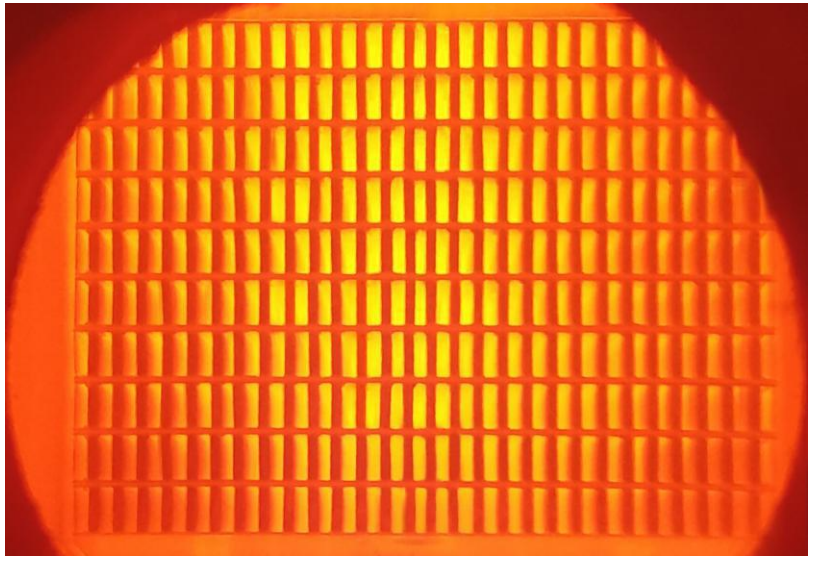
Core Tubular Stainless Steel(CTS) Slabs

Applications in Residential System

Mar.20, 2018 R&D Dept
Drafted: L·J·T
Verified: LS.
Approved:
Privacy level: Public

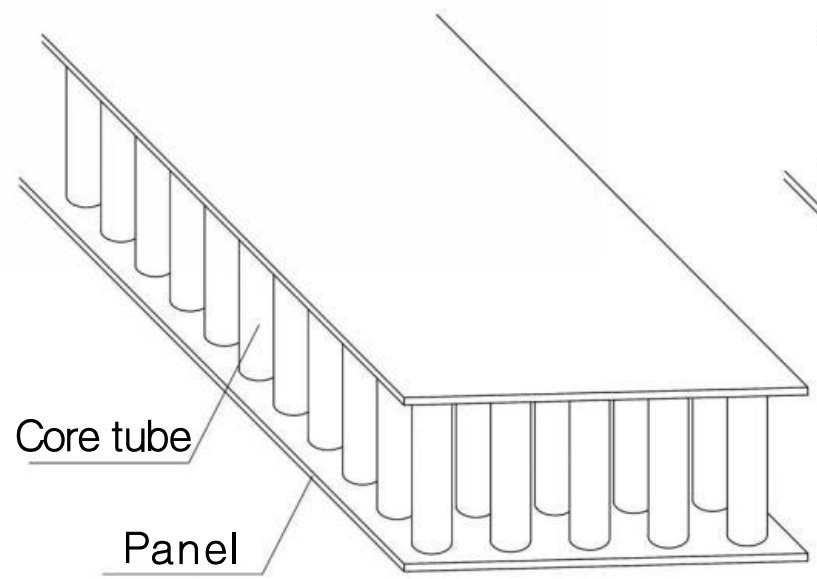
Core Technologies

- CTS slab, epoch-making material was developed by BROAD with thousands of employees during 2015-2017, brings out disruptive revolution in building, road &bridge, vehicle and aviation sectors.
- CTS slab is similar with honeycomb aluminium slab with a super light and super strong mechanical characteristics. It consists of two steel panels clipped with thin-wall core tubes, adopting copper brazing technology. The gap between tubes is stuffed with rock wool for sound and thermal insulation.
- The size of a standard CTS slab is 12m L x 2m Wx0.15m H, which can be used as a column, beam or floorslab directly, or can be cut randomly as per building designs.
- CTS slab is 8~20 times lighter than reinforced concrete with the same size, actualizing a qualitative leap in building earthquake resistance.
- CTS slab is 5~7 times lighter than I-section steel & similar steel with the same rigidity, disruptively cut the cost of steel structure.
- Anti-corrosion performance is 100+ times more effective than that of carbon steel. The life span is almost limitless.
- CTS slab stands 300℃ higher fire-resistance than carbon steel.
- CTS slab components are as smooth as a mirror, whereas the concrete and carbon steel need surface treatment.

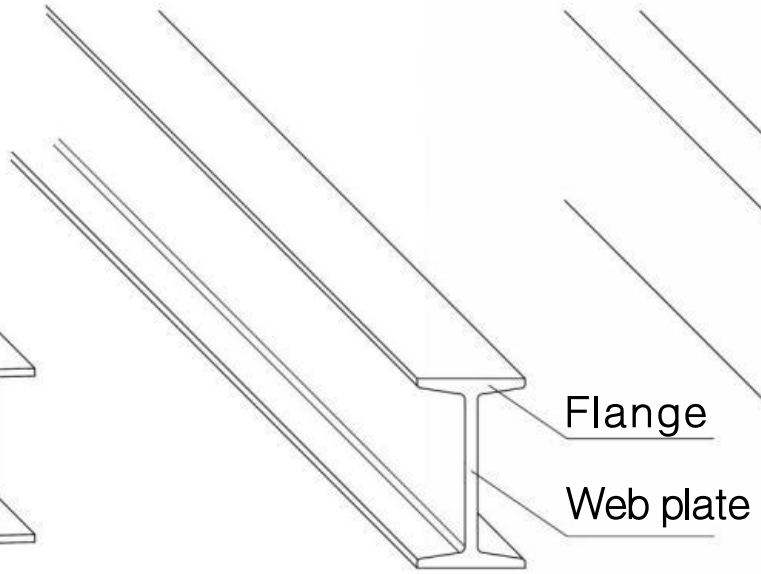


Mechanics Characteristics

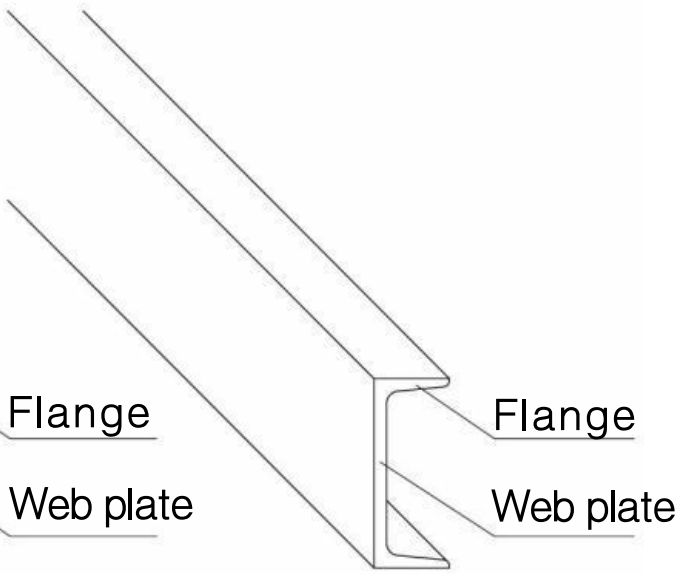
- Panels of CTS slabs equal the Flange of I-beam and channel steel, bearing the bending load.
- Core tubes of CTS slabs equal the Web plate of I-beam steel and channel steel, standing shear force.
- Core tubes support panels continuously, in order to obtain materials with even distributed enhanced rigidity.
- Panels and core tubes are welded together with a unitary CTS slab.
- CTS slab is with high structural torque and bending rigidity.



CTS Slab

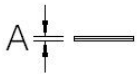
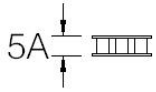
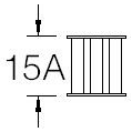
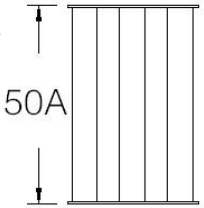


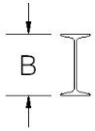
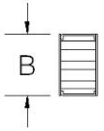
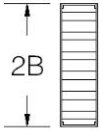
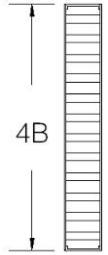
I-Beam



Channel Steel

Rigidity Comparisons

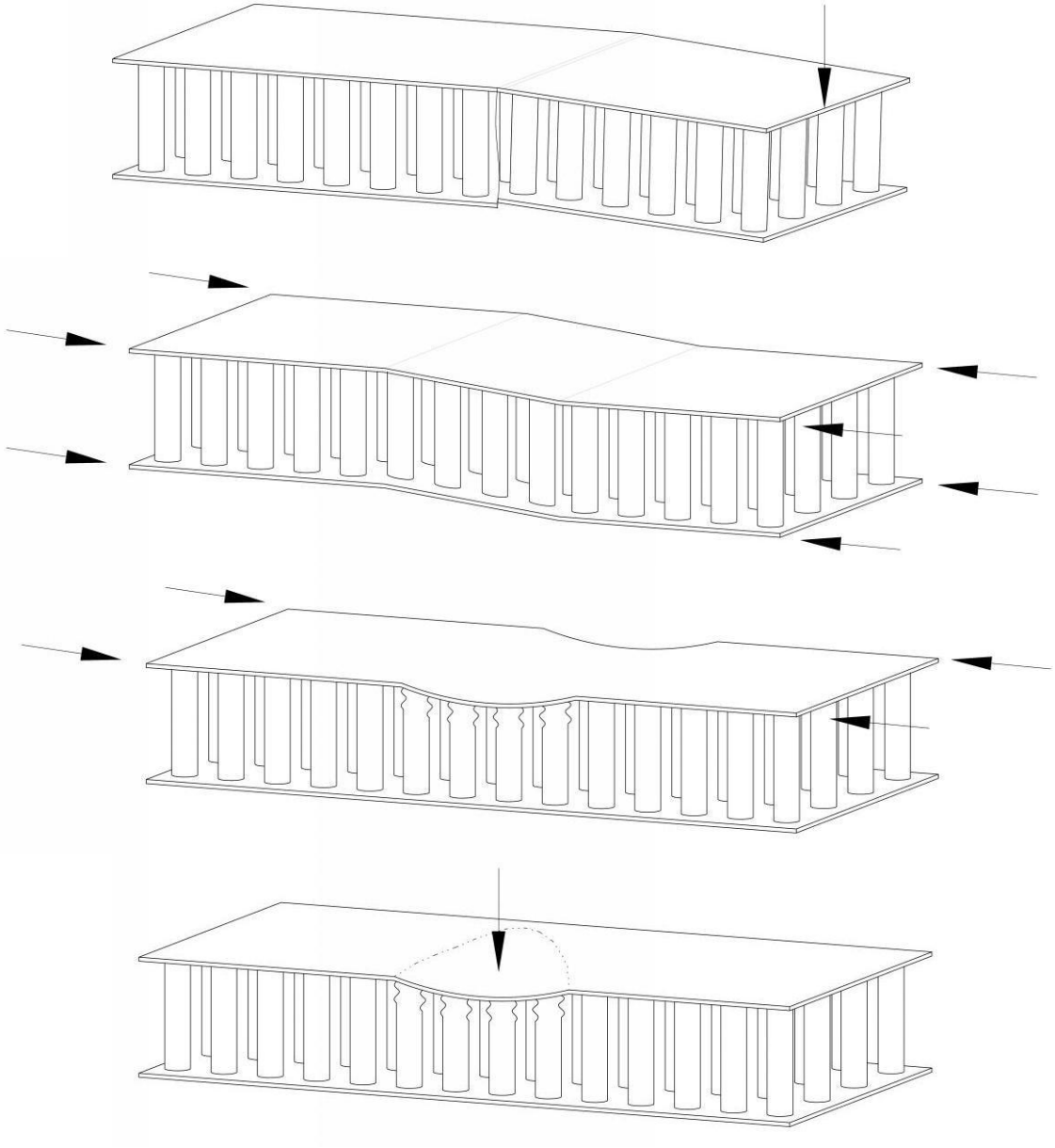
Compare with carbon steel	Solid carbon steel 	CTS slab 5 times thicker 	CTS slab 15times thicker 	CTS slab 50times thicker 
Rigidity	1	61	631	7351
Bending strength	1	12	42	147
Weight	1	1.03	1.09	1.11

Compare with structural steel	I-Beam 	CTS slab Same height 	CTS slab 2 times higher 	CTS slab 4 times higher 
Rigidity	1	1.4	6.8	20.4
Bending strength	1	1.4	3.4	5.1
Weight	1	0.58	0.87	1.45

Failure Modes

All possible failure modes should be considered in CTS slab design. The main failure modes include:

- Intensity: Panel and core tubes must bear the pulling stress, compressing stress and shear stress. The welding connection of panel and core tubes must be able to transport the shear stress between panel and core tubes.
- Shear stress crimp: the thickness of core tubes' wall and the shear modulus must avoid premature shear failure when CTS two ends bear stress.
- Panel wrinkle: the compressive modulus and the compression stress must avoid wrinkle failure of the panel
- Local bearing: the compression stress of core tube must bear the local load of a panel.



Part Parameters

- CTS slab size：12×2×0.15m
- Size tolerance：±1mm
- Material： stainless steel SUS304
- Tensile strength： 520MPa
- CTS slab specifications
- Welding process：≥1000℃ hot-air no-oxygen copper brazing
- Sound insulation of slab: 63db(equal 300mm concrete)
- Anti-corrosion: 100+ times more effective than that of carbon steel in atmospheric environment

Item	No.	SPEC	Panel		Core Tube			Copper foil ring		Frame					Total W.T kg/m²
			Thick	W.T kg/m²	SPEC	K value	W.T kg/m²	Thick	W.T kg/m²	Thick	SPEC	Copper foil bar Thick	W.T kg/m² Copper foil bar	W.T kg/m² Frame	
Big CTS slab	1	A1.5-0.18-150	1.5	23.79	Φ32x0.18 Core tube span 60x80 208 pcs/m² 80 tf/m²	0.42	4.52	the upper 0.3	0.41	4	[shaped fold 20	the upper 0.3	0.08	5.93	34.65
	2	A2.5-0.18-150	2.5	39.65			4.46	the lower 0.15	0.26	6		the lower 0.15		5.87	50.39
	3	A4-0.3-150	4	63.44	Φ32x0.3 Core tube span 60x128 133 pcs/m² 85 tf/m²	0.46	4.66							8.66	77.02
	4	A6-0.3-150	6	95.16			4.53							8.47	108.4

Typical Building Type

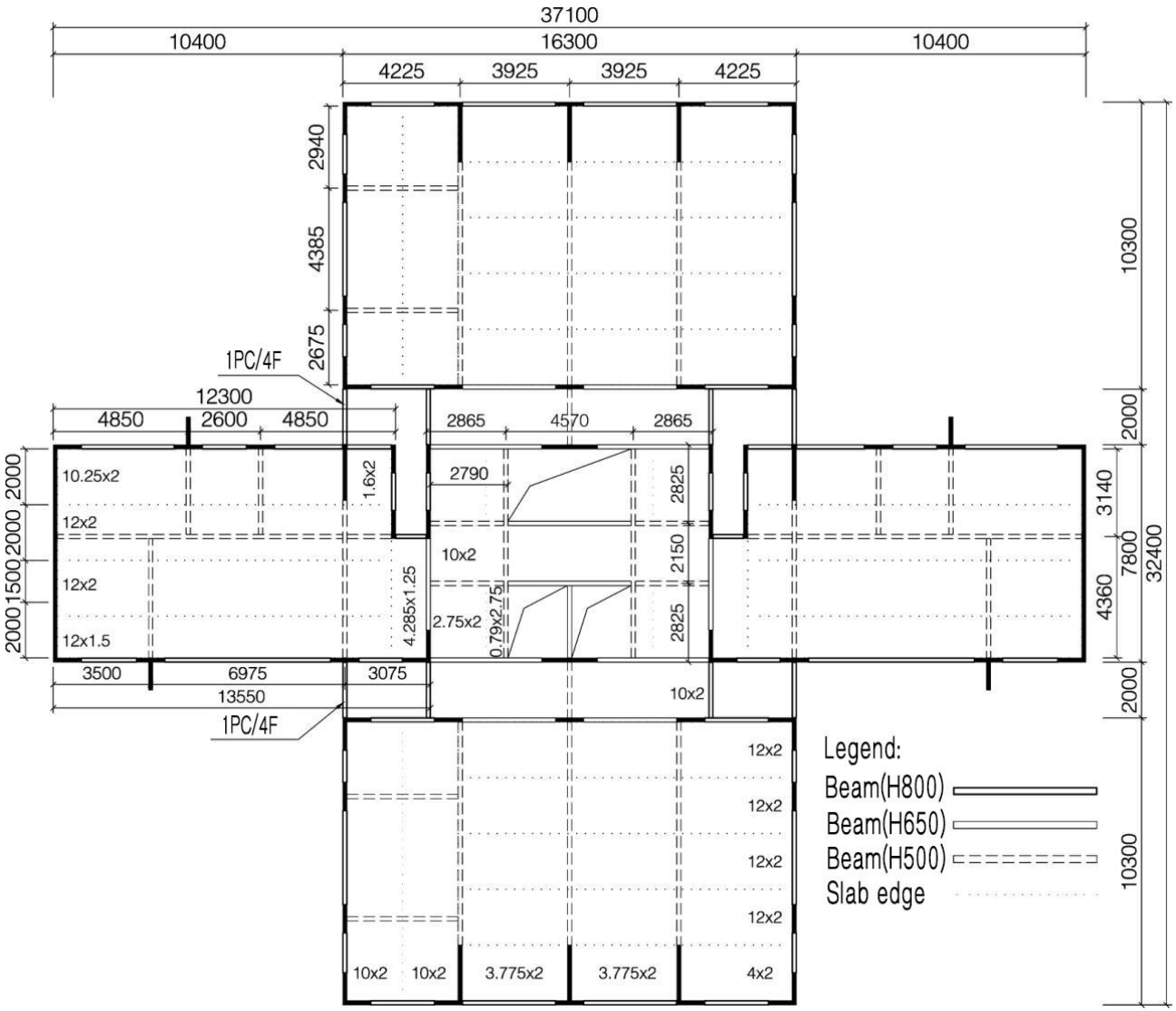
4-winged type

Code	Housing Type	Carpet area(m^2)	Shared area(m^2)	Housing type area(m^2)	Utilization rate	Contour area of balcony outside structure(m^2)	Transport area(m^2)	Building area/floor (m^2)
A	4bedrooms+2living rooms+2toilets	106.5	14.73	121.23	87.75%	10.5	78.1	642.7
B	3bedrooms+2living rooms+2toilets	87.9	12.16	100.06		13.2		

Typical Structural Layout

- The structure is of core tubular shearwall steel frame.main connection among column, beam, slab is welded (also can be bolted if customers require)
- The thickness of slab panel is 1.5 mm, the thickness of core tube is 0.18mm.According to load,the thickness of column and beam plate is 1.5mm, 2.5mm,4mm, 6mm,etc. The thickness of core tube is 0.18mm~0.3mm.
- Standard CTS slab is 12m L x 2m W x 0.15m H. The length of slabs can be cut at random
- According to the results of structural calculation and special applications, the following non-standard CTS slabscan be selected:

① CTS width, length
② CTS thickness
③ Core tube thickness
④ Arc CTS slab
⑤ Reinforced column, beam and broken bridge
⑥ Bolt connected CTS slab



Typical Housing Type A

Building areas： 121.23m^2

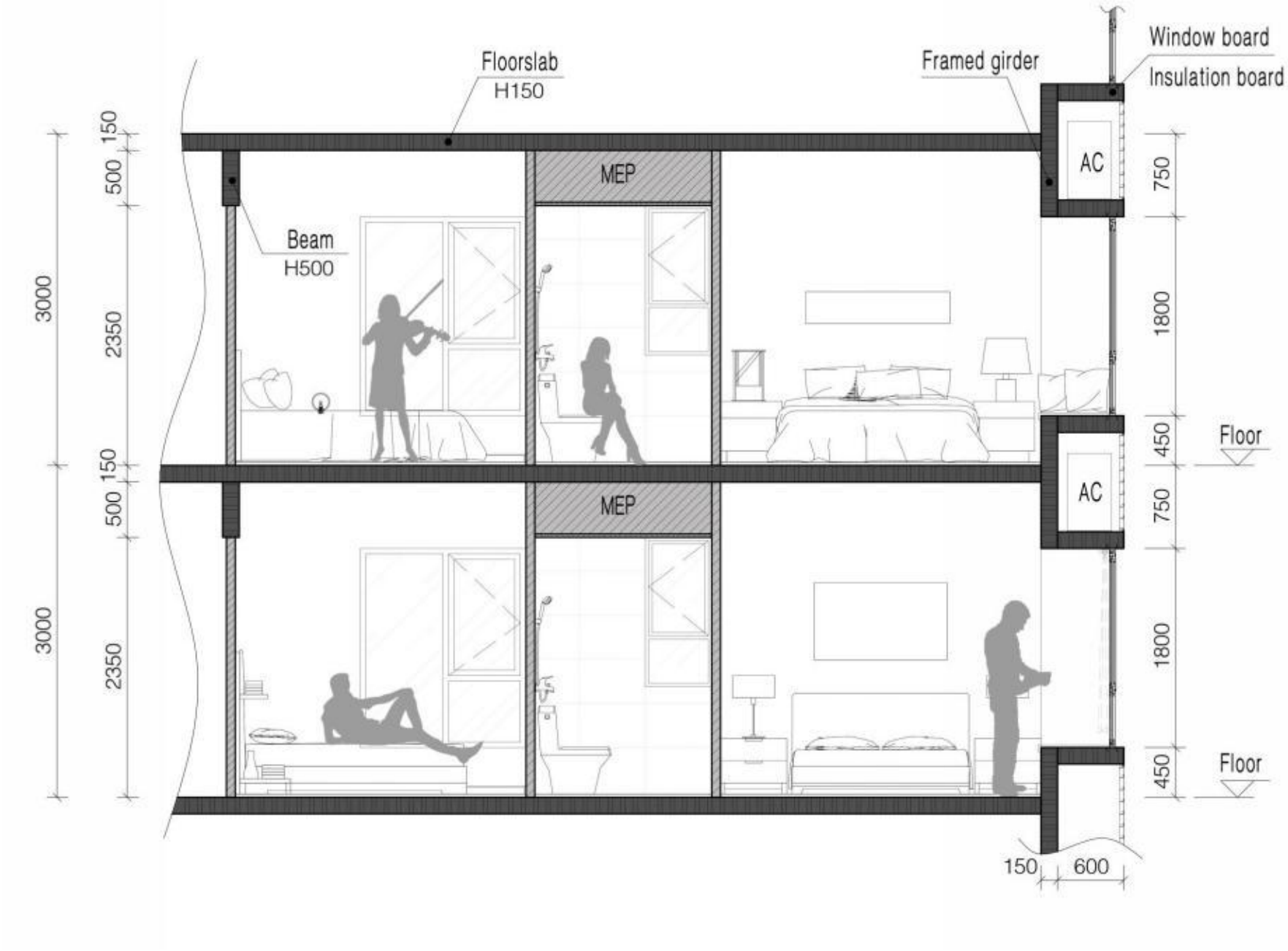
4 bedrooms+2 living rooms+2 toilets+2 balconies

Typical Housing Type B

Building areas： 100.06m^2

3 bedrooms+2 living rooms+2 toilets+2 balconies

Typical Section

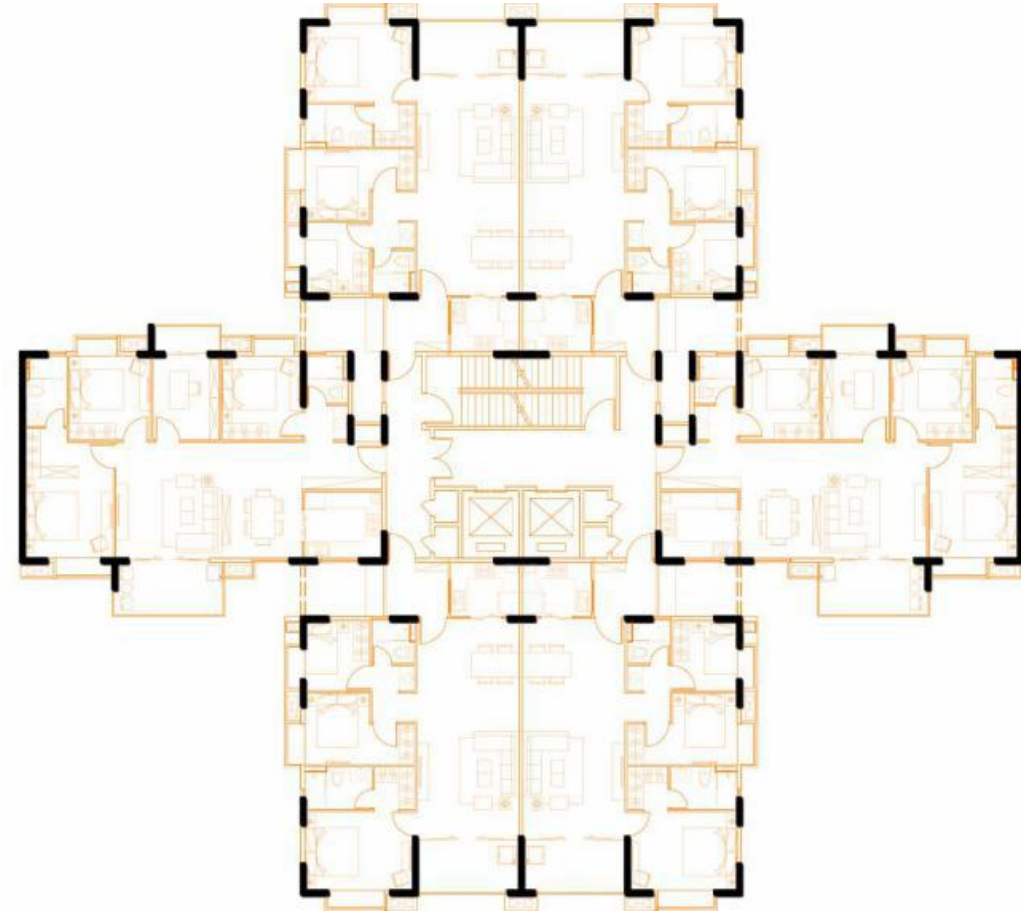


Structural Arrangement Comparisons

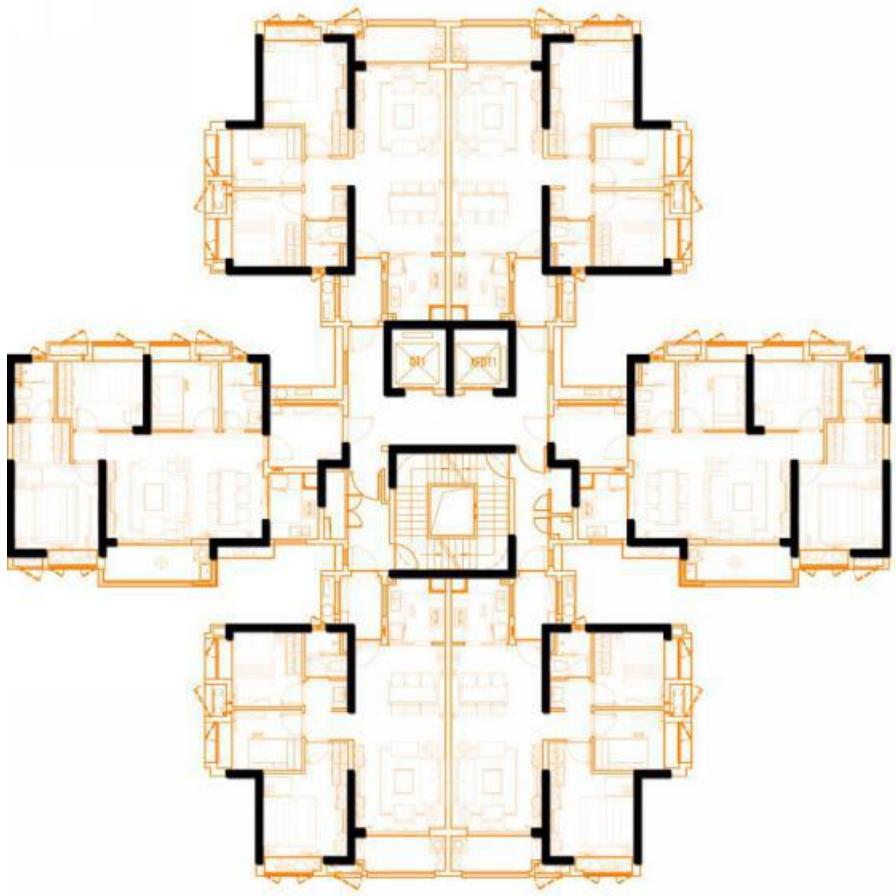
BROAD CTS slab structure:

- Peripheral shear wall adopts “L” shape or “—” shape
- No structural wall or column indoor creates a unitary flexible big space
- Indoor beam height is consistent.Beam arrangement is not in conflict with partition

BROAD CTS Slab Structure

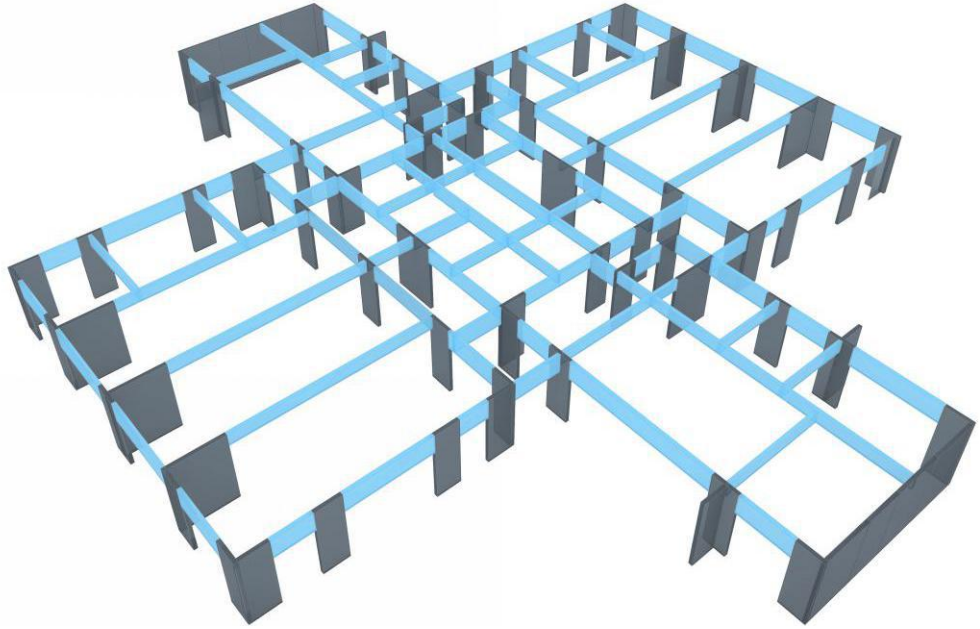


Traditional Concrete Structure

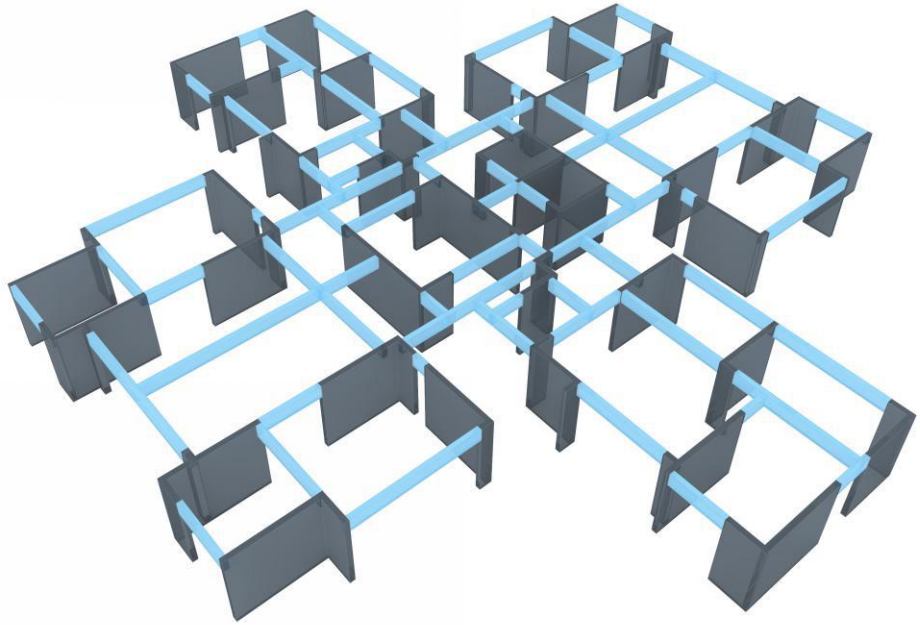


Structural Model Comparison

BROAD CTS Slab

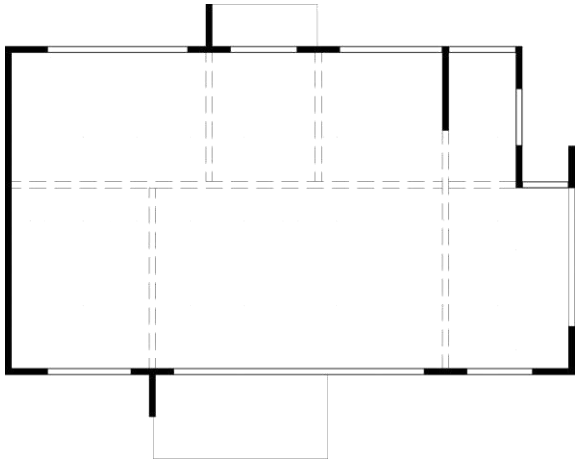


Traditional Concrete Structure



CTS Slab Structure, Flexible Housing Types

- Housing type is free from structural columns, shear wall restrictions
- Housing type can be changed at random after completion
- Water supply piplines,air conditioning tubes and fresh air ducting can be set flexibly



120m² Housing Type

4-people sweet home

(4 bedrooms+2 toilets+big space living room)

2-people enjoyful home

(1bedroom+2 toilets+big space living room)

2-people comfort home

(2 bedrooms+2 toilets+big space living room)

3-people loving home

(3 bedrooms+2 toilets+kids room)

Structural Design & Cost Tips

Design

- Architects can consider CTS slabs as sheet material, and design a building as they like
- To control cost, architects should study dimensions of standard CTS slabs repeatedly and try to adopt standard parts. Non-standard ones will bring about additional cost & extended construction time
- Attention should be paid to the restriction of container mode transportation if non-standard parts are prefabricated by clients' blueprints.The length of floor slabs & columns should be restricted to 12m, 9m or 6m, for they are carriers of transportation sets. It is acceptable to put a small quantity of non-standard parts into transportation sets.

Structure Cost Comparisons

- CTS slabs are of light weight and big rigidity, which enjoy cost advantages in skyscrapers. Meanwhile, as structure occupies small space, building utilization rate is 2% ~ 6% higher than conventional buildings, especially it is striking for high land cost projects
- Mid/low-rise（≤12F）higher than conventional buildings
- High-rise（13~33F）close to conventional buildings
- Super high-rise, and big space building,30%~60% lower than conventional buildings

Adopted Standards

- Although CTS slabs are of new materials, but the strength calculation & structure system calculation conform to conventional building standard inclusive China standard and US and EU ones
- Conceptual drawings, preliminary drawings, workshop drawings,fire protection are reviewed and verified to meet the local standards & regulations
- Structure system: shear wall structure, bundled-tube structure (or two combined)
- China standard Steel Structure Design Codes(GB 50017-2003),Stainless Steel Technical Regulations(CECS410:2015)
- Strength calculation method： numerical analysis of finite element
- Recommended softwares for strength calculation：SAP2000、Midas、YJK

Installation Construction

1. Installation can be done by BROAD or a professional company designated by BROAD, or clients can install by themselves under the supervision of BROAD. BROAD can provide the hoisting devices for super high-rise buildings.
2. Structure installation：3～6 F/standard type ,1F/non-standard type.
3. BROAD does not make the foundation, our CTS building is the same with that of conventional buildings, but our load is 3~5 times lighter.
4. International standard container modes are used, which are completely consistent with the dimension, weight & bayonet coupling of trucks, trains, vessels and hoisting tongs in docks.