ELEPHANT
Gypsum Board

BUILDING SCIENCE

CHANGING THE WAY BUILDINGS
ARE DESIGNED AND BUILT

BUILDING SCIENCE

we are constantly redefining the way buildings are designed and built. Faster and cheaper construction, consuming less building materials and energy efficiency are our priorities as these advantages will enable stakeholders to build high performance buildings with less construction and operation costs than a traditionally-designed building.

BUILDING AS A SYSTEM

- **The "Building Science"** approach evaluates the building as a whole to quantify building performance, and optimise occupancy and functionality.
- **The conventional Beam–Slab** with masonry method is labour intensive and others low productivity.
- Through 3rd party studies, USG Boral finds that the combination of a **Post Tensioned Flat Slab structure with drywall** provides an efficient building solution that would potentially reduce construction time and costs.
- **High acoustic performance requirements**, such as between guest rooms and ballrooms in hotels, suit drywalls compared to masonry walls which will be heavier, wider, more dense and requiring double configuration compared to drywalls, adding to the cost and requiring more time.
- Masonry's productivity is estimated at 0.25M^2 per man compared to **2.25 M^2 per man for drywall**, and drops further if it has to meet the hotel's acoustic requirements.

32 % REDUCTION IN CONSTRUCTION TIME

21 % REDUCTION USAGE OF STRUCTURAL CONCRETE

20% REDUCTION IN SUPERSTRUCTURE COST

10 % REDUCTION IN SUBSTRUCTURE COST

FINANCIAL BENEFITS

- Residential developers will be able to claim earlier progress payments from the purchaser's financial institution.
- Reduce the total amount of interest paid and able to obtain a lower interest rate due to the shorter period of the loan.
- With Post Tensioned Flat Slab (PTFS) structure, a developer would be able to add additional storeys (and units) to a building without increasing the building's height.
- Reduction in consumption for electricity will allow building owners to drastically reduce their carbon footprint.
- External DEFS drywall can reduce, by up to 90%, the amount of heat transferred through a building's envelope.

Residential

POST TENSIONED FLAT SLAB (PTFS) + DRYWALL

Superstructure
13% – 20% Reduction of Superstructure Cost
- Lower building height
- Less external wall or Cladding
- Lighter structure
- Faster
- No beams
- Flexible column locations

Substructure
6% – 10% Reduction of Substructure Cost
- Lighter superstructure = Smaller substructure
- Smaller footings
- Pile savings

Sustainable
21% Reduction of Structural Concrete
- Energy savings
- Less concrete
- Carbon credits, lower carbon footprint
- Less labor & transport
- Pile savings
- Less formwork
- Less construction debris

Cost & Time
32% Reduction of Construction Time
- Additional floors = additional income
- Days saved = Interest on loans saved + early business start
- Construction cost reduced
- Efficient cash flow management

Efficient Spatial Planning
Get 1 Extra Floor for Every 10 Floors Built vs. Beam–Slab on Other Buildings
- Additional floors
- Flexible space
- Unrestricted space
- More gross floor* area (GFA) or GLA

* Subject to plot ratio zoning laws

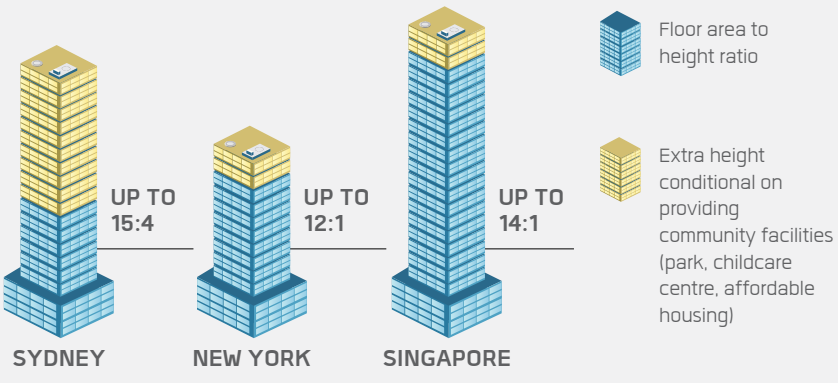
Plot Ratio or Floor Area Ratio

Plot ratio of a building is obtained by dividing the gross floor area (GFA) of the building by the area of the site on which the building is erected.

The Government imposes restrictions upon plot ratio as a means of controlling the density of population.

Town Planning is empowered to prepare statutory Outline Zoning Plans directing the types of buildings that may be erected on specified areas on the plan; and may also stipulate the plot ratio that is applicable to the areas specified on the plan.

HOW HIGH CAN YOU GO?
FLOOR AREA TO HEIGHT RATIO ALLOWED IN MAJOR CITIES.

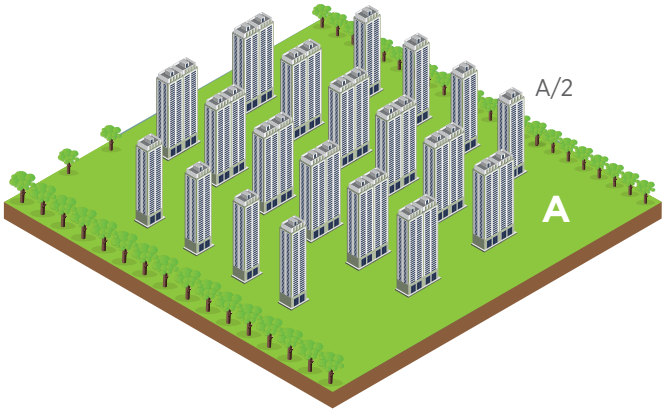


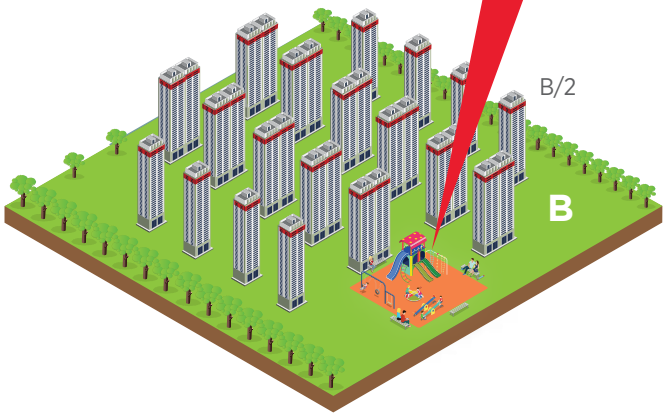
CONVENTIONAL VS POST TENSIONED FLAT SLAB (PTFS)

USD 5.3 MILLION BEAM–SLAB OR AAC 30 STOREYS (637DAYS)

USD 5.2 million Post Tensioned Flat Slab (PTFS) or Drywall 32 storeys (583 Days)

This building is not required. Can be turned into a park, community centre etc. which could allow for additional allowance for plot ratio bonus ie extra height.
USD 4 million saved Post Tensioned Flat Slab (PTFS) or Drywall (considering additional cost for 2 floors to all buildings (construction cost only).





30–STOREY CONVENTIONAL (BEAM – SLAB)

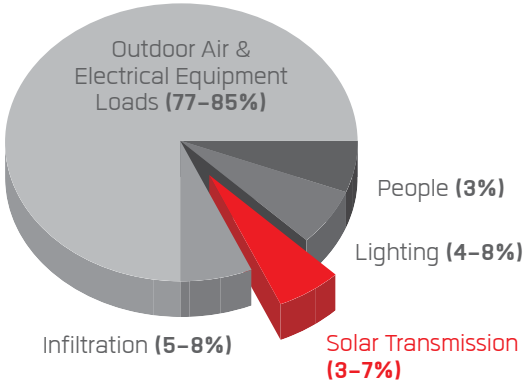
32–STOREY POST TENSIONED FLAT SLAB (PTFS)

Type		Floor Area (m^2)	Levels	Single Building Area (m^2)	Numbers	Sub Total (m^2)	Total Building Area (m^2)	Total Building Height (m)	Total Footprint Area (m^2)	Site Area (m^2)	Plot Ratio	Footprint
30–STOREY CONVENTIONAL	A	632	30	18,960	12	22,7520	30,3360	93	10,112	117,242	2.59	8.62%
	A/2	316	30	9,480	8	75,840						
32–STOREY POST TENSIONED FLAT SLAB (PTFS)	B	632	32	20,224	11	22,7520	30,3360	92.8	9,480	117,242	2.59	8.09%
	B/2	316	32	10,112	8	75,840						

NOTE: Information obtained through 3rd party studies.

THERMAL STUDY – SOLAR TRANSMISSIONS (30–STOREY BUILDING + DRYWALL)

HEAT LOAD COMPONENTS



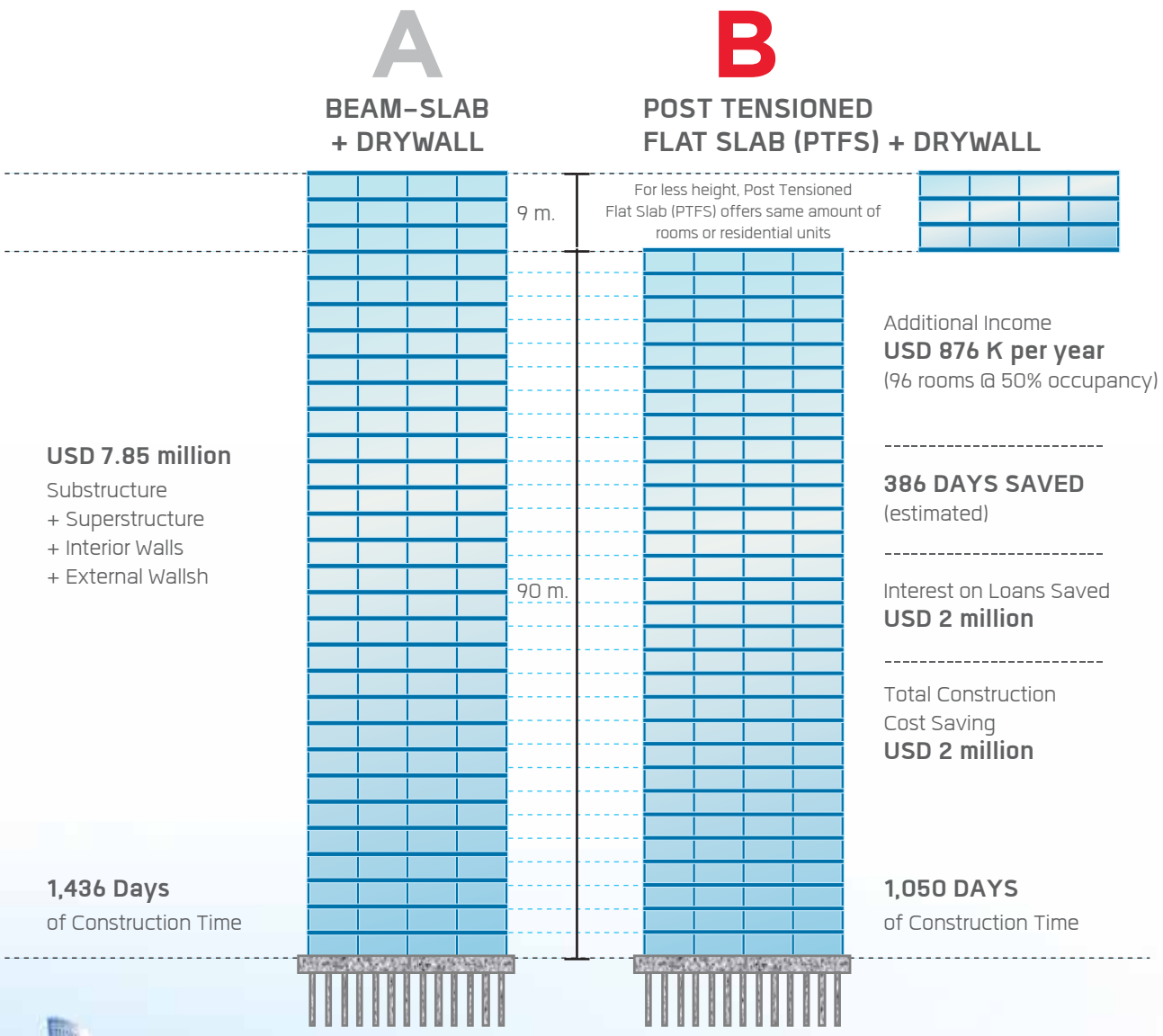
SOLAR TRANSMISSION

90% SAVING ON THE COST FOR HEAT TRANSFER

10.8KW.H PER DAY WITH DRYWALL COMPARE TO 105.9KW.H PER DAY WITH BRICK

Hotel

POST TENSIONED FLAT SLAB (PTFS) + DRYWALL



BENEFITS OF POST TENSIONED FLAT SLAB (PTFS)

1. Extra Income Gain from Early Business Starts for Hotels

The faster construction speed for Post Tensioned Flat Slab (PTFS) drywall structure compared to Beam-Slab structure enables earlier business start, benefitting building owner by getting extra or earlier income and less loan interests.

Hotel	System****	Number of Rooms	Room Price (USD per day)	Occupancy Rate (%)	Construction Time (Days)	Time Saved (Days)	Total Extra Income (USD)
A 30-STOREY BEAM-SLAB	W1Ext+SGI-H1	960	50	50	1,420	16	384,000
B 30-STOREY POST TENSIONED FLAT SLAB (PTFS) 90m	W1Ext+SGI-H1	960	50	50	1,050	386	**9,264,000**

SCENARIO:

Early Income Gain or Business Start = 50% Occupancy of Number of Rooms x Room Price (USD per day) x Time Saved (Days)
= 480 Rooms x USD 50 x 386 days
= **USD 9,264,000**

2. Additional Income from Extra Floors in Hotels

Extra floors provide additional income. For hotels, extra floors mean more guestrooms and more income from guestroom service.

Hotel	Rooms per Floor	Extra Floors	Total Extra Rooms	Room Price (USD per day)	Occupancy Rate (%)	Income per Day	Construction Cost (USD)	Payback Period (Year)	Additional Income (USD per year)
33-STOREY POST TENSIONED FLAT SLAB (PTFS)	32	3 (9m.)	96	50	50	2,400	5,366,700	6.16	**876,000**

SCENARIO:

Additional Income Gain Per Year = 50% Occupancy of Total Extra Rooms x Room Price (USD per day) x 1 Year (365 days)
= 48 Total Extra Rooms x USD 50 x 365 days
= **USD 876,000**

3. Shorter Financing Loan Periods

The shorter completion time of Post Tensioned Flat Slab (PTFS) drywall method compared to Beam-Slab method provide savings from shorter financing loan period.

Hotel	System****	Total Cost (USD)	Construction Time (Days)	Total Loan Interest (USD)	Reduced Loan Interests (USD)
A 30-STOREY BEAM-SLAB	W1Ext+SGI-H1	17,014,603	1,420	5,325,304	443,559
B 30-STOREY POST TENSIONED FLAT SLAB (PTFS) 90m	W1Ext+SGI-H1	14,966,013	1,050	3,338,221	**2,430,642**

Building a 30-storey hotel using a Post Tensioned Flat Slab (PTFS) drywall method saves 386 days compared to Beam-Slab method, with potential additional reduction in loan interest of **USD 2,430,642.**

Summary of Total Gain: Opportunities for Hoteliers

1 EARLY INCOME GAIN OR BUSINESS START OF USD **9,264,000**

2 ADDITIONAL ANNUAL INCOME GAIN USD **876,000**

3 REDUCTION IN LOAN INTEREST USD **2,430,642**

NOTE: ****Information obtained through 3rd party studies.

Australia
China
India
Indonesia
Malaysia
Middle East
New Zealand
Philippines
Singapore
South Korea
Thailand
Vietnam

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