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Hitachi Social Innovation – Transport Solution for Colombo Metropolitan Region & Suburbs through an innovative solution using Monorail technology

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Hitachi social Innovation believes in solving the social issues by applying innovative technologies

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Social issue of Colombo Metropolitan Region & Suburbs

There is an urgent need to provide a

i. comprehensive and integrated transport solution to meet the mobility needs and expectations of the people
ii. for immediate, medium term and long term solution in a affordable and time bound manner
iii. keeping in mind socio, economic, environmental and safety aspects

❖ **Planning of the Transport Solution**

- Selection of the most efficient transport solution, affordable by all sections

❖ **Financing of the implementation**

- Provide a viable financing alternative for implementing the solution
- EIRR (socio, economic & environment) and not FIRR (economic) is important.

❖ **Implementation / Construction**

- Implementation of the solution in time bound manner involves the methodology of construction and the project management ;

❖ **Operations and maintenance** of the transport system

Selection of the optimal transport solution

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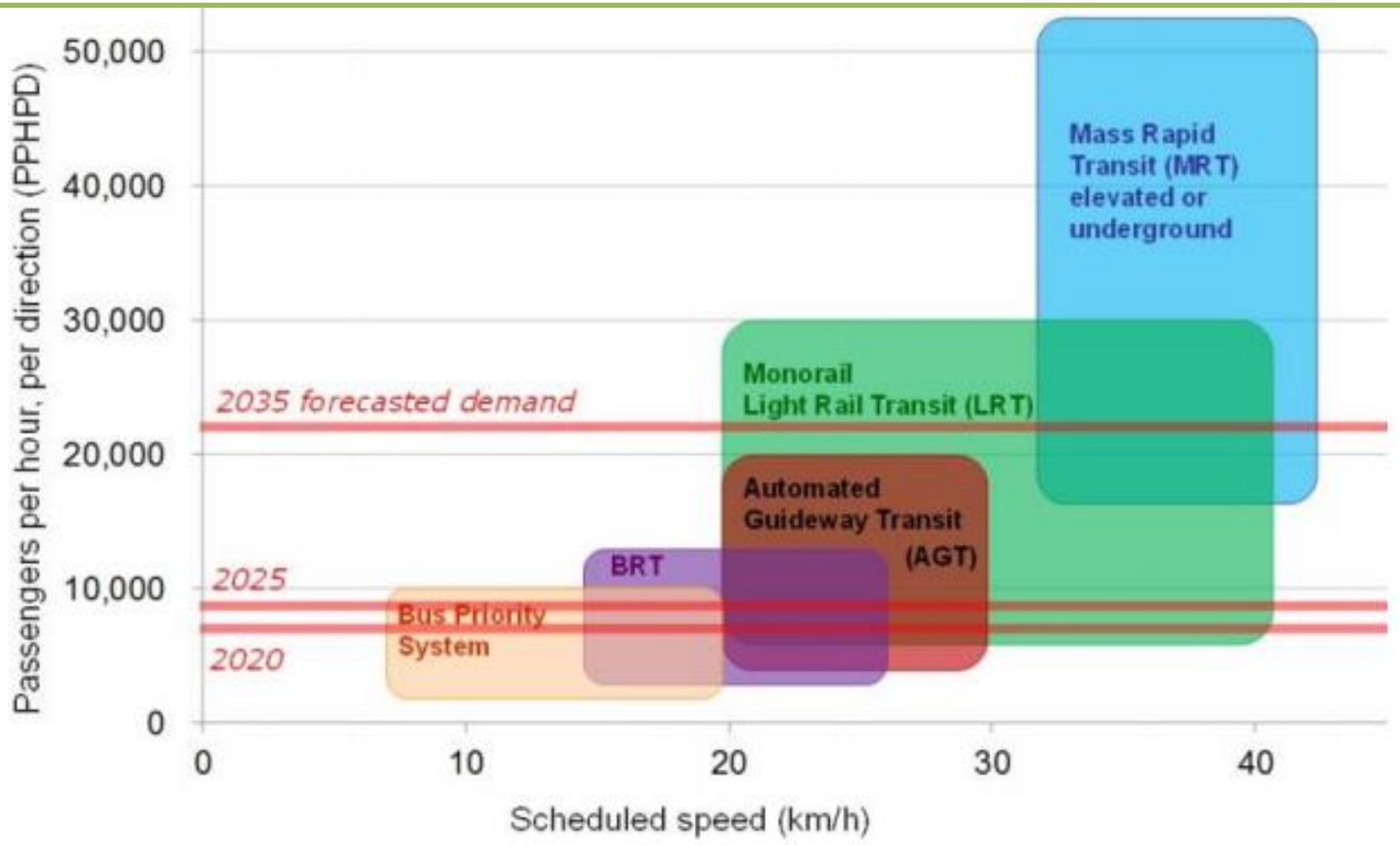
- Passenger Carrying Capacity (PPHPD) => (No of passengers per vehicle) X (no of cars/train) X (No of trains in the corridor, i.e. 60/headway in minutes) => 200X3 X24 => 14400
- Scheduled speed => average speed per round trip *(Not the max speed)*



Selection of the optimal transport solution – Monorail vs Metro system

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Parameters	Monorail system	Metro System
Type of transport system	Rubber tyres cars; 66% ~100% motorized bogies; elevated with beams structure (track)	Steel wheel or rubber tyres ; 50% ~100% ; underground or elevated viaduct with ballastless track
Car Length / width Axle loading	~ 15 m / 2.9m ; 6p/m^2 2 car ~ 8 car train	~22m / 2.7 to 3.2m; 6p/m^2 3 car ~ 12 car train ;
Axle Loading*	9-11 tonne/axle	14-17 tonne/axle
Frequency of trains	150 secs (operating); 100 secs (design) driverless	100 seconds with driverless operation
Passenger Capacity*	9,600 to 30,000 phpdt	20,000 to 75,000 phpdt
Power Supply	750V - 1500V DC 3rd Rail	25KV AC / 1500vDc OHE 750V - 1500V DC 3rd Rail
Max. gradient & Min. Curve Radius*	6% / 50m	4% / 200m
CAPEX for system	30-35 mUSD per km	45-65 mUSD per km

* determines the construction costs for a project

Specifications of a Monorail System

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- Type of monorail system : Straddle type monorail
- Width of each Track : 850m
- Distance between tracks : 3.7m
- Platform length : 65m for a 4-car train with 60m
- Rolling Stock / Train : Light weight aluminium, Air conditioned, 2.9m width, with regenerative braking using VVVF energy efficient technology
- Power Supply : 750vDC 3rd Rail traction
- Signalling system : CBTC signalling with ATP, ATO and ATS/OCC
- Telecommunication : Telephone system, passenger information system, public address, radio system, CCTV

Selection of the optimal transport solution – Monorail vs Metro system

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View of Simple Beam Structure

View of the Slab Structure

Key differences in terms of permanent way

- ROW requirements – land acquisition requirements, land availability along the alignment; rehabilitation and demolition
- Construction methodology – easier to construct; pre-cast beams at off-site casting yard; lesser space to launch the beams; quicker to launch at night time
  - Minimal interruption of public roads during daytime;Less impact on traffic
- Light view – the monorail structure allows sunlight for better lighting and open spaces

A Monorail is a railway in which the track consists of a single beam per direction ; elevated

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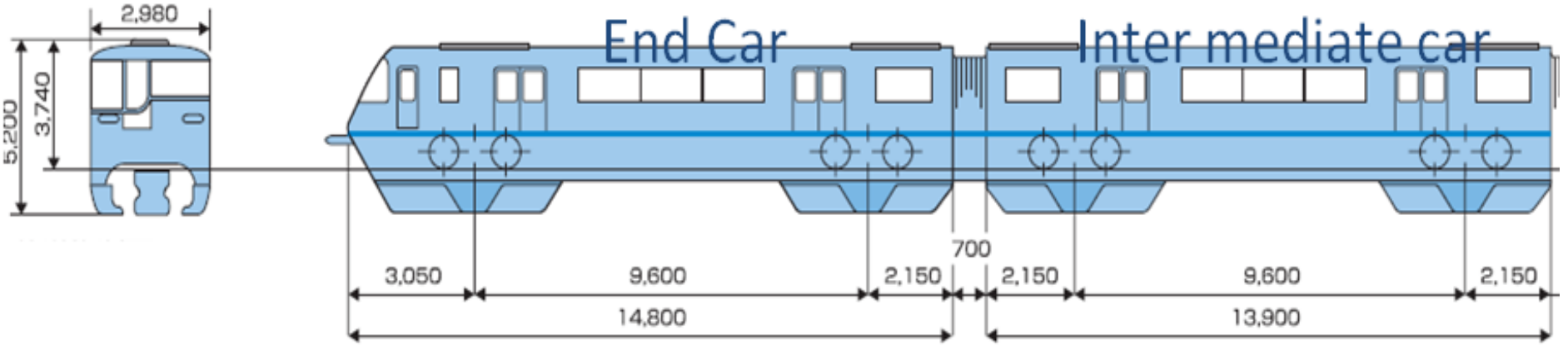

Different beam structures for different terrains

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Simple and Light – Various Routing Possibilities

[Over Road Medians]

[Over the Rivers & Canals]

[Along Existing Roads]

[On Hills & Slopes]

[Along the Shoreline]

[Over Road Flyovers]

Symbol of the city aesthetics and appearance

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Dubai Palm Jumeirah Monorail, UAE

Okinawa Monorail, Japan

Sentosa Monorail, Singapore

Daegu Monorail, Korea

Suitable: Low Noise and Good Ride

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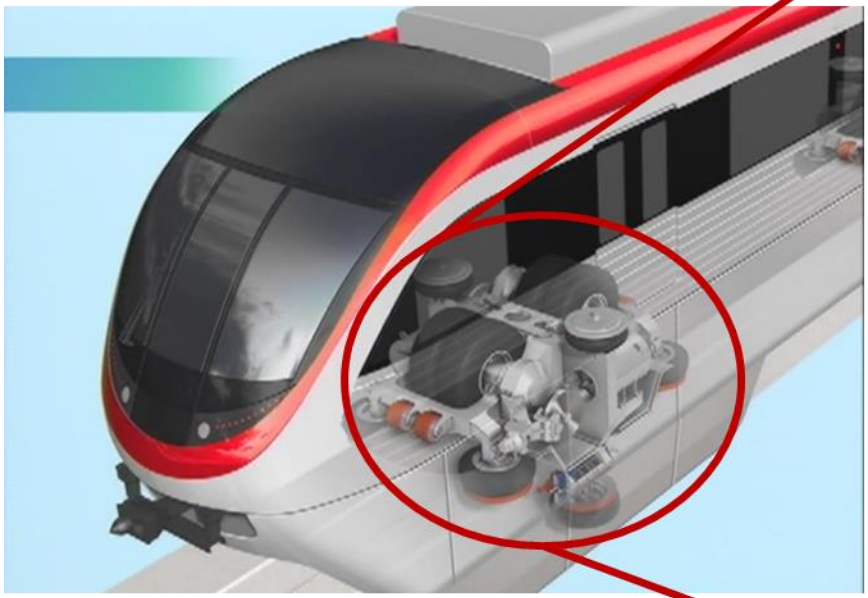
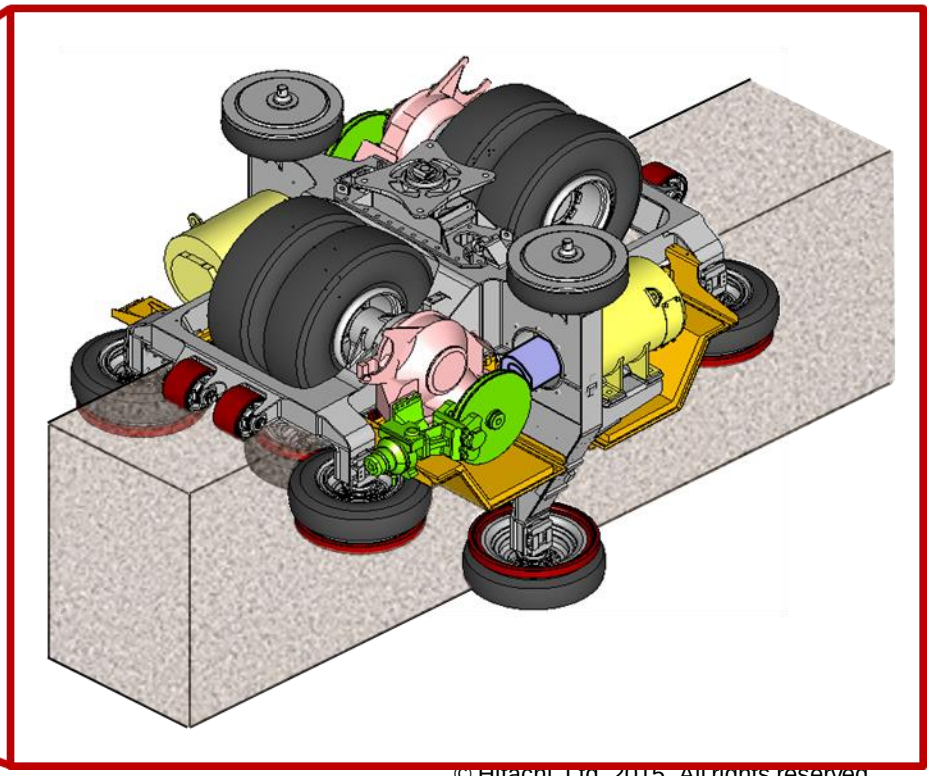
- **Aluminum carbody (extrusion technology)**
  => Light weight, noise & heat insulation, recyclable
- **Bogie Assembly**
  Tandem Axle => Better ride comfort
  Rubber Tyre => Lesser noise both interior and exterior ; less vibrations





Colombo Megapolis “Malabe Fort Kotahena Corridor MRTS”

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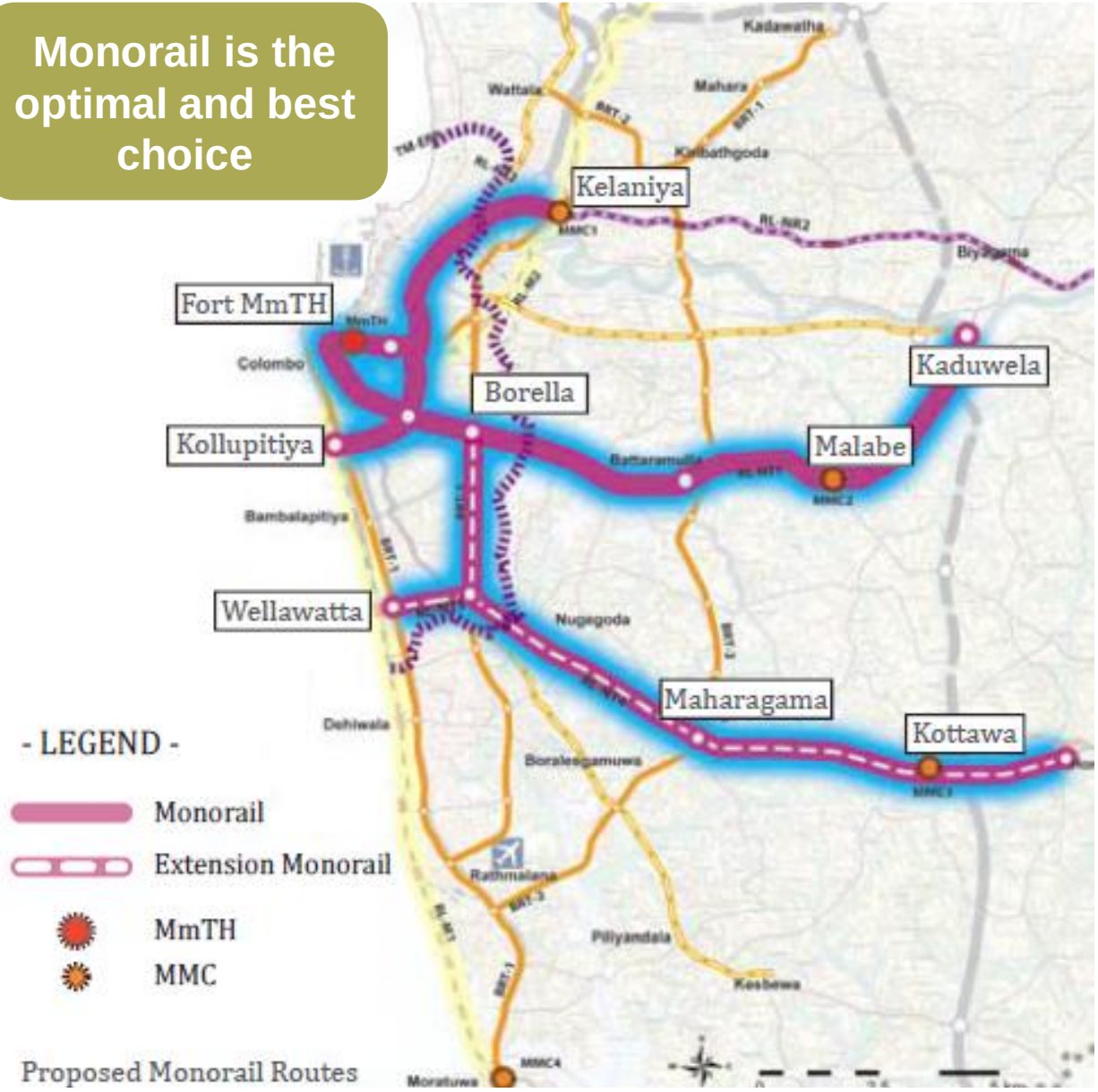
Monorail is the optimal and best choice



Ground reality of the alignment

Insufficient Road Network: Road cannot be widened, no space on road & narrow right of way

Sharp Curves & Grades : ROW along the median of the road will mean sharp curves; steep grades

Passenger carrying capacity demand: 7800 (2020) to 21000 (2035)

Monorail Advantages: Short Construction Time vs Metro system

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Sample Scenario: Line Length:10km (double track) ; Stations:10 ; Capacity :10,000 pphpd

Benefits of Short Lead Time Result in:

- ✓ Reduction in overall construction cost
- ✓ Increased opportunities in providing public service
- ✓ Early start of revenue collection
- ✓ Improvement of project viability

Monorail Advantages: Beam design and construction cost comparison Japan vs Overseas

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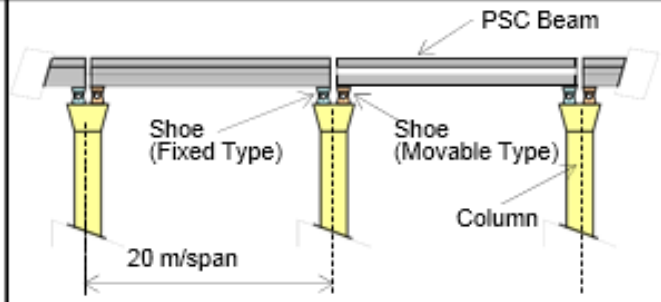
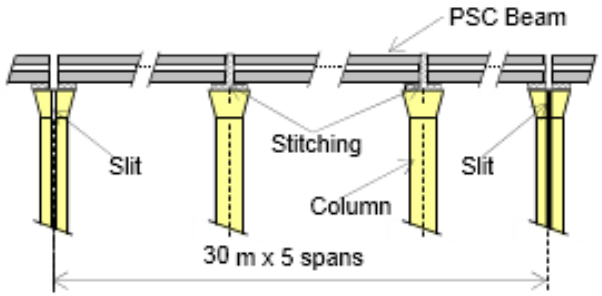
"Japanese" standard design VS "Overseas" standard design

Guide way Type & Standard Length

	Simple Beam (Japan)	Continuous Beam (Overseas)
Characteristic Feature	 Stand-alone and supported by shoe	 Stitching & continuously connected
Advantage	Easy adjustment of beam installation levels (earthquake etc)	Lower cost due to less parts; Ride quality is good with lesser FP
Disadvantage	Guideway & expansion joint cost increase ; more inspection ;cost ↑	Complex design and time taking site installation
Reference	All monorail system in Japan (20m)	Sentosa monorail (25m) ; Dubai monorail (30m)

Monorail Advantages: Safety assured with proven track record across projects

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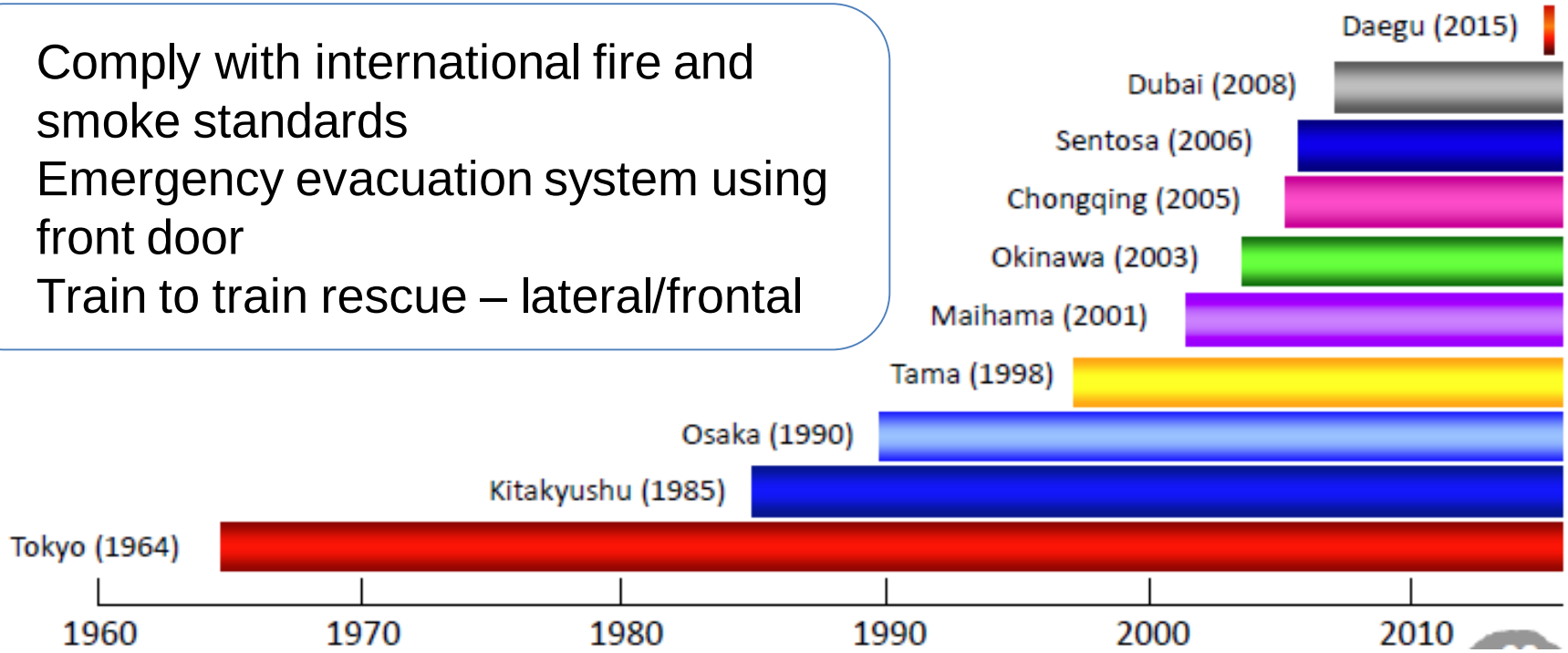
With strict safety standards for urban transit in Japan, Hitachi Monorail System have achieved

- Trouble free operations over half century
- ZERO personal injury record

Hitachi monorail systems are safely in operation under tropical and harsh or climate Okinawa, Sentosa and Dubai

- Comply with international fire and smoke standards
- Emergency evacuation system using front door
- Train to train rescue – lateral/frontal



Monorail Experience: Proven Delivery & performance record Japan & worldwide

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	Tokyo	KitaKyushu	Osaka	Tama	Okinawa
					
Year of Start	1964	1985	1990	1998	2003
Line Length/Station	17.8Km / 11	8.8Km / 13	28.0Km / 18	16.0Km / 19	12.9Km / 15
Ops headway	2.5 minutes	6 minutes	4 minutes	6 minutes	6 minutes
Operating PPHPD	19,800	8,100	11,550	7,700	6,200
Design PPHPD	33,000	24,300	23,100	23,100	18,600
Number of Trains	20 trains 6 cars / train 1.100 pass. / train	10 trains 4 cars / train 810 pass. / train	20 trains 4 cars / train 770 pass. / train	16 trains 4 cars / train 770 pass. / train	12 trains 2 cars / train 310 pass. / train
Maximum Speed	80 Km/h	65 Km/h	70 Km/h	60 Km/h	60 Km/h
Notes	1st monorail for public transportation in Japan		Withstood major earthquake in 1995	Effective use of VVVF inverter	Operated in tropical climate

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	Chongqing (CHN)	Sentosa (SIN)	Palm (UAE)	Daegu (KOR)
				
Year of Start	2005	2006	2008	2015
Line Length / Stations	19.2 Km / 18	2.1 Km / 4	5.1 Km / 5	24.0 Km / 30
Operational headway	3 minutes	4 minutes	15 minutes	5 minutes
Operating PPHPD	15,400	3,000	2,400	7,200
Design PPHPD	23,100	6,000	6,000	24,000
Number of Train	21 trains 4 cars / train	4 trains 2 cars / train	4 trains 3 cars / train	28 trains 3 cars / train
Maximum Speed	60 Km/h	60 Km/h	60 Km/h	80 Km/h
Notes		✓ Operated in tropical climate ✓ Being upgraded to CBTC Signaling	✓Operated in extreme temperatures ✓Driverless operation with attendant	✓Fully unattended operation

2d- Monorail Flexibility for future extensions : Tokyo Monorail (based on Hitachi 10000 series)

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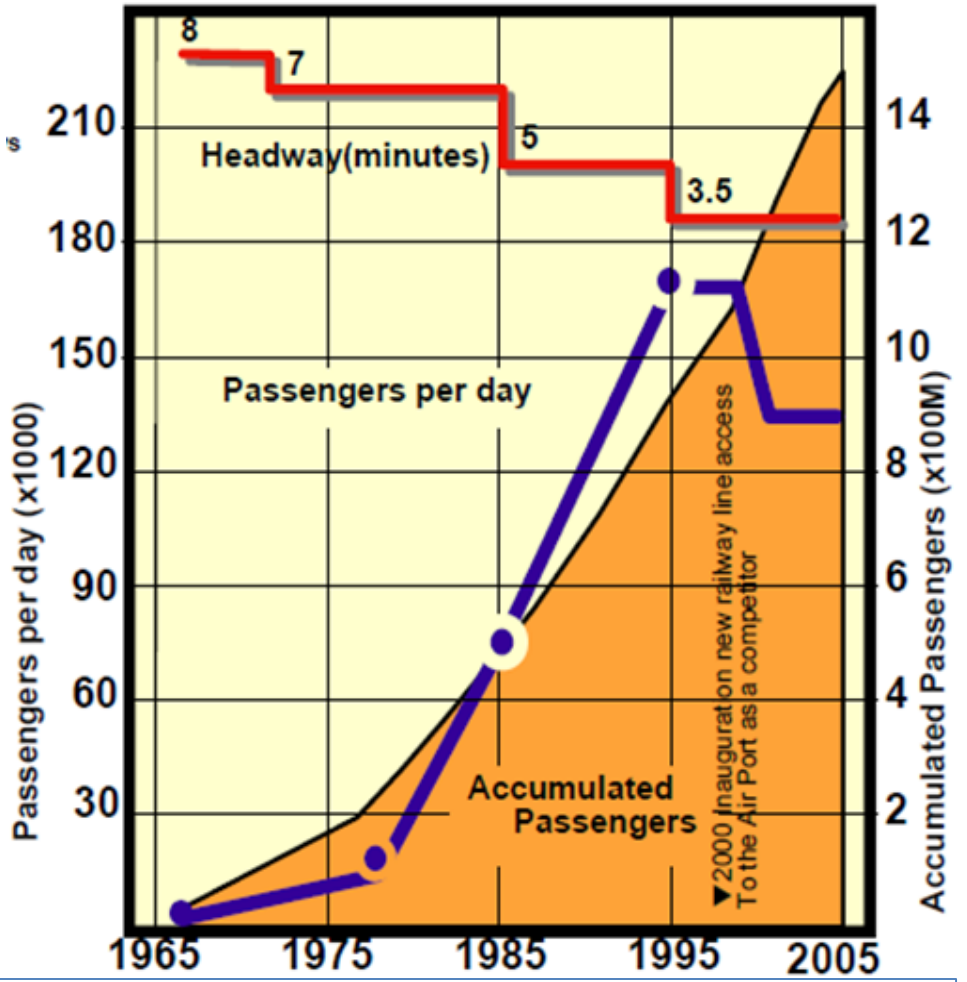
Parameters	Mono Rail
Car Length / Width	~ 16 m / ~ 3m
Power Supply	750 V DC, 3rd Rail
Operational Headway	2.5 seconds
Max. Operating Speed	80 kmph
Capacity (PHPDT)	26,000



- **Ops. started with 3cars train; extended to 6cars; improved headway from 8 mnts to 2.5 mnts at peak traffic ops in 2015. Best ops. headway of 2.5 sec.**
- **Hitachi 1000 is replaced by Hitachi 10000 trains now in service since 2014.**

Summary

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Hitachi highly recommends deployment of Monorail for this corridor because

a. Monorail is an OPTIMAL Fit – technically & economically suitable and effective as a new transit system - Sharp curves, limited land availability, fully elevated

b. Financial Sustainability – To be constructed by public funds. Operations to be viable with integrated transport

c. Environmental & Social compatible

d. Easy to deploy, in the most congested city environment

e. Hitachi's Proven Track Record & Safety demonstrated worldwide

Thank You

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