Steel Construction in India-- Its Potential and Cost Competitiveness

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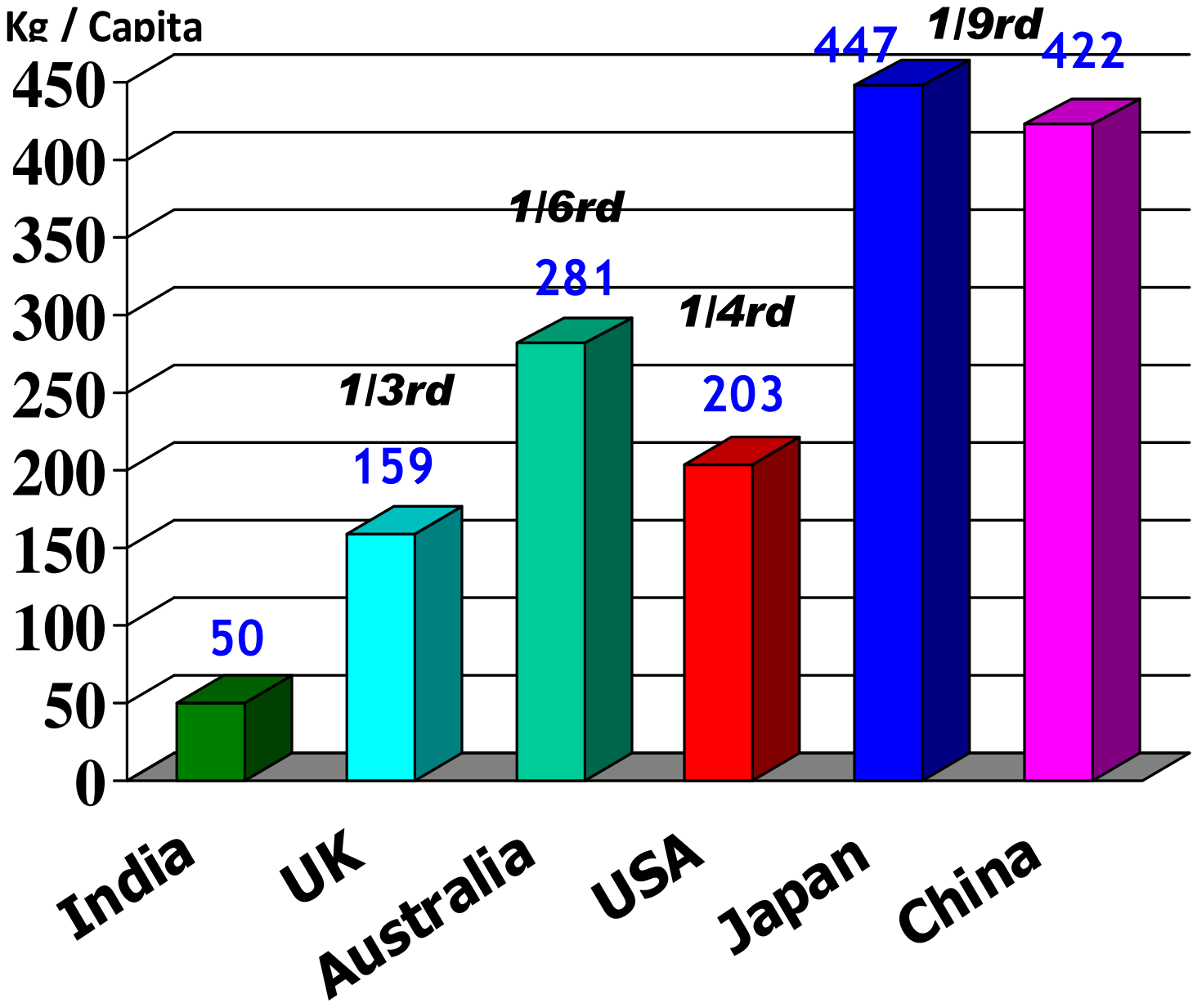
We shall cover

- *Per capita steel consumption in India*
- *Steel construction -- Advantages*
- *Pre-engineered buildings*
- *Space frame construction*
- *Steel-concrete composite construction*
- *Steel construction in housing*
- *Cost competitiveness – Some examples*
- *Indian scenario*
- *Summary & Conclusions*

India 3rd Largest Steel Producer

- *Steel demand in India* **during 2010 & 2011 @ 13.7%--** *World Steel Association's Projection*
- *During 2011*, **Estimated** *Steel Consn. in India* **-- 71.6 MT;** *1/8th of China* **-- 595 MT;** *1/18th of World* **-- 1309 MT**
- *Steel Production in India in 2009* **was 62.8 MT –** *3rd Largest steel producer in the world*.

Per Capita Steel Consumption



Larger per capita steel consumption in the advanced countries is mainly due to popularity of steel intensive construction in those countries.

Spectrum of Steel Construction

- ***Housing & Buildings: Offices/ Residential, Low Rise / High Rise***
- ***Bridges & Flyovers: Rail/ Road,***
- ***Car Parks & Shopping Plazas***
- ***Sports, Medical & Entertainment***
- ***Airports & Seaports***
- ***Power & Telecommunication***
- ***Rural Housing***
- ***Crash Barriers, Rigid Pavements***

Steel Construction Advantages

- ***Sleek & Slim—Yet High Performance***
- ***Broad architectural possibilities***
- ***High DUCTILITY-- Excellent shock loading & seismic resistance; minimum loss to life & property & thus compensation to affected citizens—Huge economic burden on the States***
- ***Certified product properties***
- ***Readily available in all forms***
- ***No shrinking and warping***

Steel Construction Advantages

- *Equal strength in tension & compression*
- *Enables easy construction scheduling*
- *Permits large span construction—a modern trend*
- *Real initial & life cycle cost: Much lower*
- *Flexibility in design & fabrication: Fast Track Construction*
- *Easy installation of utilities*
- *Fully recyclable on replacement — Concrete not environment friendly*
- *Termite and rot resistance*

Limitations of RCC & PSC

- ***Very Weak in Tension***
- ***High Dead Load to Live Load Ratio***
- ***Not Suitable for Cyclic and Shock Loads—as Experienced in Earthquake Situations***
- ***Corrosion of Reinforcements***
- ***Poor Quality: Honeycombing &/or Segregation***
- ***Complex Connections for EQ Design***

STEEL is strong in tension, while CONCRETE is strong in compression.

Best way is to take advantage of-- composite effect of both steel and concrete

Market Share of Steel Construction has been increasing

- **In UK, 80-90% single & multi-storey industrial & commercial bldgs—steel framed.**
- **In Japan— 40% of all buildings are steel intensive.**
- **In USA > 60% of bldgs – steel framed.**

Steel Construction-- Main Types

- ***Pre-engineered building construction***
- ***Space frame construction***
- ***Steel-concrete composite construction***

They significantly reduce time & real initial cost

Pre-engineered Light Steel Bldgs.(PEBs)

- **Small bldg units** are constructed with light steel framing & modular steel framing
- **Very popular** in Japan, USA, Australia, UK
- **Becoming** common in India
- **Complete design optimization**
- **Saving** in construction **time upto 40%;**
- Excellent thermal & sound insulation
- **Typical applications** -- domestic houses, hostels, hotels, superstores, petrol & gas stations, warehouses & factory sheds etc.

- ***PEBs are cost effective primarily due to compressed time frame.***
- ***In the UK, a three storey 78-bed Cardiff Holiday Hotel—(involving steel framing, bathroom pods, dry lining the structure and concrete floors)--could be built in 26 weeks against a requirement of 36 weeks by conventional construction.***
- ***There are many such examples in most of the European countries.***

Indian Examples

A saving in cost by 30% and time by 15-20% has been realized by switching over by the oil majors (BPCL, IOCL, HPCL) from traditional RCC construction to modular steel construction for their oil filling station canopy structures

For warehouse superstructure with roof & wall cladding for an area of 5000 m^2, a saving in time by 33% & in cost by 12% has been reported for the major users such as Container Corporation, IOCL, Exide, Mahindra Ford, Videocon.

Typical PEBs by Kirby & TSE

Large No. of PE Bldgs : Gas Stations; Factories; Power Plants; Workshops; Bottling Plant; Ware Houses; Rice Mills; Car parks; Printing Press; Cold storage; Computer showrooms; Laboratories

Space Frame Structures

- ***3-dimensional structures.***
- ***Made of lightweight hollow circular, rectangular or square sections.***
- ***Provide larger column free spaces /spans.***
- ***Used for construction of roofs of: auditoria; convention halls; passenger stations; indoor and outdoor stadia; exhibition halls; airport terminals; factory buildings; warehouses; temporary and permanent hangers***

Typical Indian Examples

- An entertainment center (1100 sqm) with column free space has been built-- as an extension of Hotel Blue Heaven within a time period of one month at a cost of Rs 60 lac against a requirement of 6 months time and Rs 1 crore as the cost.
- Space frame solution had been adopted for the cylinder storage shed (64.4 m x 53.2 m), at an estimated cost of Rs. 1.2 crores against probable cost of Rs.1.8 crores with other RCC option.

Steel-Concrete Composite Construction

Composite construction is a combination of rolled or fabricated steel sections with concrete slab topping using shear connectors

Strength of combined unit is increased—beam sizes are smaller for the same load

Composite action with steel beam and pre-cast slab

Slimflor beam with pre-cast slab

Typical Examples of Steel Construction

Multi-storey Car Park, Heatrow

Genesis Multi-storey Car Park, World Cargo Centre, Heathrow

Amsterdam, Netherland : Office Building-Free standing unit; columns a pair of 560 mm steel tubes

Canbera, Australia; Bus Stand; Built-up angle Steel Section ***Columns at 7.2m*** distance;double articulated roof frame

Hongkong Stadium: Seats : 30,000 Covered + 10,000 Uncovered; Best Architectural Solution : 50 M Wide Roofs; 240 M Arch; Fabricated Hollow Sections

HOUSING SEGMENT

Residential Steel Framed Buildings

USA: 1992—500 houses; 1993—15,000; 1994—40,000 houses; 1995—80,000 houses; 1996—Target: 250,000 houses

Australia: Pioneer for family houses

Japan: Since 1950—steel framed houses in use; 1993—368,000 steel framed houses

British Steel Exhibition House, UK

Light Steel Framing in Domestic Construction : 4 BR : 1992;
60% Energy Saving Through Thermal Insulation.

Steel Framed House in Cheltenham, UK (Speed Frame)

Finland : Apartment Building in Raahe-

Self supporting volumetric tower elements; Building frame: Steel hollow sections filled with concrete; Low interest loan to encourge use of steel

Growth in Housing Sector

- ***Expected growth in housing sector = 35% p.a.***
- ***Liberal tax incentives w.e.f. 2000***
- ***Easy availability of Bank loans***

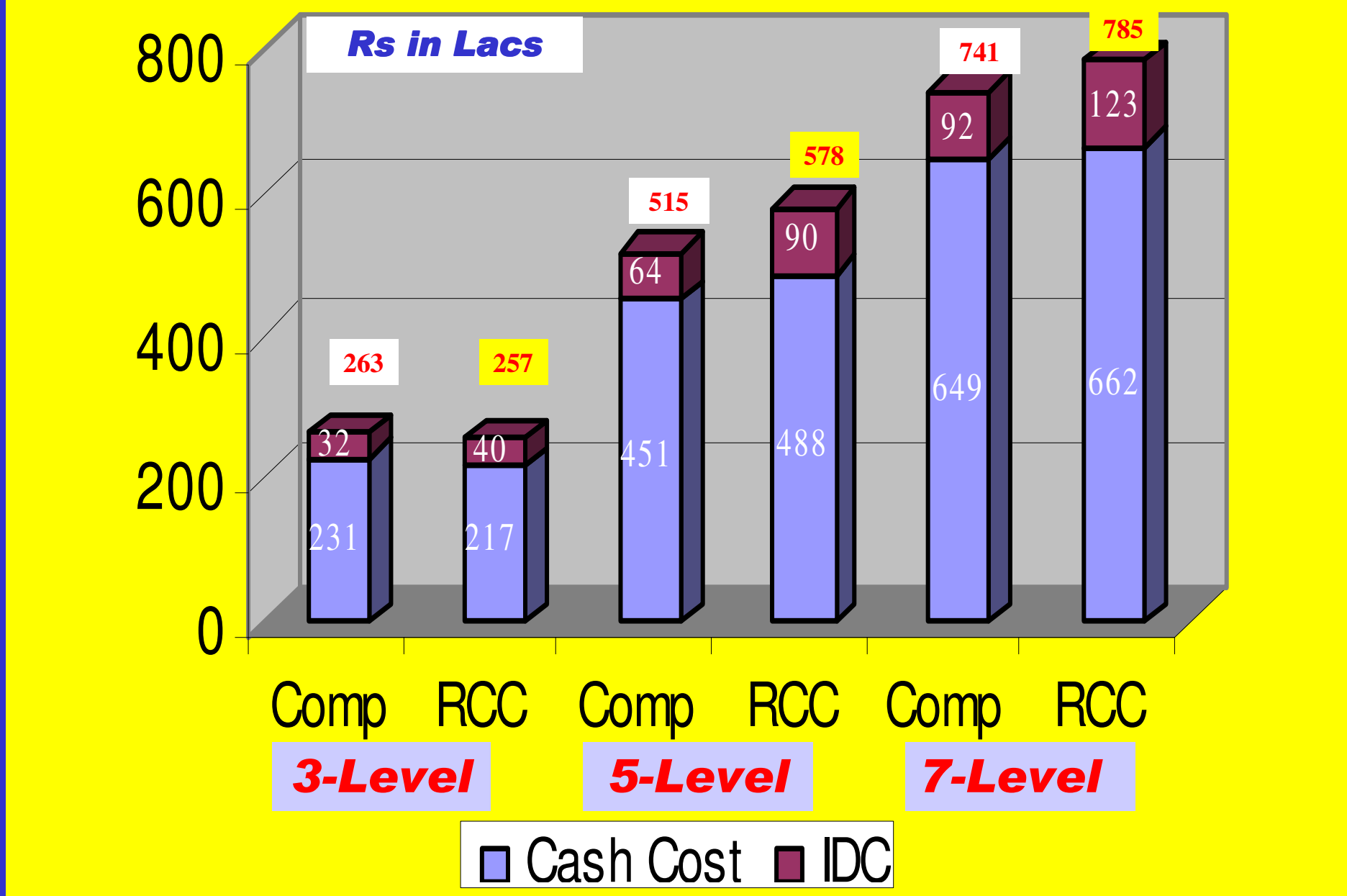
Housing is an Important Area in India

HUDCO's estimate--3.5 millionlyr (2010-20)

For housing modules with steel columns & beams using sandwich wall & roof panels—Time saving: 30-60%;

Does Steel Qualify in Terms of Cost?

Multi-Level Car Park--Initial Cost



Initial Cost of a Typical Urban Flyover

Initial Cost

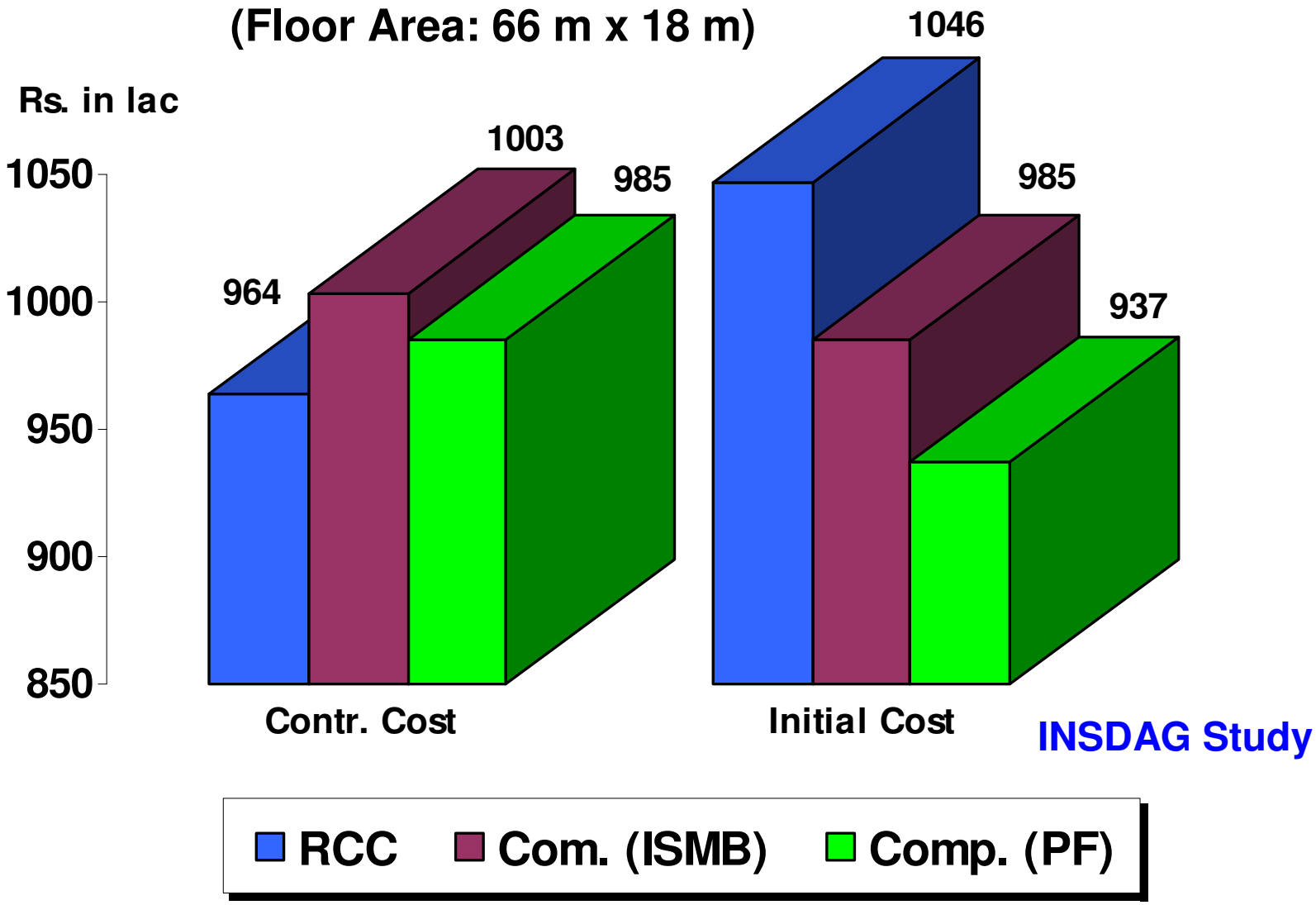
Rs in Lacs

	Kolkata	
	RCC/ PSC	Steel-Concrete Composite
Direct Construc-tion Cost	827	874 (5.7% higher)
Time Cost	69	54
Road User Cost	271	201
Total	1167	1129 (3.2% less)

Similar outcome for Mumbai

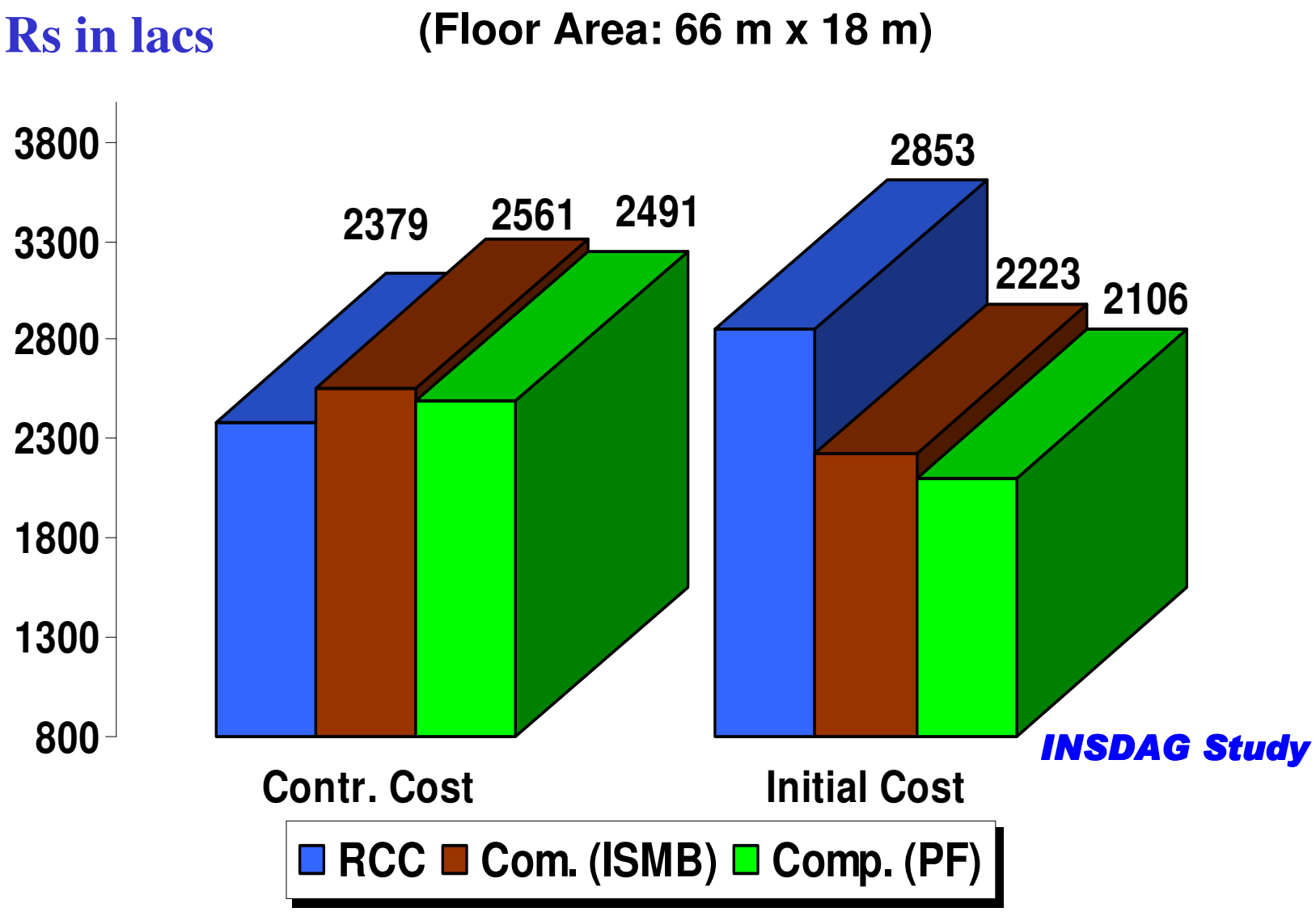
Cost Comparison: RCC vs Composite

Multi-storey building in Kolkata: B+G+3



Cost Comparison: RCC vs Composite

Multi-storey building in Kolkata: B+G+8



Life Cycle Cost

(BMRTS: From Boot Partner's View Point)

Initial Span: 25 m Concrete; 35 m Steel

Rs in Crore

30 km stretch	PSC	Comp.
Direct Cost	440.0	481.0
IDC-Time Cost	92.5	59.0
Diff. Income	--	(-)167.5
Insp. & Maintenance	0.9	4.8
Total	532.6	377.3

Composite (25 m span) Direct Cost: Rs 433 Cr.

Life Cycle Cost

(BMRTS: From Owners View Point)

Rs Crore

30 km stretch	PSC	Comp.
Direct Cost (Revd. Comp.--Rs 433 Cr)	440	481
IDC-Time Cost (@ 15%)	92	59
Differential Income	--	(-)167
Maintenance Cost	10	55
Major Repair Cost	132	24
Social Cost—Public	159	12
Scrap (15% of Steel Value)	---	(-)41
Environmental Cost	--	(-)9
Total 48%	833	400

Env. Cost: 1 person/km/2daysX365 daysX3 yrsX Rs 5000/-X30 km

Indian Panorama

Hotel Natraj, Mumbai

Luv-Kush Bldg Ahemedabad

7-Storey Building in Bandra

Architect-- Shakti Parmar; Structural Engr--Niranjan Pandya: Fabricators—Techno Works

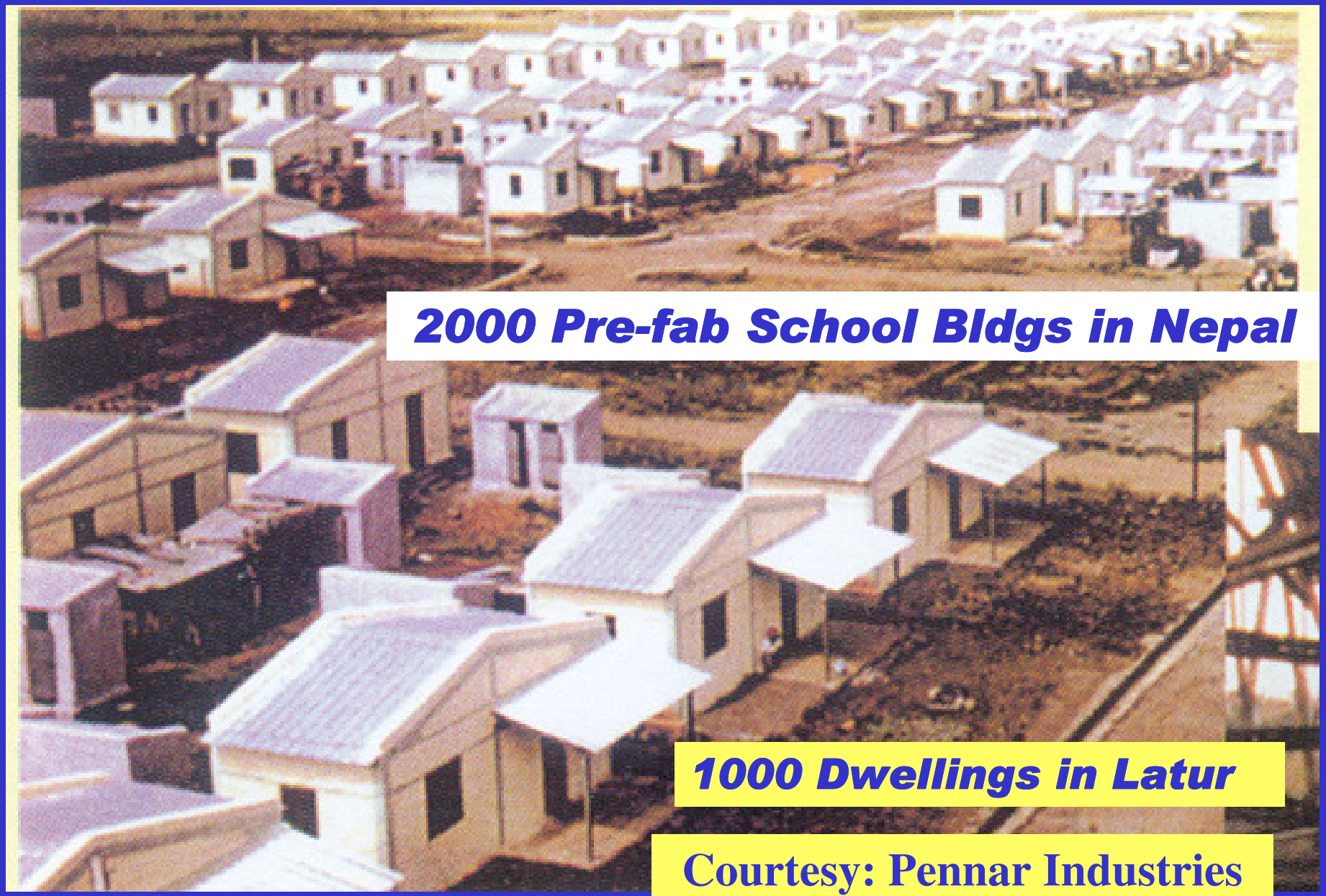
Basement—RCC; All 7 Floors—Steel Construction; All Columns, Primary & Secondary Beams—IS:8500 (YS-410 Mpa); Construction Time: June 2001—Feb. 2002; Fire Protection—Automatic Sprinklers

Oswal Overseas Bldg, Gurgaon

Typical floor: 3,500 sqm with secondary beams castellated; Metal deck roofing; Entire roof constructed in 30 days.

KTI Building in Noida, Delhi

EQ Resistant PEBs



2000 Pre-fab School Bldgs in Nepal

1000 Dwellings in Latur

Courtesy: Pennar Industries

Canopy at Calcutta Airport

Vidyasagar Setu, Kolkata

Fig.2 The second Hooghly cable stayed bridge

Scrap Collection and Recycling

Concluding Remarks

- *Per capita steel consumption in India is quite low -- mainly due to lower level of steel intensive construction.*
- *Steel construction - many advantages*
- *Steel construction finds extensive application in all segments of industry.*
- *PEBs, Space frames and Composite construction—quite competitive to RCC*
- *Life cycle cost & real initial cost—extensively used in advanced countries for decision making. India should also do.*


Thank You

Limitations of Steel

- ***For Slender Members-- Weak in Compression***
- ***Skill in Fabrication & Joining***
- ***Myths about: Availability; Corrosion; Durability; Life Span etc***

Multi-Storey Car Park: Stuttgart Airport