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 BROAD SUSTAINABLE BUILDING
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T30A TOWER HOTEL technical briefing

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BROAD SUSTAINABLE BUILDING 9M earthquake resistant 5X energy efficient 20X purer air



## BSB Technological Features

#### Sustainability

"BSB" is the abbreviation for BROAD sustainable building (factory-made). Its sustainability is derived from 8 aspects: earthquake resistance, energy conservation, air purification, durability, material saving, recyclable construction materials, construction materials free of formaldehyde, lead, radiation, asbestos and no construction sewage, dust or wastes. BSB has accomplished the extremity of these 8 aspects that today's human technologies can ever imagine.

#### 9 Magnitude Earthquake Resistance

BROAD was a central air conditioning manufacturer who exported its products to over 70 countries. We developed sustainable buildings due to Wenchuan Earthquake in 2008. One year since the earthquake, a team of 300 BROAD R & D engineers has done hundreds of testing, and then invented integrated earthquakeresistance technology of "steel structure + diagonal bracing + light weight". China Academy of Building Research conducted earthquake resistance tests for 7-storey and 30-storey sustainable building simulators scaled at 1:4 & 1:10, and accurately verified that earthquake resistance of BROAD Sustainable Building is 3~12 times higher than that of conventional buildings in the world (Magnitude 6~7, 0.05~0.12g on average; Magnitude 8, 0.22g highest). (See details in Earthquake Resistance Comparison List, test report & video documentary)

#### 5X More Energy Efficiency

BSBs adopt at least 30 different energysaving technologies. Ordinary people can understand thick thermal insulation of exterior wall & roof, multi-paned windows, external solar shading, heat recovery fresh air, LED lighting, power generation by elevator descending & water-saving toilets.

Most countries in cold areas adopt 10cm thermal insulation & double-paned windows, whereas BSBs adopt 35 cm thermal insulation and 5-paned windows: in warm winter and hot summer areas as well as torrid areas, most countries use only 3 cm thermal insulation or no thermal insulation at all, whereas BSBs adopt 15 cm and 3 or 4-paned windows, which make BSBs like a sleeping bag in winter and a cooler in summer. Another significant energy-saving technology of BSB comes from BROAD-invented heat recovery fresh air system. By exchanging heat between outdoor fresh air and indoor exhaust air, it recovers 70%~90% of energy and ensures extreme freshness of the indoor air of BSBs with little energy loss. If we convert the HVAC energy consumption of buildings around the world into oil, it equals 35~70 L/ m<sup>2</sup>a, whereas BSBs is 7~12 L/m<sup>2</sup>a, which is 5 times more energy efficient. (See details in Energy Conservation Comparison List, and energy metering for each BSB is available for your check)

## RATED PARAMETER SHEET

Items	Main Building	Lobby	Basement
Code	T30A	JT240A	DXS3000A
Floors	30	1	1
Main functions	330 hotel rooms, 700 beds	Hotel lobby	Parking, machine & laundry rooms
Nominal area m <sup>2</sup>	About 16200 ( about 540 each floor)	240	1
Building area m <sup>2</sup>	17338 (578 each floor)	264	3039
Overall dimensions m	L24.04 x W24.04 x H99.9	L16.24 x W16.24 x H13.7	L59 x W51.5 x H4.5
Total building weight t	9840	190	13000
Building dead load kg/m <sup>2</sup>	320	470	4000
Building live load kg/m <sup>2</sup>	250	250	400
Storey height/clear height m	3.3/2.75	13.7/11.9	4.5/3.9
Distance between columns m	7.8	15.6	7.8
Building structure	Steel structure	Steel structure	Reinforced concrete
Earthquake resistance level	9 magnitude (0.6g)	9 magnitude (0.6g)	8 magnitude (0.22g)
Fire protection rating	Per fire protection of public buildings A	Per fire protection of public buildings A	Per fire protection of public buildings A
Energy consumption of A/C and ventilation m <sup>2</sup> a	70 kWh	150 kWh	40 kWh
Indoor temperature	Winter 20~24 °C; summer 24~27 °C	Winter 20~24 °C; summer 24~27 °C	No air conditioning, ventilation only
Fresh air exchange frequency	5 times/h	2 times/h	6 times/h
Indoor air cleanliness	or air cleanliness 20 times purer than outdoor		No air purification

### 20X Purer Air

Air purification is the most crucial technology to each household. For it is closely related to people's life expectancy and various kinds of human diseases. WHO certifies that 68% of human diseases are related to indoor air pollution. However, the value of air purification can be ignored most easily, because air pollution is invisible to naked eyes. We install air quality detectors in each room, residents can check the indoor PM (PM0.3, PM2.5 and PM10), formaldehyde and CO2 level at any time and can at the same time compare with the outdoor PM. In common people's opinion, this detector seems to be so expensive that a public debate needs to be held on whether a country should invest a few sets of PM2.5 monitoring devices for each city. But BROAD installs a detector in every room. It's definitely a technological revolution for the miniaturization and cost-lowering R & D process, which is like putting a building-like computer some decades ago into a small cellular phone today.

Another challenge is how to actualize "super filtration". At Amazing present, for the whole world, only IT chip assembly lines and When hundreds of millions of people were amazed at the video of surgical operating rooms are using "super filtration" equipment "30-storey built in 360 hours" in the second week of 2012, most of that is even more costly than the building itself. Nevertheless, them were still not aware of the more amazing figures hidden behind BROAD invented a low-cost "super filtration" technology and the building in the video: integrated it into the heat recovery fresh air machine. It is a • 9 magnitude earthquake resistance, compared with conventional combined system with 3-stage filters. The first stage adopts buildings, the steel consumption is 10~20% less and concrete the traditional coarse filter, collecting big particles; the second consumption is 80~90% less. stage utilizes BROAD-invented "electrostatic cleaner", following • 5 times energy efficiency, 20 times purer air, 10%~30% lower in cost the principle of "positive attracts negative" to filtrate 98% of than that of conventional ones. PM0.3, PM2.5 & PM10, and then the remaining PM is filtrated • Low cost, while the building automation level is even higher than by expensive "HEPA filters". The final air filtration efficiency can that of the most advanced smart buildings in the world. be as high as 99.8%. When the fresh air is completely purified, Amazing construction speed, while zero injury during construction PM can only be brought in by people from outside. Therefore, process. indoor air is at least 20 times purer than outdoor air (See details Perfect construction quality, while no fire, no water & no dust in Air Quality Comparison List, and air quality monitoring for (no welding, no concrete, and no polish with emery cloth), each room of BSB is available for your check).

#### Factory Made

BSB is the most profound innovation in human history. It has broken all the preconceived concepts of people in all aspects from revolution scope to innovation profundity, integration intensity of resources to classification density of information, architectural industry mode to real estate consumption mode.

The most revolutionary element about BSB is its construction mode: a 3.9×15.6m "main board" including flooring and ceiling, embedded shafts of ventilation, water supply & drainage, electricity and lighting. All needed pillars, diagonal bracings, doors, windows, walls and even sanitary & kitchen wares for the room installation are placed on main board for factory shipment. One truck can carry 120m<sup>2</sup> main boards and then deliver them to the construction site to be hoisted in installation place. What all workers need to do is just screwing bolts, painting.....Such a high-efficiency construction mode makes on-site installation only account for 7% of the total construction hours. Therefore, BSB can be 93% factory-made, whereas the current world's highest is only 40%.

- construction waste is less than 1% of that of conventional buildings. • We built the 30-storey hotel in 360 hours just to avoid the rainy season. However, building a starred hotel with 700 beds from ground breaking to opening in 48 days is definitely a miracle!

BSB is rewriting human history.



### PUBLIC AREAS LIST

No.	Name	Floors	Quantity	Area m <sup>2</sup>
1	Elevator room	1~30	30	363
2	Stair case	-1~31	32	710
3	Gallery	2~28	54	1144
4	Lobby and restaurant	1	7	600
5	Conference & office area	2	8	420
6	Club	30	7	480
7	Public restroom	1,2,30	6	32
8	Public kitchen	1	1	120
9	Laundry room	-1	1	120
10	Machine room	-1,16	6	380
11	Underground parking	-1	For 65 cars	2380
12	Total	6749		

#### UNDERGROUND PARKING & MACHINE ROOMS





#### ■ 17~22F STANDARD ROOM, MEDIUM SUITE



23, 24F SMALL SUITE, MEDIUM SUITE



#### 25, 26F SMALL SUITE, LARGE SUITE







■ 29F PRESIDENTIAL SUITE (Remove double, 2 suites become one)



### ■ 30F CLUB



### GUEST ROOMS LIST

Туре	Code	Name	Floors	Quan- tity	Room area (m <sup>2</sup> )	Kitchen & bathroom area (m <sup>2</sup> )	Subtotal room area (m <sup>2</sup> )	Subtotal kitchen & bathroom area ( m <sup>2</sup> )	Sanitary ware	Kitchen ware	Furniture	Electric applia- nce
Standard room	K,J	Standard room with medium bathroom	3~22	160	19.5	3.4	3120	544	3 large pcs 6 small pcs	/	15-pc set	5 pcs
	Н	Standard room with small bathroom	3~16	56	28.3	1.7	1584.8	95.2	3 large pcs 5 small pcs	/	17-pc set	5 pcs
	G	Standard room with large bathroom	3~15	52	24.6	5.4	1279.2	280.8	4 large pcs 7 small pcs	/	15-pc set	5 pcs
Suite	F,E	Small suite	23~26	12	39	6.8	468	81.6	3 large pcs 6 small pcs	Small cabinet & appliances	22-pc set	8 pcs
	D	Medium suite	17~24	32	52.9	8	1692.8	227.2	8 large pcs 12 small pcs	Small cabinet & appliances	24-pc set	8 pcs
	С	Large suite	25~26	8	72.4	10.5	579.2	84	11 large pcs 18 small pcs	Small cabinet & appliances	37-pc set	12 pcs
Deluxe suite	В	Ambassador suite	27~28	8	95.2	19.2	761.6	153.6	11 large pcs 28 small pcs	Small cabinet, cupboard & appliances	31-pc set	12 pcs
	A	Presidential suite	29	2	182.6	58.8	365.2	117.6	16 large pcs 29 small pcs	Large cabinet, cupboard & appliances	66-pc set	13 pcs
			Total	330	/	/	9851	1598	1356 large pcs	62 kitchens	5811 pcs	1886 pcs
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## ENERGY CONSERVATION COMPARISON LIST

No.	Category	Items	BSB	Traditional buildings (including 5-star hotel)
1	Key index	A/C and ventilation energy consumption (per primary energy)	70kWh / m²a (equivalent to 7 kg oil)	350kWh / m²a (equivalent to 35 kg oil)
2		Average heat-transfer coefficient of building envelop	0.3W / m²K	2W / m²K
3		Power distribution for lighting (on average)	2W / m <sup>2</sup>	6W / m <sup>2</sup>
4		Toilet water consumption (each time)	3 liters	12 liters
5	Thermal insulation	Materials of external wall thermal insulation	Rock wool 150mm 0.23W/m²K (inside glass curtain wall)	Little or no thermal insulation
6		Window, glass layers	4 layers	1 or 2 layers
7		External solar shading	Automatic shutters (in glass curtain wall)	Internal solar shading
8		Internal window thermal insulation	Automatic curtain	No
9	Ventilation	Ventilation equipment	Heat recovery fresh air machine	No heat recovery
10		Ventilation power consumption	0.6~0.9W / m <sup>3</sup>	1.2~1.8W / m <sup>3</sup>
11		Fresh air heat recovery efficiency	70~90%	No
12		Fresh air by pass	Air does not go through heat exchanger during transitional seasons	No
13		Air supply method	Underfloor air supply	Ceiling air supply
14		Fresh air flow route	7~15m	3~5m
15	Equipment	Chiller/heater	Non-electric air conditioning Total COP 112%	Electric air conditioning Total COP 52%
16		Power consumption of A/C water distribution system (electricity/cooling)	3%	10%
17		Room temp. regulating methods	Central fan coils (2 sets for entire building), Mix of fresh air & exhaust air can be adjusted automatically in each room	One set of fan coils for each room
18		Indoor humidity regulating methods	High pressure water mist	Steam
19		Elevator	Generate power when ascend empty- loaded or descend fully loaded	No power generation
20		Kitchen ventilation	Inverter controlled	Fixed
21		Laundry drier	Waste heat from Chiller/heater & power generation	Steam or electricity
22		Drinking water	Produced by hotel itself (reverse osmosis water)	Outsourced bottled water
23	Smart control	Fresh air & air conditioning	Automatically turned off 2 hours after people's departure	No
24		Fan frequency regulating	Inverter controlled	Fixed
25		External solar shading	Automatically start when temp. ≥23°C	No
26		Internal thermal insulation curtain	Automatically closed when temp. ≥33°C or ≤14°C (no people inside)	No
27		Lighting in rooms	Automatically turned off half an hour after people's departure	No
28		Lighting in public areas	Automatically turned off when people leave	No
29		Energy metering	Independent metering, total metering	Total metering
30	Others	Lighting source	All LED lighting (100 lumen / W)	Incandescent or fluorescent lighting (10~70 lumen/W)
31		Garbage classification, recycle	8 garbage shafts for each floor	No
32		Recover heat from bathing waste water	Heat up tap water in winter	No
33		Utilize toilet sewage water	Produce biogas	No
34		Thickness of A/C water & hot water pipe thermal insulation	80mm	20 mm
35	Total energ (per prima	y consumption a year ry energy)	2.2 million kWh	11 million kWh

Notes: 1. Energy consumption, thermal insulation & window layers are per the standard of "Hot summer & warm winter areas". See the comparison list in the following page for other climate areas.

2. Calculation basis: Converted primary energy/electricity: 4kWh/kWh, converted oil/electricity: 0.25L/kWh, annual lighting hours: 2000, hotel occupancy rate: 80%.

3. Compared with traditional buildings (including 5-star hotels), this hotel saves 8.8 million kWh a year in terms of the total energy consumption of air conditioning, ventilation, lighting, elevators, water pumps, etc. If we convert it into oil per primary energy (10kWh/L), it equals 880,000 liters or 730 tons of oil saving and 2000 tons of CO2 cutting each year, which is equivalent to 110,000 tree planting.

## AIR QUALITY COMPARISON LIST

No.	Category	Items		BSB	Traditional buildings (including 5-star hotel)
1	Technical	Ventilation mode		100% fresh air	30% fresh air, 70% exhaust air
2	mode	Fresh air filtration mode		Coarse filter+ electrostatic cleaner+ HEPA filter	Coarse filter
3		Air conditioning moc	е	Central fresh air+ central A/C coils	Central fresh air+ terminal fan coils
4		Indoor temp. regulating mode		Regulated by proportion between fresh air and exhaust air in machine room	Regulated by terminal fan coils (on/off)
5	PM	Fresh air filtration	PM0.3	99.8%	0
6	pollution	efficiency	PM2.5	100%	0
7		figures are in microns)	PM10	100%	< 50%
8		Indoor PM concentro	ation	20~100 times lower than outdoor	Same as outdoor
9		Cleaning interval of ind	oor tabletops	10~30 days	Every day
10	Chemical	Fresh air exchange frequency Indoor CO <sub>2</sub> concentration Indoor VOC (formaldehyde,etc.)		5 times/h (per air flow cross section)	0.5~1 time/h (per volume)
11	pollution			< 800 ppm	< 1800 ppm
12				< 0.01 ppm	< 0.1 ppm
13		Indoor fresh air inlet l	ocation	Underfloor air supply, ceiling air exhaust	Ceiling air supply & air exhaust
14		VOC , lead & radiation from construction materials		E1 (top-grade in Europe)	Uncertain
15	Bacteria	Air cross contamination i	nside buildings	Zero pollution (no exhaust air)	Polluted (70% exhaust air)
16	pollution	A/C coils		Sterile	Infected
17		Air supply duct		Sterile	Infected
18		Bacteria pollution of conc	lensate pipe	Only the machine room (2 rooms)	All rooms
19		Sterilization of fresh a	ir	High voltage static electricity	No
20	Detection	Dust ( PM)		Each room (every 8 hours)	No
21	and	CO <sub>2</sub>		Each room (every 1 hour)	No
22	control	VOC (formaldehyde, etc.)		Each room (every 1 hour)	No
23		Fresh air flow		Each room (every 1 hour)	No
24		Fresh air flow regulating		Automatic	No
25	25 Overall assessment of indoor air quality		20~100 times purer than outdoor	Dirtier than outdoor (WHO certifies it is 5 times worse than outdoor)	

## ENERGY SAVING MEASURES COMPARISON IN DIFFERENT AREAS Energy consumption/m<sup>2</sup>a

Chilly areas like Moscow & Harbin

Traditional buildings: no wall insulation, single-paned window Energy-saving buildings: 100mm wall insulation, double-paned window BSB: 350mm wall insulation,

Traditional buildings:

Hot summer and chilly winter areas like New York, Tokyo & Beijing



Hot summer and warm winter areas like Athens, Shanghai & Changsha

Hot areas like Dubai, Bombay & Hongkong



Energy-saving buildings: 30mm wall insulation. double-paned window (converted into oil L)



## COMFORT COMPARISON LIST

No.	Items	BSB BSB	Traditional buildings (including 5-star hotel)
1	Clear height	2.75m	About 2.4~2.6m
2	Distance between pillars (span)	7.8m	About 3~5m
3	Cold (heat ) radiation of exterior wall & windows	No (feel comfortable with temp. at 22 °C in winter and 26 °C in summer)	Yes (only feel comfortable with temp. at 26 °C in winter and 22 °C in summer)
4	Indoor odor	No	Yes
5	A/C noise	No	Yes
6	Toilet ventilation noise	No	Yes
7	Window transparency	Transparent (clear glass)	Opaque (coated glass)
8	Adjustment of sunlight from windows	Automatic (remote control & wiring control)	Manual
9	Lighting adjustment	Luminance Level 2 or 3/ lighting	Luminace Level 1 / lighting

## BUILDING LIFE DESIGN COMPARISION LIST

No.	Items	BSB BSB	Traditional buildings (including 5-star hotel)
1	Life design of building structure	600 years (do inspection & maintenance every 60 years)	60 years
2	Inspection feasibility of load-bearing structure	Can be 100% inspected (remove the interior wall plate)	Inconvenient for check
3	Anticorrosion of steel structure	Cold galvanized	Anticorrosion painting
4	Thermal bridge of exterior wall & window	<0.01% (per area)	Large area (cause condensate corrosion)
5	Interior wall board	Fiber cement plate (over 60 years life span)	Gypsum board (less than 20 years life span )
6	Glass curtain wall frame	Stainless steel	Aluminium alloy
7	Water supply pipe(city water, hot water, A/C water)	Copper	Steel

## CONSTRUCTION MODE COMPARISON LIST

No.	Items	BSB BSB	Traditional buildings (including 5-star hotel)
1	Construction waste	25†	About 3000t
2	Construction dust	No	Yes
3	Construction ignition work (welding & gas cutting)	No	Yes
4	Construction water consumption	No	About 5000t
5	Wall & Ceiling decoration	No plaster	Plaster
6	Steel consumption	68 kg/m <sup>2</sup>	Reinforced concrete: about 75kg/m <sup>2</sup> Steel structure: about 140kg/m <sup>2</sup>
7	Concrete consumption	100 kg/m <sup>2</sup>	About 1000 kg/m <sup>2</sup>
8	Construction site material delivery	150 vehicles	About 1000 vehicles
9	Construction scaffold	No	Yes
10	Topsealing & Elevation	15 days	About 1 year
11	Interior decoration	1 month	About 1 year

Note: The foundation is not included. Designed by construction design institute per BSB parameters & local geological features, BSB foundation is similar to that of conventional buildings, only that it can be reduced due to lighter building weight.

## EARTHQUAKE RESISTANCE COMPARISON LIST

No.	Items	BSB	Traditional buildings (including 5-star hotel)
1	Earthquake resistance level	9 magnitude (0.6g)	Per local standard (generally 7 magnitude, 0.1g)
2	Earthquake resistance test	Equivalent model simulation test scaled at 1:10	No
3	Building weight (foundation excluded)	350kg/m <sup>2</sup>	Generally 1200kg~1500kg/ $m^2$
4	Building structure	Unique diagonal bracing steel structure	Reinforced concrete structure
5	Special structure of earthquake resistance	Diagonal bracing	No
6	Quality & safety assurance of structures	Factory-made,quality controllable	On-site construction, poor quality control

# 中国建筑科学研究院

#### Earthquake Resistance Test Conclusion of 30-storey **BROAD** Sustainable Building

30-storey BROAD Sustainable Building (BSB) is a new structural system designed and developed by BROAD Sustainable Building Co., Ltd, which is made of steel and diagonal bracing structures. Entrusted by BROAD, China Academy of Building Research conducted scaled simulation earthquake resistance test on this structure. The simulator is designed by our academy at a scale of 1/10, and produced and set up by BROAD.

The test was carried out on May 6, 2011 at the State Key Laboratory of Building Safety and Environment of China Academy of Building Research (CABR) according to Specifications for Seismic Test Methods (JGJ101-1996).

30-storey BSB experienced 42 times of simulated earthquakes with different amplitudes in total, using 3 earthquake waves (natural and artificial waves). Tests showed that under the common earthquake intensities of 7 magnitude, 8 magnitude & 9 magnitude, no obvious damage occurred to the main structure. After the rarely-occurred earthquake of 9 magnitude (0.6g), the overall structure did not collapse.

Details and suggestions can be referred to the test report.



## An Introduction to BROAD SUSTAINABLE BUILDING CO., LTD

LTD (BSB hereafter) is a wholly owned subsidiary of BROAD Group, specialized in BROAD sustainable buildings featuring magnitude By April 2012, BSB core technology reached finalization with 16 9 earthquake resistance, 5X more energy efficiency, 20X purer air, 93% factory-made, and 1% construction waste.

Headquartered and with its R&D Center based in Xiangyin County of Hunan Province, southern China, BSB has workshops of 80,000sqm in 2011, and will reach 220,000sqm in 2012 and 360,000sqm in 2013. By then, it can reach an annual production and installation capacity of 7.5 million sqm-10 million sqm. BSB's key goals are as follows:

- 1. Improving R&D of BSB technologies, further setting up supply simultaneously. chain for accessories across the world.
- 2. Developing 50 franchised companies evenly distributed in Chinese provinces, 100 internationally.



- Established in March, 2009, BROAD SUSTAINABLE BUILDING CO., 3. Selling BSBs in compliance with local regulations in Hunan building market.
  - BSBs built separately in Hunan, Shanghai, Zhejiang and Mexico. Besides, 6 franchised partners have been developed in Ningxia, Fujian, Shandong, Shanxi and Hubei with identical size to Xiangyin BSB Factory.
  - BROAD envisions in the near future, there will be one BSB among three buildings worldwide, allowing all men and women to share BSBs' solace, proving that by responsible use of technology, the earth's environment and human living can be elevated