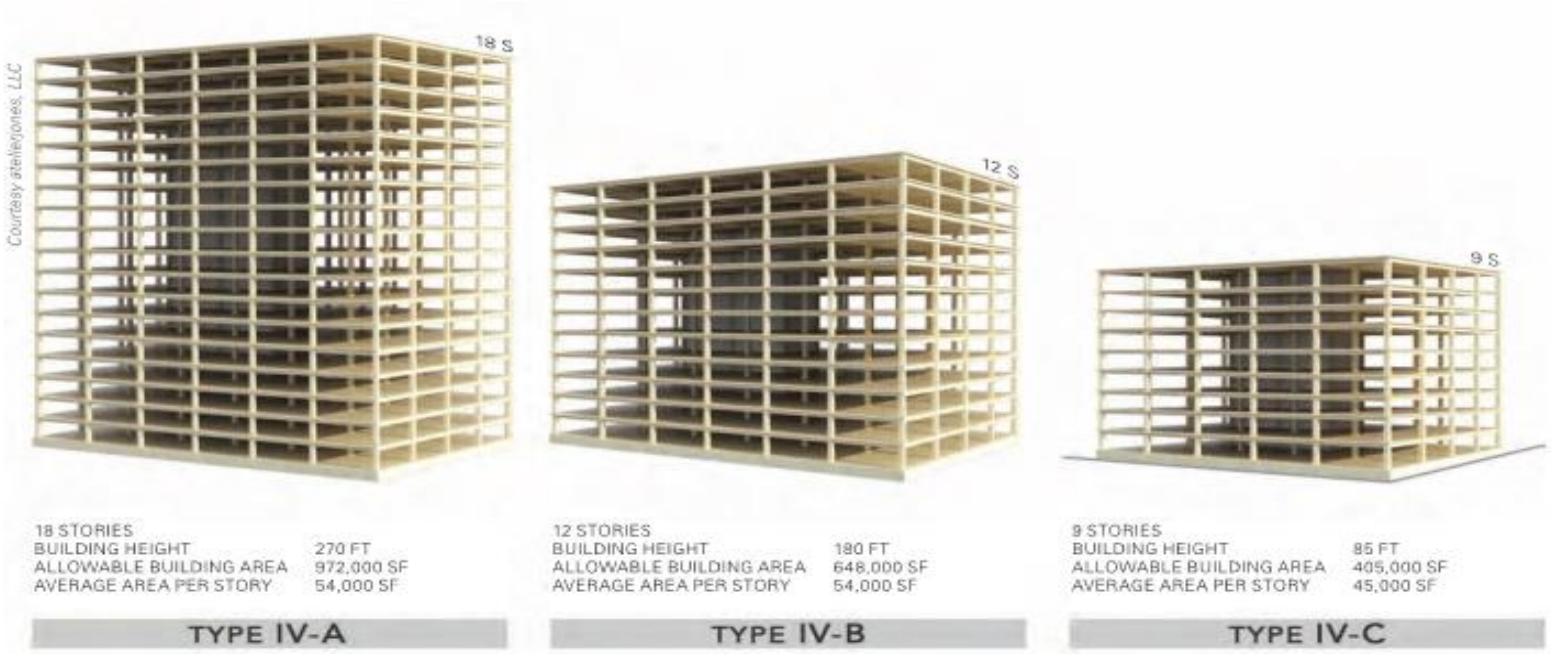
See link below to our ON TRACK series on the levers we can pull to achieve net zero by 2050
https://glotmansimpson.com/blog/

- Performance-based concrete and material specifications
- Eliminate transfers – unlock the potential of PT
- Optimize structural element strength and sizing (i.e. foundations, columns etc..)
- Track embodied carbon through the design

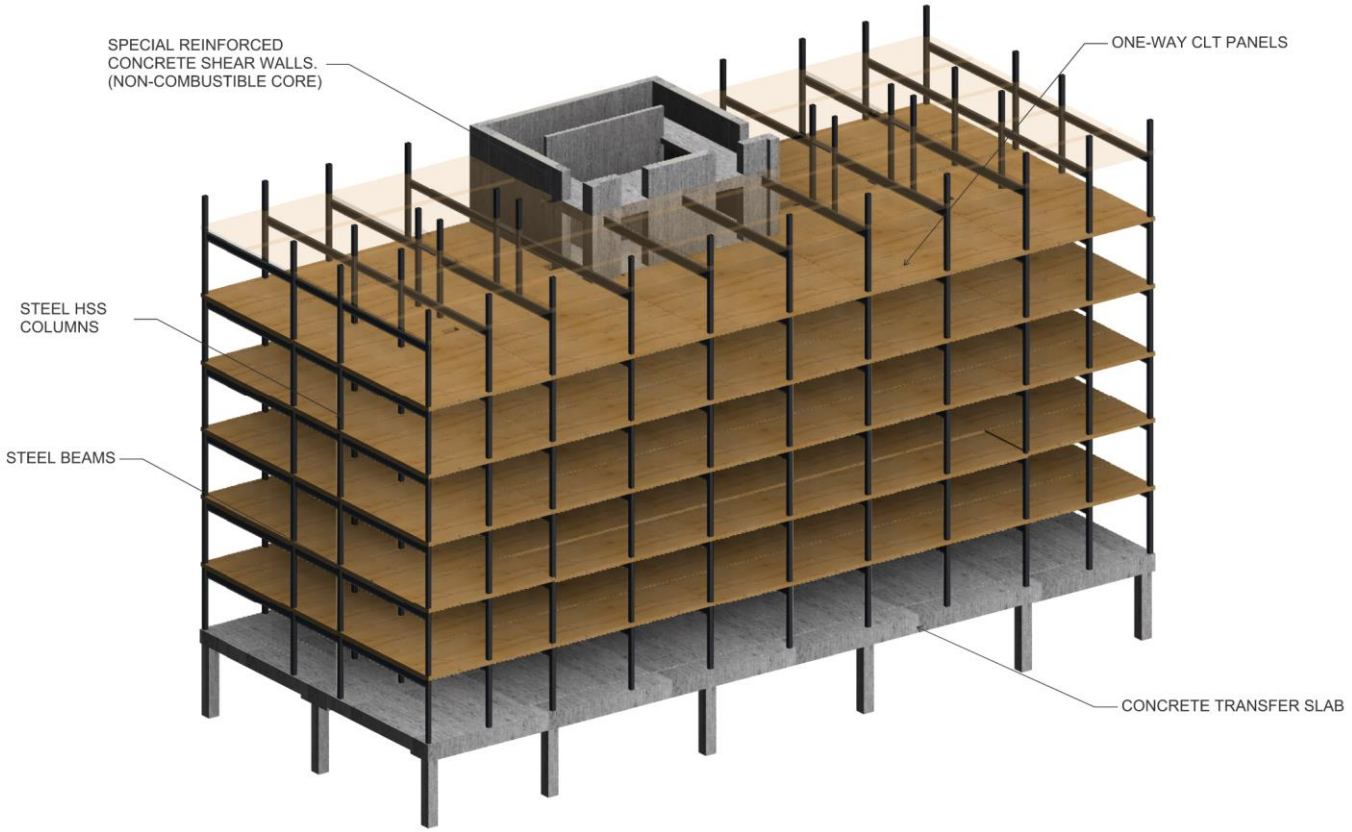
INTEGRATED GWP PROJECT CALCULATOR



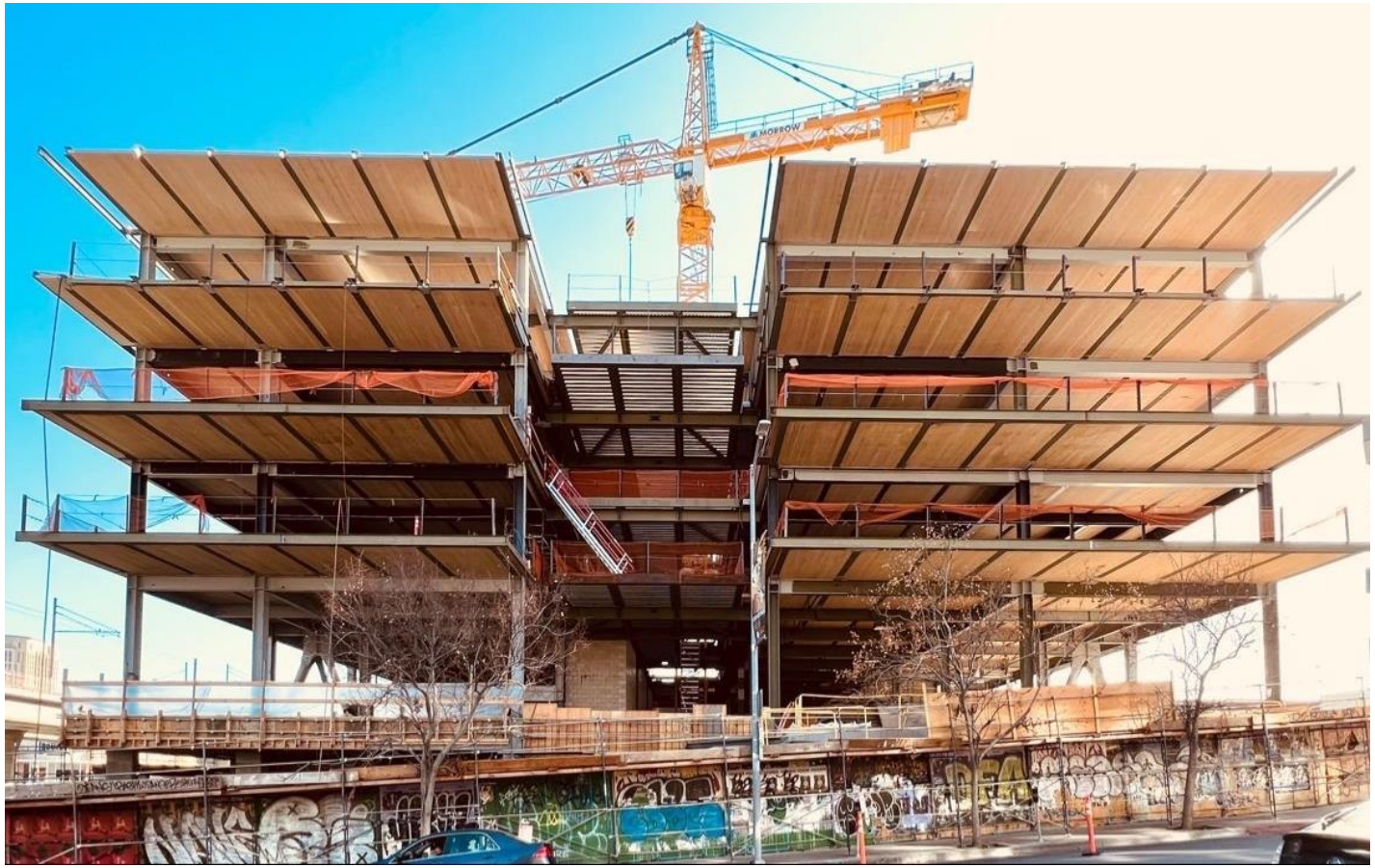
GOING TALLER WITH TIMBER



GOING TALLER WITH TIMBER



GOING FARTHER WITH TIMBER




THANK YOU
2023-05-12