Tehran Pars Royan

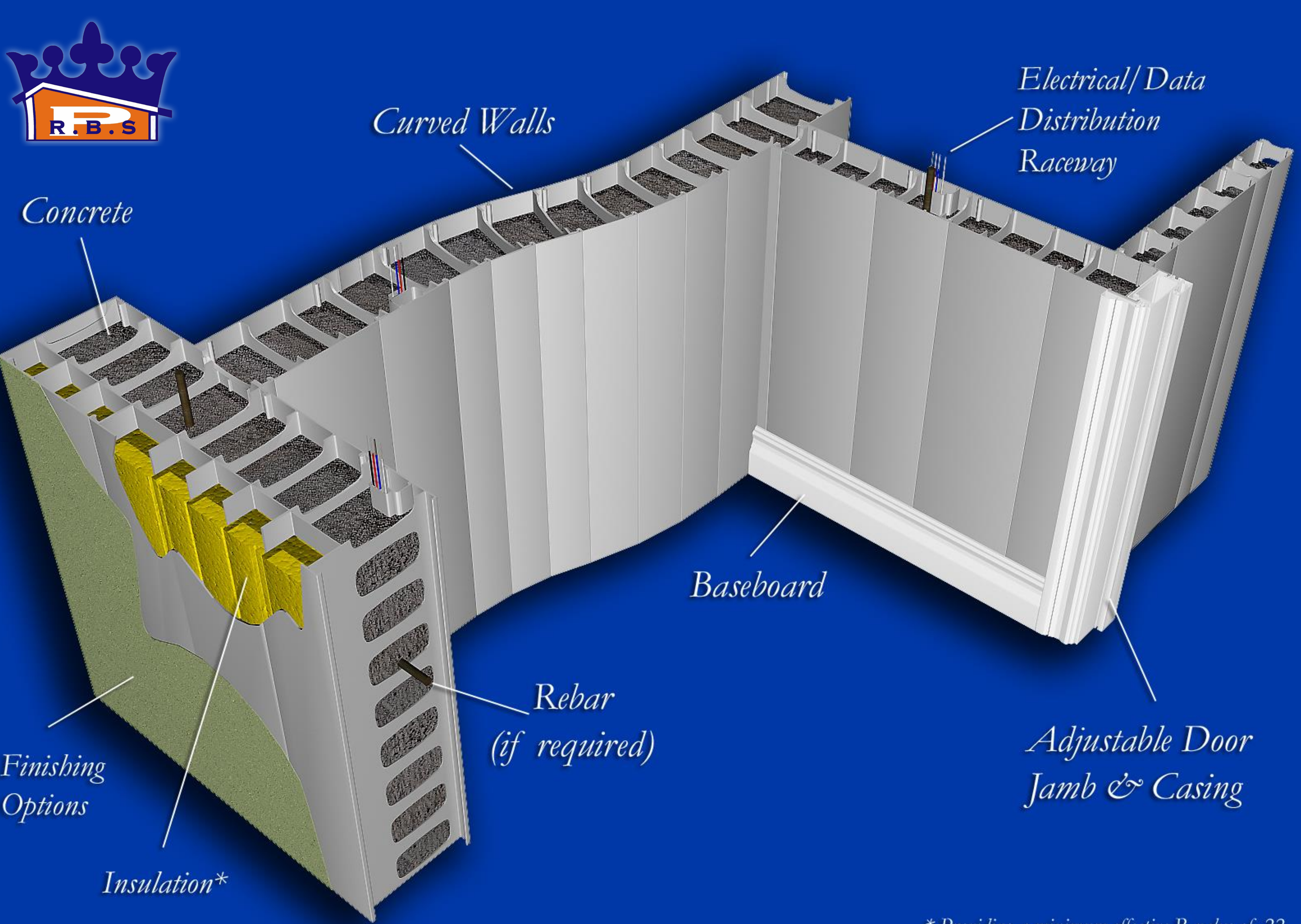
Presents

INTRODUCTION OF RBS STRUCTURAL SYSTEM

WHAT IS RBS?

RBS System designs and builds your building walls with all details by PVC-finished parts and transfer them to your site.

On the site, parts are assembled quickly as possible and are sliding. Concreting inside the parts to complete the construction of structural skeleton is simultaneous with construction of walls, installation of facilities and wiring, and refinish.



* Providing a minimum effective R-value of 22 for the wall assembly

INTRODUCTION OF RBS PARTS

RBS parts are made of PVC with special additives, formulation of which has been exclusively designed for the following features:

Features of PVC included in templets

INTRODUCTION OF RBS PARTS

- ✓Durability over time
- ✓Beautiful finished surface
- ✓Resistance to bump/scratch
- ✓Resistance to ultraviolet

Features of PVC included in templets

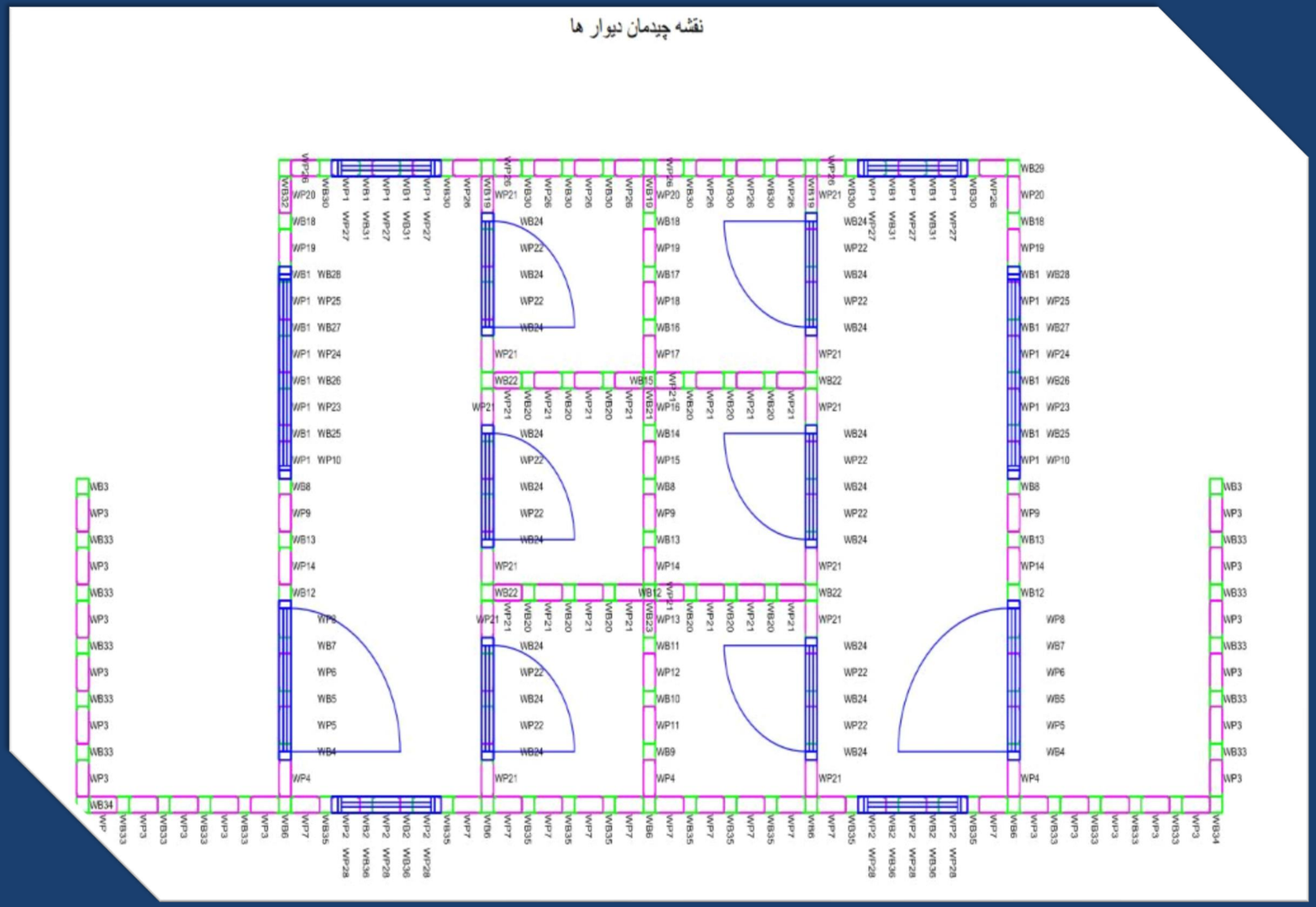
Beautiful finished surface

The process of building RBS walls:

Design step

The process of building RBS walls

1.Design Step



The process of building RBS walls

2- Production Step

- ✓Producing of parts by extrusion method based on the length mentions in the order
- ✓Applying punch operation, circle cut, cutting angle, etc. based on shop drawings
- ✓Labeling, packaging, and shipping parts to the site

The process of building RBS walls: Production step

Process of building RBS walls

3- Implementation stage

- ✓Execution of foundation and embodying dowel

The process of building RBS walls:

Production step (Execution of foundation)

The process of building RBS walls:

Production step (Execution of foundation)

The process of building RBS walls: Production step (Execution of foundation)

Process of building RBS walls

3- Implementation stage

- ✓Execution of foundation and embodying dowel
- ✓Marking the location of parts on the foundation

The process of building RBS walls:

Production step (marking wall`s locations)

Process of building RBS walls

3- Implementation stage

- ✓Execution of foundation and embodying dowel
- ✓Marking the location of parts on the foundation
- ✓Sliding parts on their location based on the labelled plan

The process of building RBS walls:

Production step (sliding templates)

Production process:

Production step (pre-assembled method)

Production process of RBS walls:

Production step (sliding templates)

Production process of RBS walls:

Production step (sliding templates)

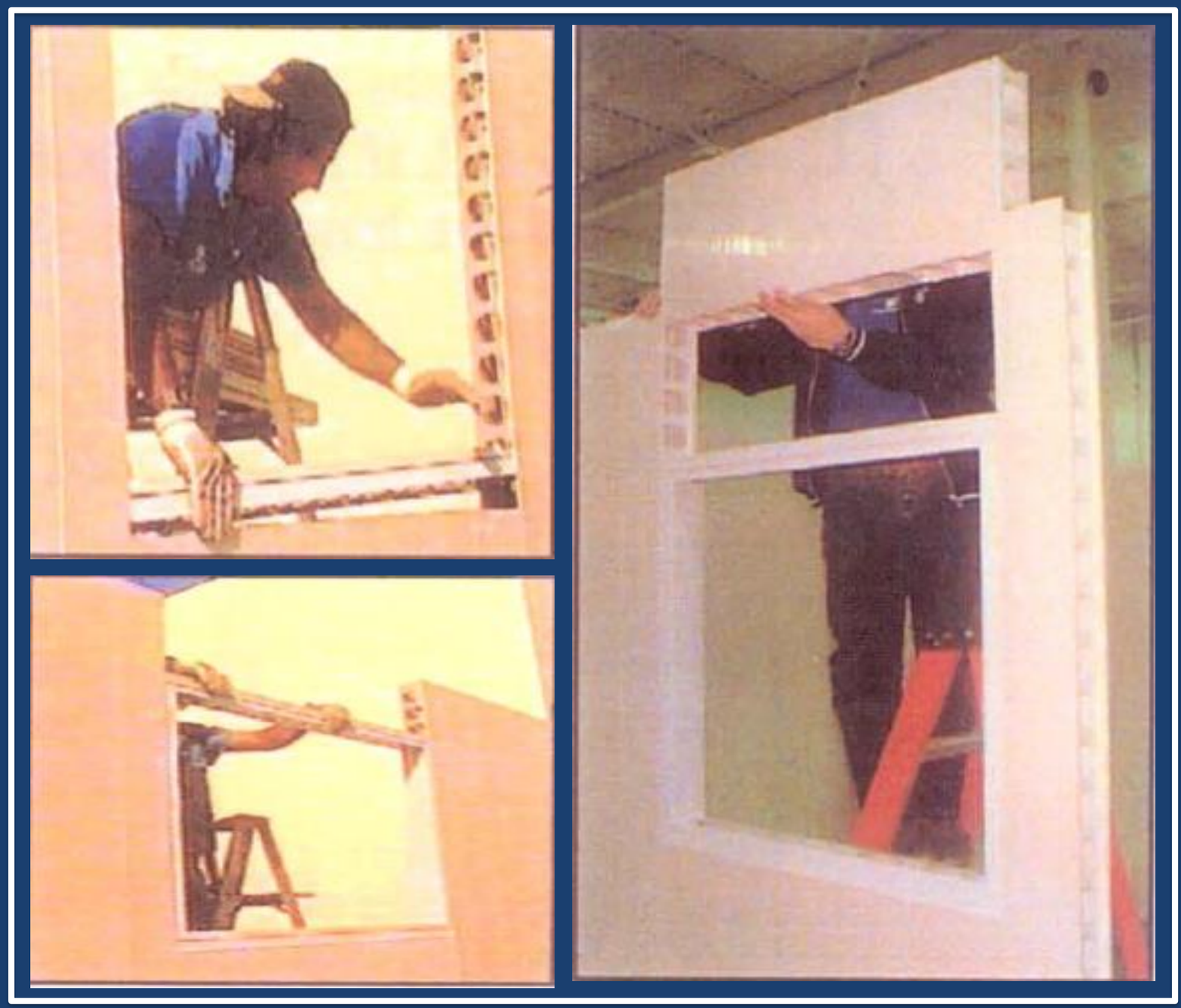
Process of building RBS walls

3- Implementation stage

- ✓Execution of foundation and embodying dowel
- ✓Marking the location of parts on the foundation
- ✓Sliding parts on their location based on the labelled plan
- ✓Installation of doors and windows

Production process of RBS walls:

Production step (installation of doors & windows)



Process of building RBS walls

Following the implementation step

- ✓Installation of armatures, pipes and ducts inside walls

Production process of RBS walls:

Production step (installation of armatures)

Production process of RBS walls: Production step (installation of ducts)

Process of building RBS walls

Following the implementation step

- ✓Installation of armatures, pipes and ducts inside walls
- ✓Bracing and leveling walls, doors, and windows

Production process of RBS walls:

Production step (bracing walls)

Production process of RBS walls: Production step (bracing walls)

Production process of RBS walls:

Production step (installation and bracing and opening)

Production process of RBS walls:

Production step (installation and bracing and opening)

Process of building RBS walls

Following the implementation step

- ✓Installation of armatures, pipes and ducts inside walls
- ✓Bracing and leveling walls, doors, and windows
- ✓Installation of beams and other ceiling parts

Production process of RBS walls:

Production step (installation of beams)

Production process of RBS walls:

Production step (installation of beams)

Process of building RBS walls

Following the implementation step

- ✓Installation of armatures, pipes and ducts inside walls
- ✓Bracing and leveling walls, doors, and windows
- ✓Installation of beams and other ceiling parts
- ✓Concreting and cleaning walls

Steps in Implementing ROYAL CONSTRUCTION SYSTEM for Single-storey Building

1) Foundation/service arrangements
2) implementing location map/installing anchor bolts of foundation of straps in the wall foot
3) assembling walls
4) assembling panels of doors, windows, and openings
5) installing ceiling beams
6) installing plumping system, sewage, wiring paths and armatures
7) bracing and leveling walls, doors and windows
8) concreting/ installing anchor bolts of ceiling
9) washing walls/waiting for concrete grab set
10) opening all bracing
11) installing wall caps/internal parts/4-way connectors
12) installing ceiling
13) aligning and final registration of ceiling
14) installing roof tiles and fittings
15) finishing roof with tiles and etc.
16) installing doors and windows
17) internal and external final finishing
18) service installation

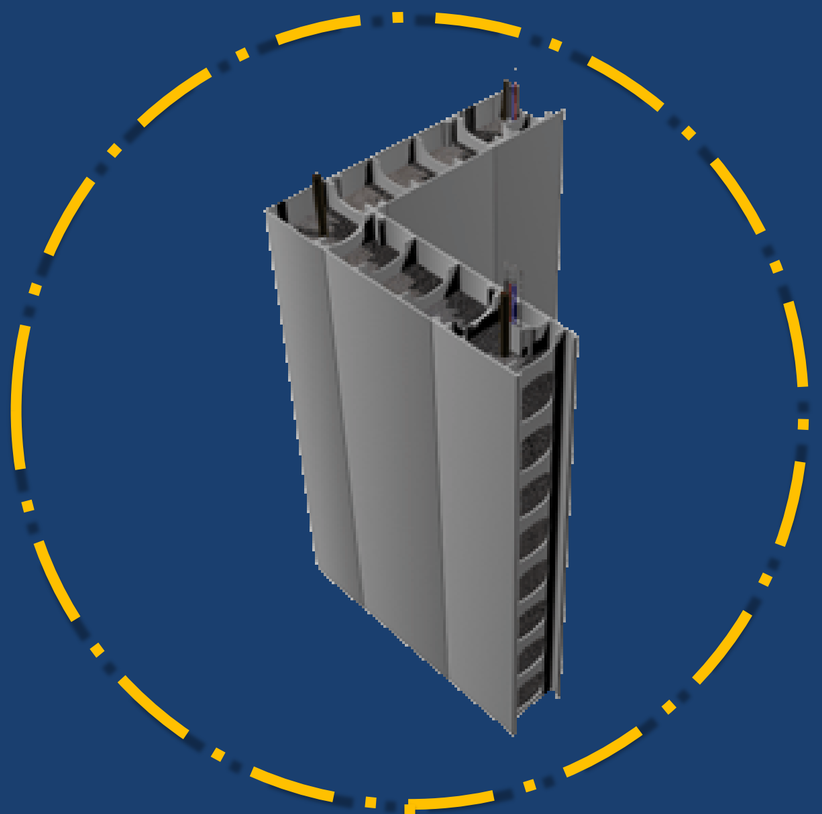
In above, steps of installing a standard single-storey unit using RBS system is presented. For a unit up to 100 square meters only 30 working days are needed from the date of order to deliver the keys.

A Sample of 52 Square Meters Unit on Faro Island

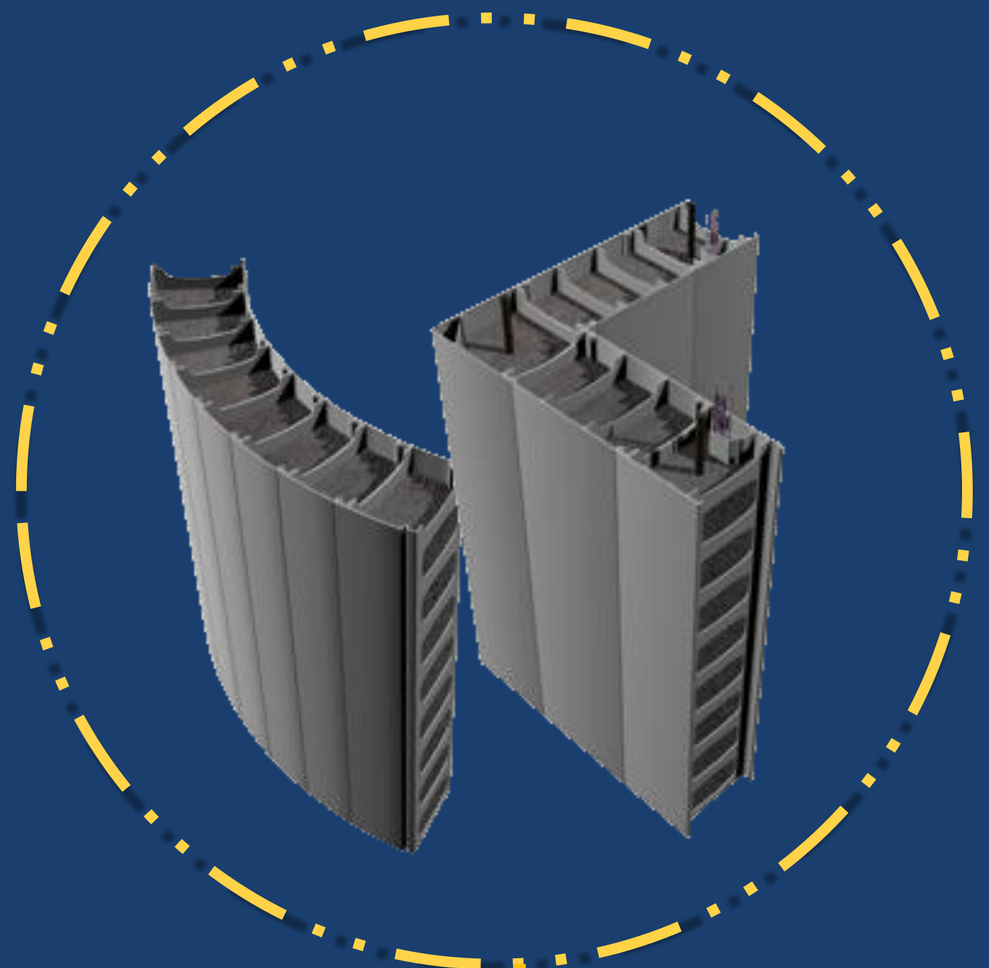
Activity	Duration
Preparation and leveling the location of foundation and chainage	Day 1
Sewage plumping	Day 2
Concreting foundation	Day 3
Implementing box and panels location of walls Placement of dowels	Day 4
Completing dowels placement and locating hot and cold water pipes, and start to layout pre-assembled walls	Day 4
Completing walls placement	Day 4
Plumbing, bracing, and concreting walls	Day 5
Starting to assemble roof and simultaneously flooring inside the building	Day 6
Finishing roofing and flooring inside and starting PVC facade	Day 7
Finishing the façade of the building, electrical wiring, installation of valves and service equipment	Day 8
Finishing electrical wiring of outside, and completing installation of 50 square meters building	Day 9

TYPES OF RBS WALLS

TYPES OF RBS WALLS



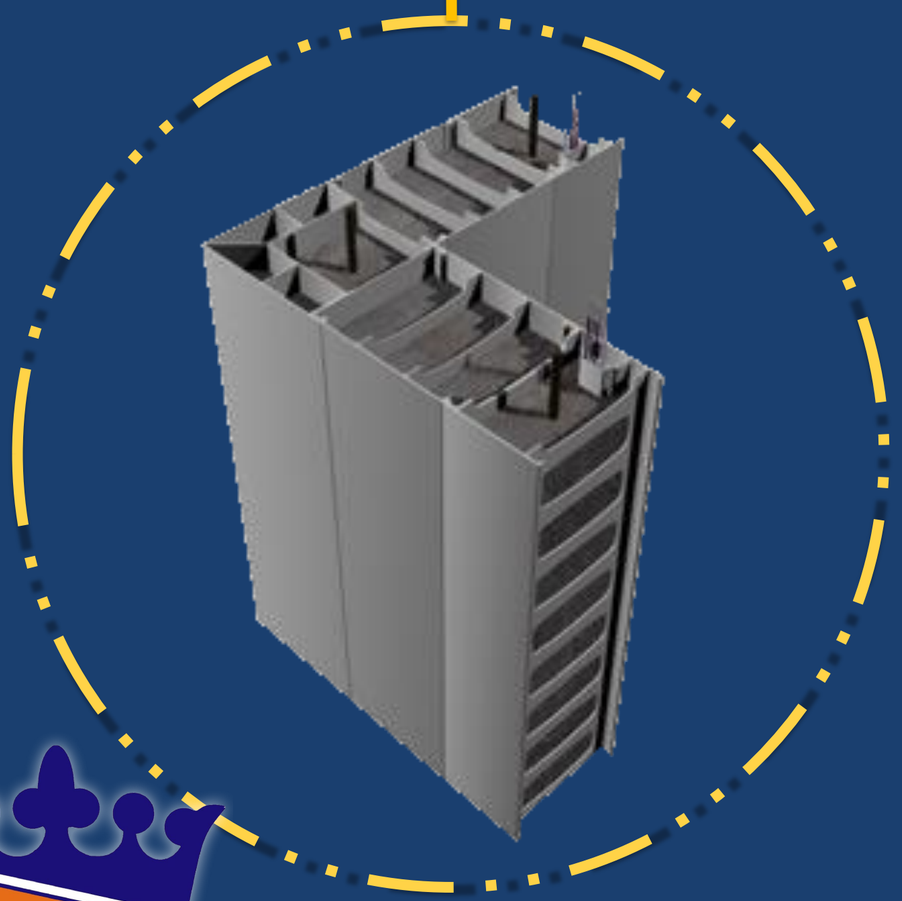
RBS4
(100mm – 4” wall)

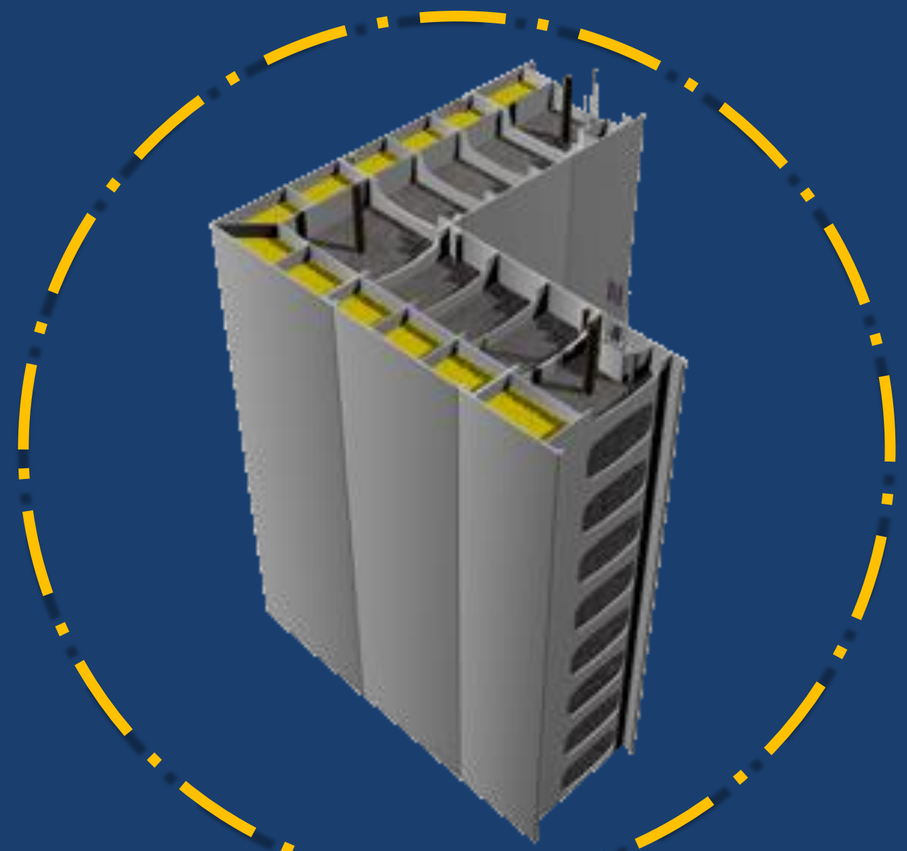


RBS6
(150mm – 6” wall)

TYPES OF RBS WALLS

RBS8
(200mm – 8” wall)





RBS8i
(200mm – 8” wall)

TYPES OF SELECTED COLORS
FOR POLYMER PARTS

LIGHT CRÈME

WHITE

BRIGHT GREY

DARK GREY

BENEFITS OF RBS SYSTEM

BENEFITS OF RBS SYSTEM

- ✓Practicality of its unlimited use in a variety of architectural designs
- ✓Fast and easy transportation of prefabricated parts
- ✓Easy to use in bulk
- ✓High speed of construction
- ✓Insulation against temperature and sound
- ✓More effective area due to reduced thickness of internal edges

BENEFITS OF RBS SYSTEM

- ✓Reducing weight of structure by assigning a structural role to all walls and optimal force distribution
- ✓Building earthquake and storm-resistant buildings
- ✓Usability in a variety of climates and weather conditions
- ✓Creating highly-crafted facades using polymer without any need to building façade
- ✓Preventing evaporation of concrete water and improving concrete process
- ✓Saving energy consumption in the structure

Benefits of RBS System

BENEFITS OF RBS SYSTEM

- ✓Preventing damage to the structure by termite and other harmful insects
- ✓Easy structure design using software provided by the company
- ✓High-end quality by employing high-level expertise
- ✓No pollution and significant construction waste at the workshop

Benefits of RBS System

BENEFITS OF RBS SYSTEM

- ✓Implementing more that 75% of construction steps industrially (at the factory) with the highest quality
- ✓Possibility of quick operation of the building constructed with this system
- ✓Very easy maintenance, repair and cleaning
- ✓Final cost same as an average-quality building while having much more quality with this system

The company guarantees 10 to 25 years warranty for orders over 10,000 square meters

Introduction of RBS Technical Features

RBS technical certificates

International Standards and Approvals

Approval of Building and Housing Research Center Affiliated to the IRI Ministry of Housing and Urban Development

- ✓ **RBS - CCMC Approval** Evaluation Report 12536-R, Issued 10 Sept, 1993: Re-evaluated 30 May, 2005 -Part 9 - NBC - Housing and Small Buildings
- ✓ **RBS - BMEC Approval**
  Minister's Ruling 95-01-20-(12536-R)
  Issued January 29, 1995
  Part 9 - OBC - Housing and Small Buildings
- ✓ **BOCA** – National Building Code (Report # 94-57)
- ✓ **NY** -Building Code (C of A No. 0093)

International Standards and Approvals

✓**RBS - ICC-ES Approval**

Evaluation Report ESR-1223

Section: 03130 - Permanent Forms

Issued September 6, 2006

✓**RBS - Florida Product Approval** Florida Product Approval # FL7382

Structural Components - Finished Forms

Issued December 6, 2006

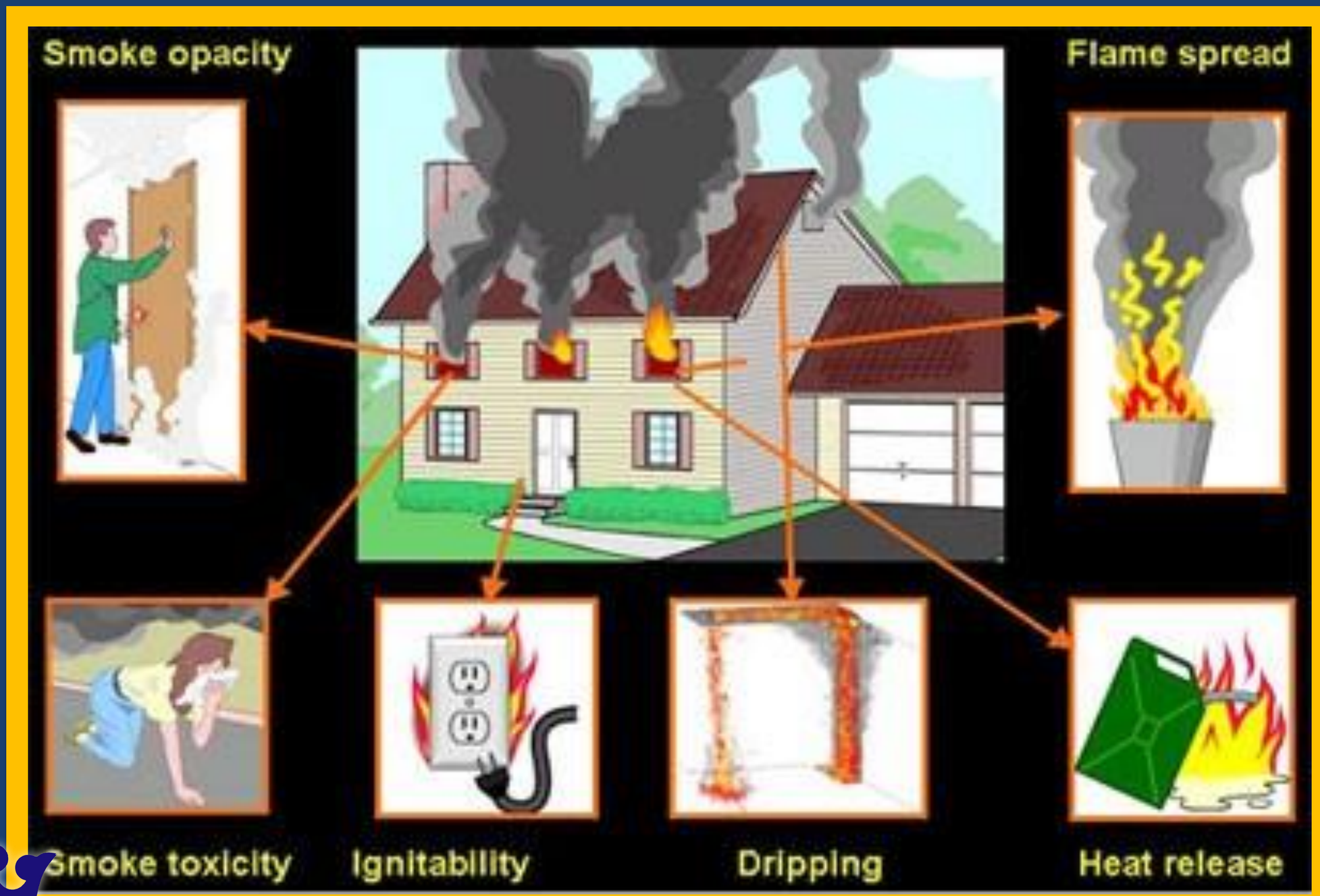
✓**ICBO** - Uniform Building Code (Report # ER-5174)

✓**OBC** (Minister's Ruling No. 95-01-20-(12536-R))

✓**PHRC** The Pennsylvania Housing Research Center (Report No. 51)

RBS Fire Resistance Performance

Importance of Fire-Resistance in The Building



RBS Fire Resistance Performance

The especial and exclusive formulation of RBS makes results in:

1. Does not flame
2. Does not release toxic gases when burning
3. Controls fire by releasing chlorine contained in the PVE compound
4. Protects concrete core from fire penetration and delays its destruction

RBS Fire Resistance Performance

Wood Results	RBS Results	Regulations Requirement	Test Method	Performance Against Fire
208-264 **406-507**	480° C 896° F	Min 343° C 650° F	ASTM D1929	Auto Ignition Temperature
260 **500**	460° C 860° F	- -	ASTM D1929	Flash Ignition Temperature
- -	0 0	10 mm/sec 0.394 in/sec	ASTM D635	Rate of Burn
- -	12.4 mm 0.49 in	Max 25.4 1.0 in	ASTM D635	Maximum Extent of Burning
100 -	19 13	Max 25 <150	ASTM E84 ULC S102.2	Flame Spread
380 -	261 75	Max 450 Report Value	ASTM E84 ULC S102.2	Smoke Development
34±11	-	-	Footnote 6	Flash Fire Propensity

Results of various fire tests on RBS

RBS Fire Resistance Performance

CAN/ULC S101 Certificate (Equivalent to ASTM E119) for RBS walls

Minimum Resistance Against Fire	Nominal Thickness of Concrete Core	Total Thickness	Wall System
45 minutes	96 mm 4 in	100 mm 4 in	RBS4
2 hours	145 mm 6 in	150 mm 6 in	RBS6
2 hours	195 mm 8 in	200 mm 8 in	RBS8
2 hours	195 mm	200 mm	RBS8i

RBS Fire Resistance Performance

Fire reaction tests reports with cone calorimeter

Test Duration	Observations
15	Exhaust
18	Sample surface get black
33	Cracking sample surface and white smoke exhaust
55	Flaming sample surface
65	Gradual buckling of coal and blowing the sample surface
115	Flaming away due to sticking to the coal, persistence of severe smoke, and
266	Flaming sample surface
275	Flaming sample surface

RBS Acoustic Performance

RBS Acoustic Performance

The obtained STC index from acoustic tests is presented based on ASTM E336 in the below table. The value of this index for the concrete wall with 100 mm thickness and a desirable quality is 40, which shows a 30% increase compared to 52 for RBS4.

STC Value	Total Thickness	Wall System
RBS4	100 mm 4 in	52
RBS6	150 mm 6 in	52
RBS8	200 mm 8 in	55
RBS8i	200 mm 8 in	58

RBS Performance in Energy Terms

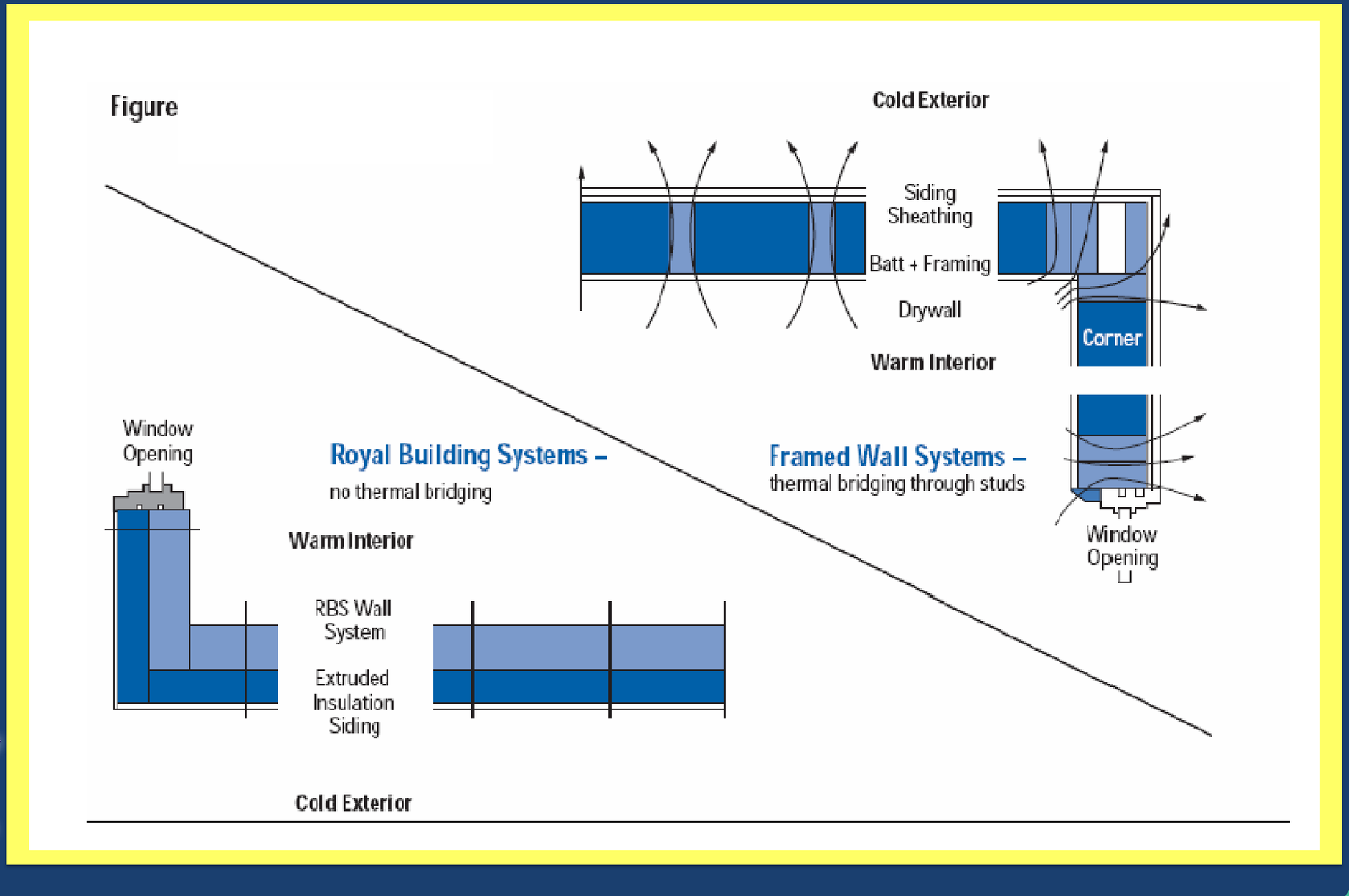
RBS Performance in Energy Terms

RBS Energy Saving Factors:

- ✓Removing seams resulting from installation of doors and windows in traditional structures with the help of integrated implementation of these parts in the walls
- ✓Having a high thermal mass resulting from the concrete core and storing energy in and maintaining it.
- ✓Application of a 5 mm insulation layer as an external insulation and reduction of thermal index of RBS wall to 45, which results in 30 to 50% reduction in energy consumption.

RBS Performance in Energy Terms

✓Removing thermal bridges caused by metal frames and fittings in ordinary walls



Mechanical Properties of RBS Parts

ASTM test results on RBS parts

Property	ASTM Test Method	Units	Requirements	Results
Impact Resistance Notched Izod	D 256	J/m Ft.-lb./in.	>53.4 >1.0	240.3 4.5
Drop Dart Impact at Room Temperature	D 4226	J/m Ft.-lb./in.	Report value	4893 1.1
Drop Dart Impact at Low Temperature (-30°)	D 4226	J/m Ft.-lb./in.	Report value	445 0.1
Tensile Strength	D 638	MPa Psi	>37.7 >5500	41.9 6023
Modules of Elasticity	D 638	MPa Psi	>2800 >377000	3158 458000
Deflection Temperature @ 1.82 MPa (264 psi) Annealed @ 65° C	D 648	° C ° F	>70 >158	73.8 165
Coefficient of Linear Expansion	D 696	Cm/cm/° C In./in./° F	$< 6 \times 10^{-5}$ $<3.3 \times 10^{-5}$	5.0×10^{-5} 2.8×10^{-5}
Weatherability	D 1925	Max. YI	Report value	+2.15
Weatherability	D 2244 D 2244 D 2244	Max. LH Max. aH Max. bH	Report value	-0.34 +0.01 +0.92

Research and Experiments on RBS

Research and Experiments on RBS

1- A study by US Air Force Laboratory (AFRL) on the performance of RBS walls against explosive charges

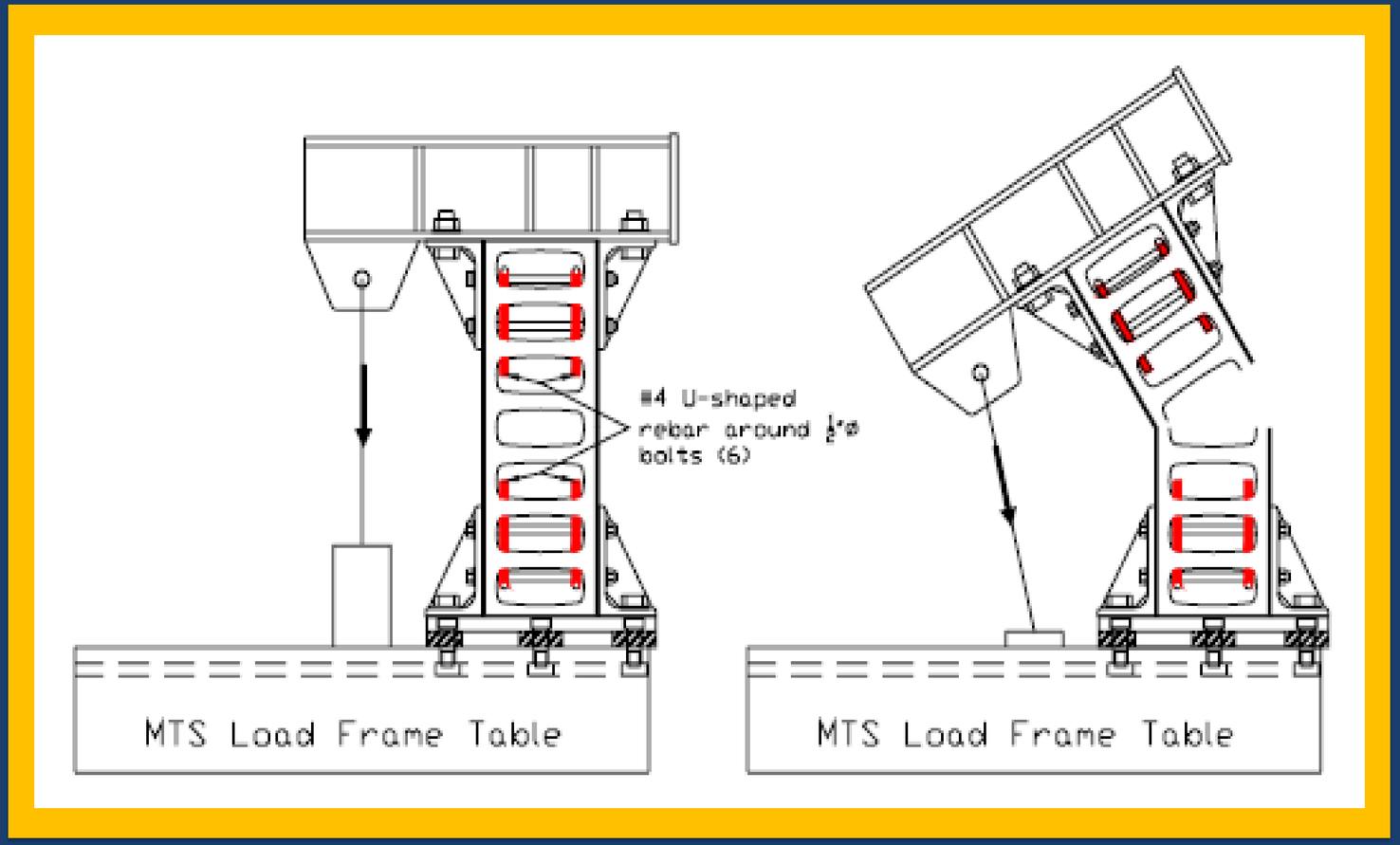
James S. Davidson, Jeff W. Fisher, and Robert J. Dinan. "Performance of Polymer-encased Concrete Walls Subjected to Blast Loads", ASCE Structures Congress (2006.)

Performance of RBS walls against explosive charges

Performance of RBS walls against explosive charges

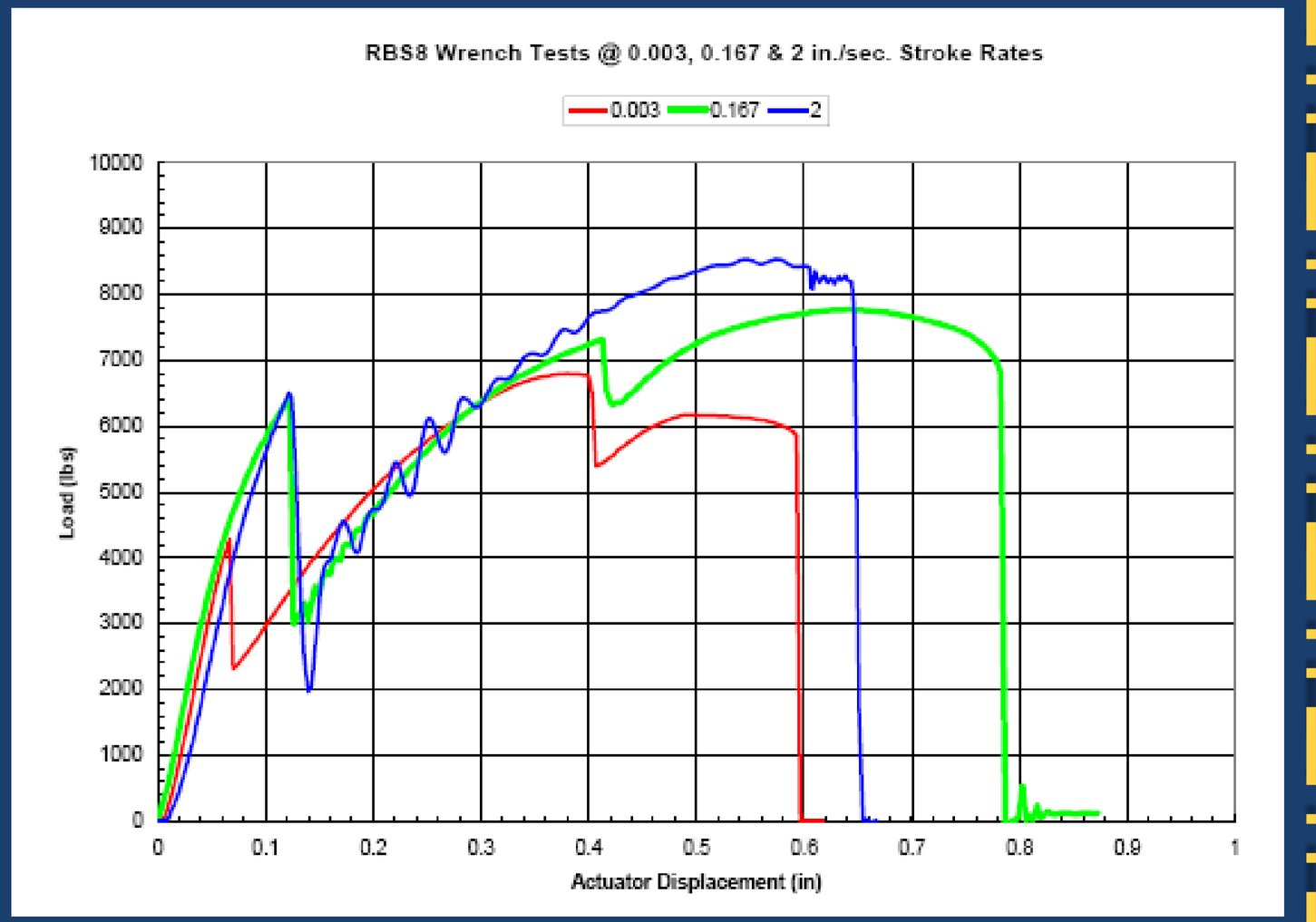
A) Flexural Test

An RBS panel was under side load at the rates of 0.003, 0.167, and 2 in/s, and the power-location shift diagram to the rupture limit was obtained.



A) Flexural Test

Power-location shift diagram in flexural test



Performance of RBS walls against explosive charges

A) Flexural Test

It was observed that RBS molding plays an important role in increasing the strength and plasticity of the wall by controlling cracks and participation in bearing stretching stresses

(a) Failure @ 0.003 in/sec Stroke Rate

(b) Failure @ 2 in./sec Stroke Rate

Performance of RBS walls against explosive charges

B) Test and Analysis of Finite Element under Explosive Charge

Five sample of pre-fabricated concrete walls with RBS molds of various thicknesses and under different supporting conditions were tested under explosion. In order to study the role of concrete mass inertia on the wall response sample no.6 was filled with sand and gravel.

Performance of RBS walls against explosive charges

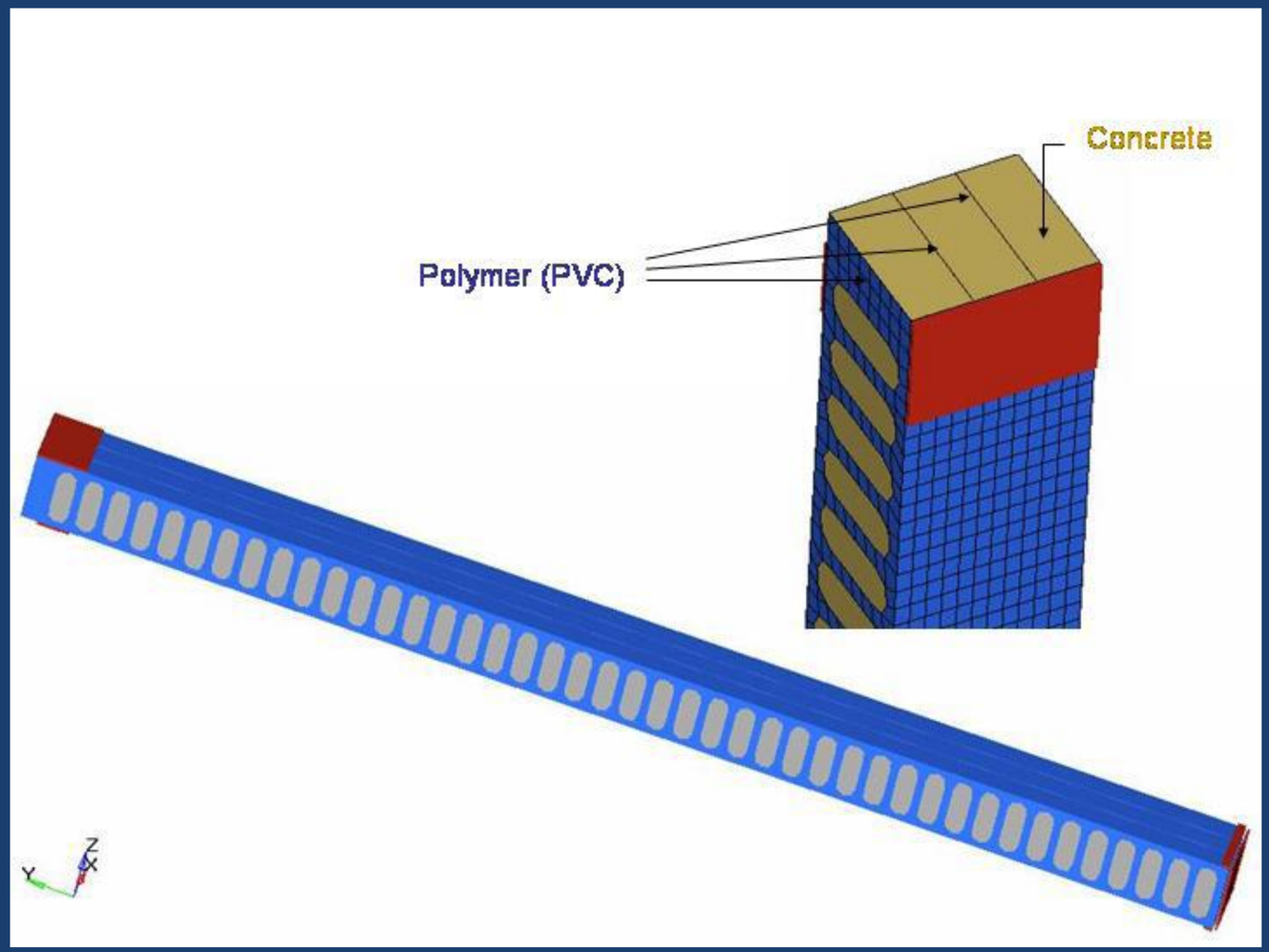
B) Test and Analysis of Finite Element under Explosive Charge

Laboratory samples and descriptive observation

Wall #	Description	Results and Observations
1	8-inch PVC form, 12 ft vertical span, dowelled into concrete at the base and a pin restraint at the top.	No external damage or residual deflection, peak inward deflection of 2.8 inch.
2	8-inch PVC form with 2-inch insulation, 12 ft vertical span, dowelled into concrete at the base and a pin restraint at the top	No external damage or residual deflection, peak inward deflection of 4.7 inch.
3	4-inch PVC form, 9 ft vertical span, dowelled into concrete at the base and a pin restraint at the top.	Tension failure in PVC at mid-height /11.2 inch defection, wall collapsed.
4	6-inch PVC form, 9 ft vertical span, dowelled into concrete at the base and a pin restraint at the top.	Tension failure in PVC at mid-height, 6.4 inch defection, wall did not collapse, peak inward deflection of 9.3 inch.
5	4-inch PVC form, 9 ft vertical span, dowelled into concrete at bottom and top as retrofit behind unreinforced 8 inch CMU wall.	No external damage or residual deflection, peak inward deflection of 5.1 inch.
6	8-inch PVC form filled with sand/gravel mix only, 12 ft vertical span, pin restraint at bottom and top.	No external damage or residual deflection, peak inward deflection of 6.1 inch.

Performance of RBS walls against explosive charges

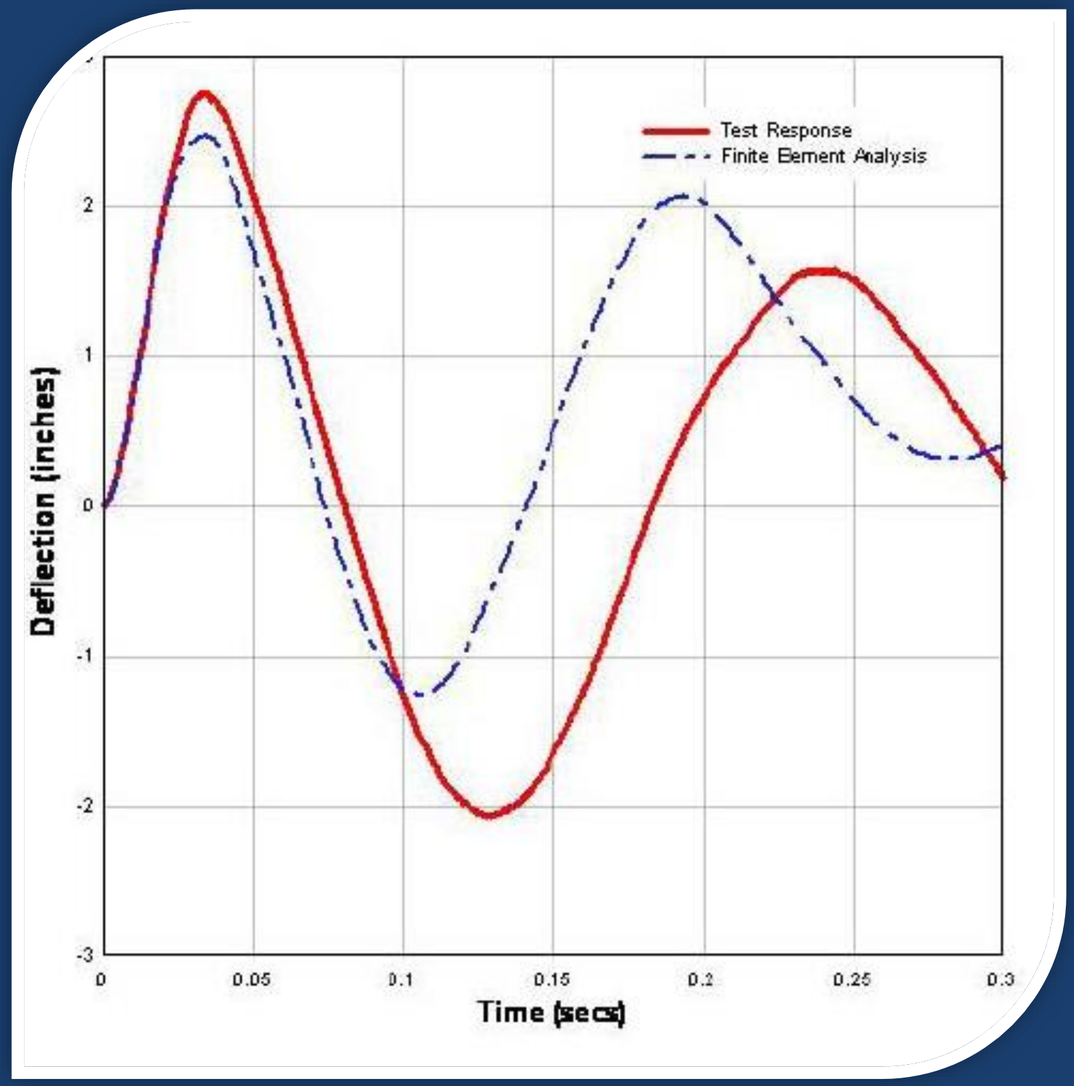
B) Test and Analysis of Finite Element under Explosive Charge



Model of finite elements in LS-DYNA Software

Performance of RBS walls against explosive charges

B) Test and Analysis of Finite Element under Explosive Charge



Good Match for Numerical and Laboratory Results

Performance of RBS walls against explosive charges

Overall Results

PVC permanent molds have a dramatic effect on increasing the protective role of wall against the explosion.

PVC material through:

a)Significant participation in increasing resistance at high strain rates; and

b)Its high non-elastic deformation capacity and effective contribution in absorption of wall energy in large deformities

greatly improves the strength of walls and their plasticity.

Performance of RBS walls against explosive charges

Overall Results

✓The presence of permanent PVC molds reduces cracks of concrete parts caused by explosive.

Performance of RBS walls against explosive charges

2- Full-scale experiments on RBS parts at Waterloo University in Canada

- ✓A. H. Chahrour, K. A. Soudki & J. Straube, "RBS polymer encased concrete wall part I: experimental study and theoretical provisions for flexure and shear", Construction and Building Materials 19 (2005) 550–563
- ✓A. H. Chahrour & K. A. Soudki "*RBS polymer encased concrete wall. Part II: Experimental study and theoretical provisions for combined axial compression and flexure*", Construction and Building Materials 20 (2006) 1016–1027

Laboratory study at Waterloo University in Canada

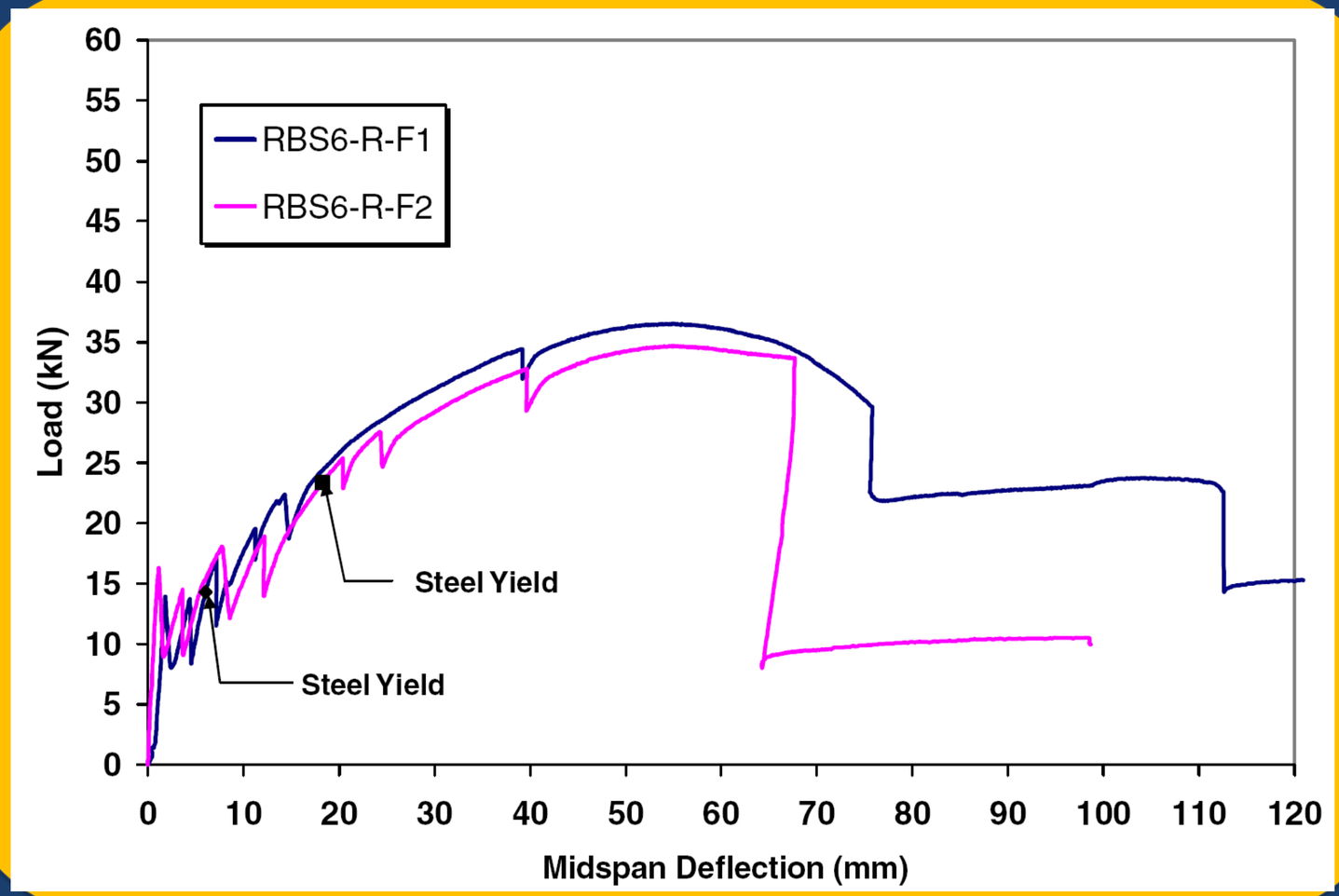
A) Loading the sample under flexural load

Laboratory study at Waterloo University in Canada

The presence of polymeric mold has increased the flexural capacity and non-elastic spin of the beam

Laboratory study at Waterloo University in Canada

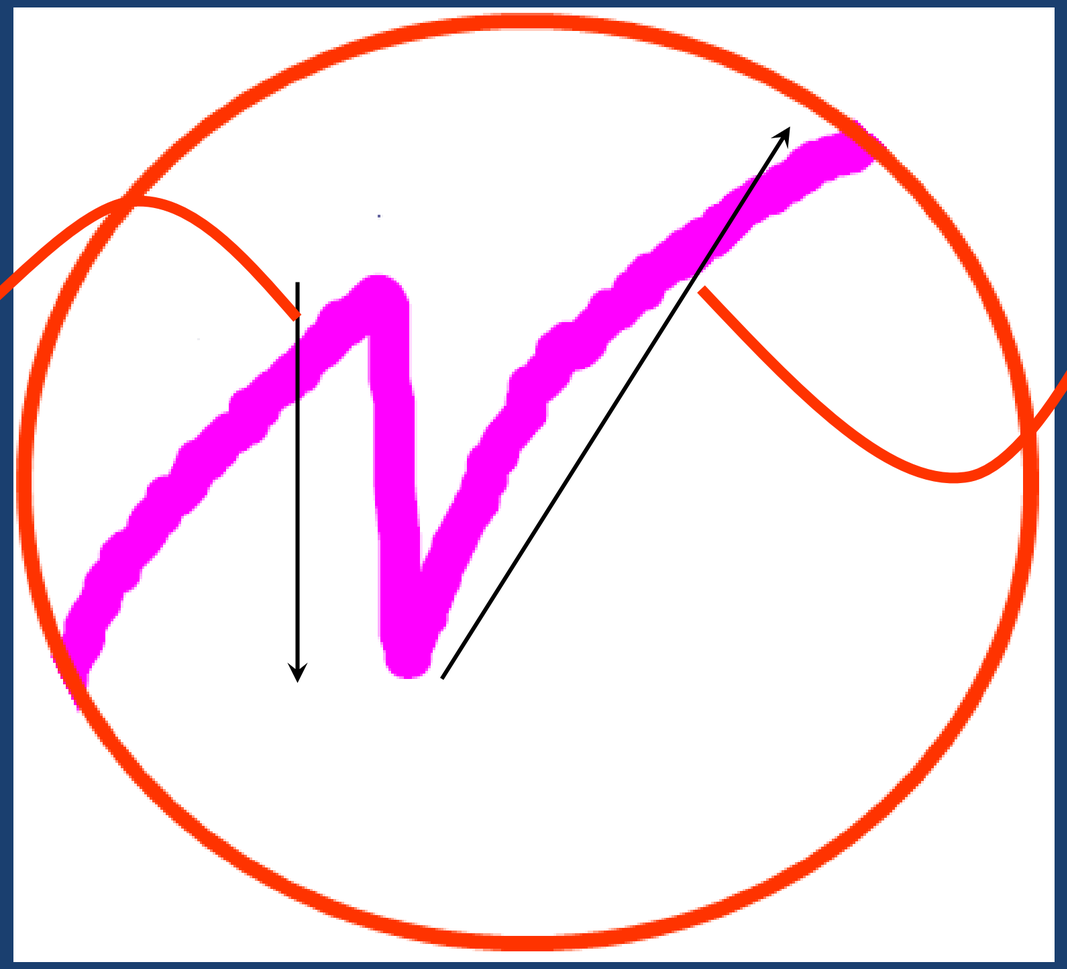
It was observed that the presence of polymeric mold increases the flexural capacity and non-elastic spin of the beam



Laboratory study at Waterloo University in Canada

After cracking, increasing deformation of the concrete in the stretching location, the tensile stress is transformed to the polymeric mold and the capacity is restored again; thereby, prevents the crack expansion and early damage to the part.

Local resistance reduction due to new cracks

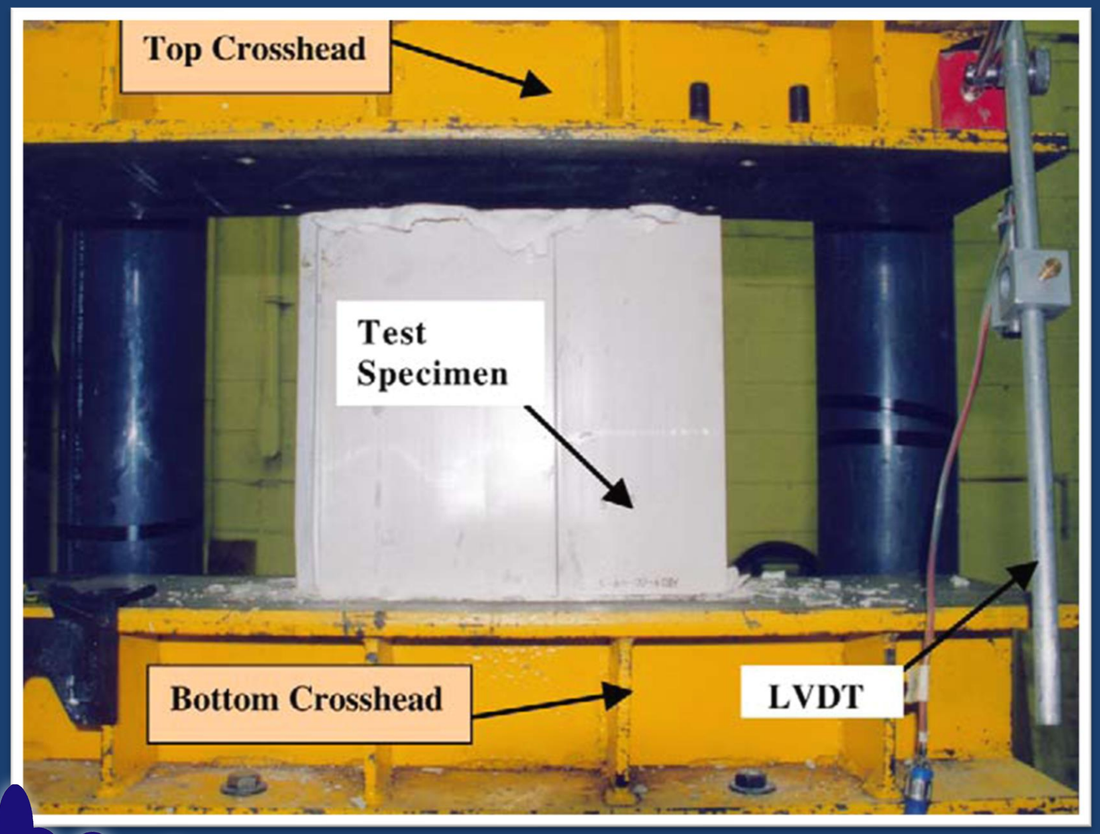


Restoring after increase in deformation and activating PVC capacity

Laboratory study at Waterloo University in Canada

B) Loading sample under pure pressure

Two series of samples were tested with and without polymer molds, and was observed that the rupture of encloded sampled with polymer had more plasticity.



In addition, the comparison showed that the presence of polymeric parts has no negative effect on the compressive strength of samples

Laboratory study at Waterloo University in Canada

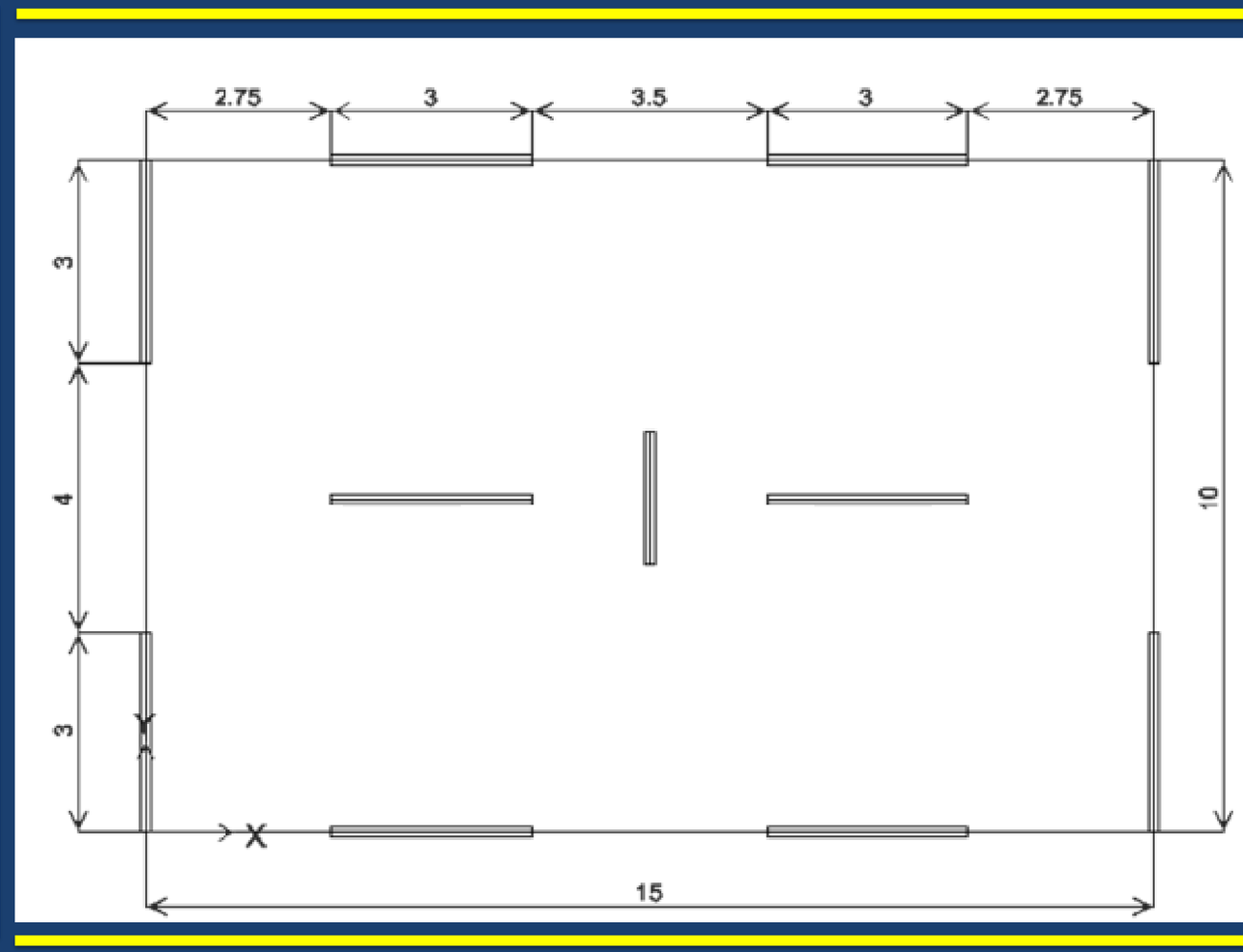
B) Loading sample under flexural pressure

It was observed that polymer tensile strength plays a significant role in increasing bearing capacity and non-elastic spin of the sample.

3- Study of construction frame performance with TBS System by the Numerical Method at Amirkabir University

Omid Dadpour, “Evaluation of seismic performance of modern reinforced concrete wall system with permanent PVC molds”, Master thesis, Amirkabir Industrial University, 2010

Two 3- and 6-storey building are shown in plan in the figure, in which 15 and 20 cm walls are used respectively in order to create gravity and lateral resistance of the system, and are modeled in OpenSees Software.



Design Principles:

✓**Gravity load:**

- code of conduct: ASCE7-05
- Usage: Administrative
- Dead Weight: 600 kg/m^2
- Live Load: 300 kg/m^2
- Ceiling System: two-way slab

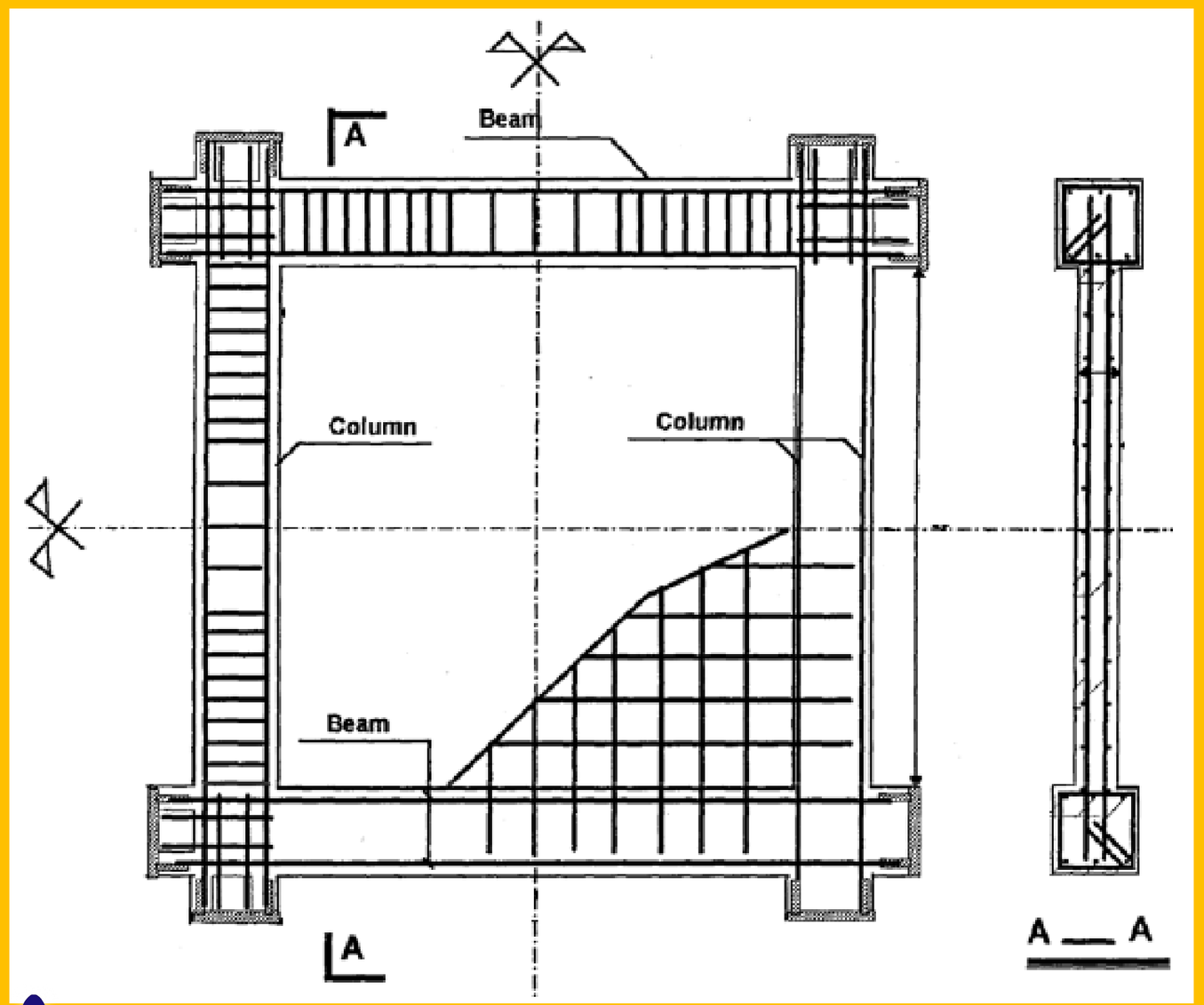
✓**Side Loading:**

- Code of Conduct: ASCE7-05
- User Group: Group 1 with I= 1
- Type of Land: Group D with Fv= 1.5 and Fa= 1
- Period Time Regulations: 0.253 sec
- Base Cutting Coefficient: C = 0.214

Specification of Examined Structures

Structure Specifications	Model 1	Model 2
Number of Floors	3	6
Height of Floors	3	3
Plan Level	150	150
Wall Thickness (cm)	15	20
Wall`s Length on X (m)	18	24
Wall`s Length on Y (m)	14	18
First Mode Frequency Time X (s)	0.208	0.518
First Mode Frequency Time Y (s)	0.249	0.611

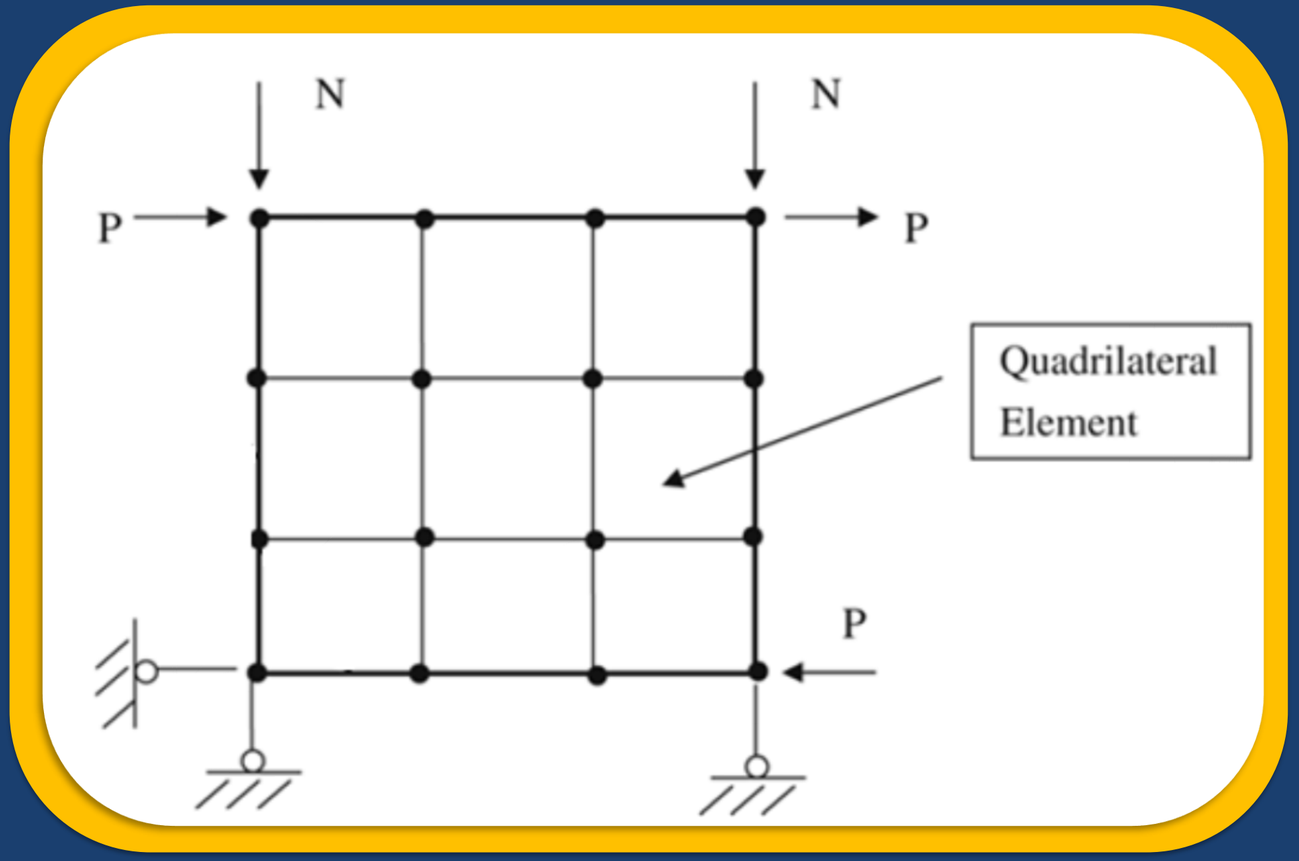
Modeling Shear Walls



For modeling flexural behavior of boundary elements and modeling shear behavior a quadrilateral element of flat tension is used.

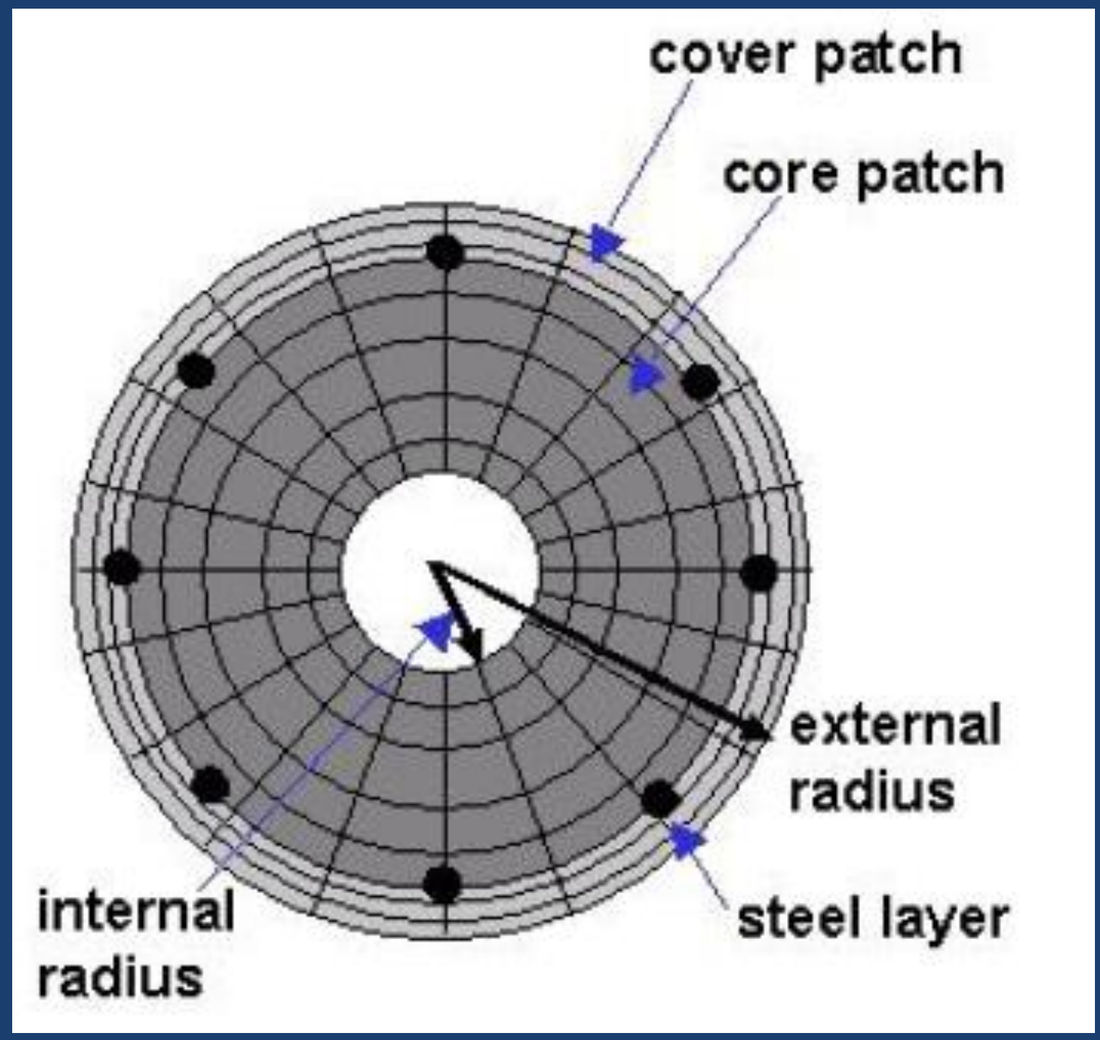
Modeling Shear Walls

Shear panel modeling by quadrilateral elements based on the cycle-driven soft membrane model (CSMM)



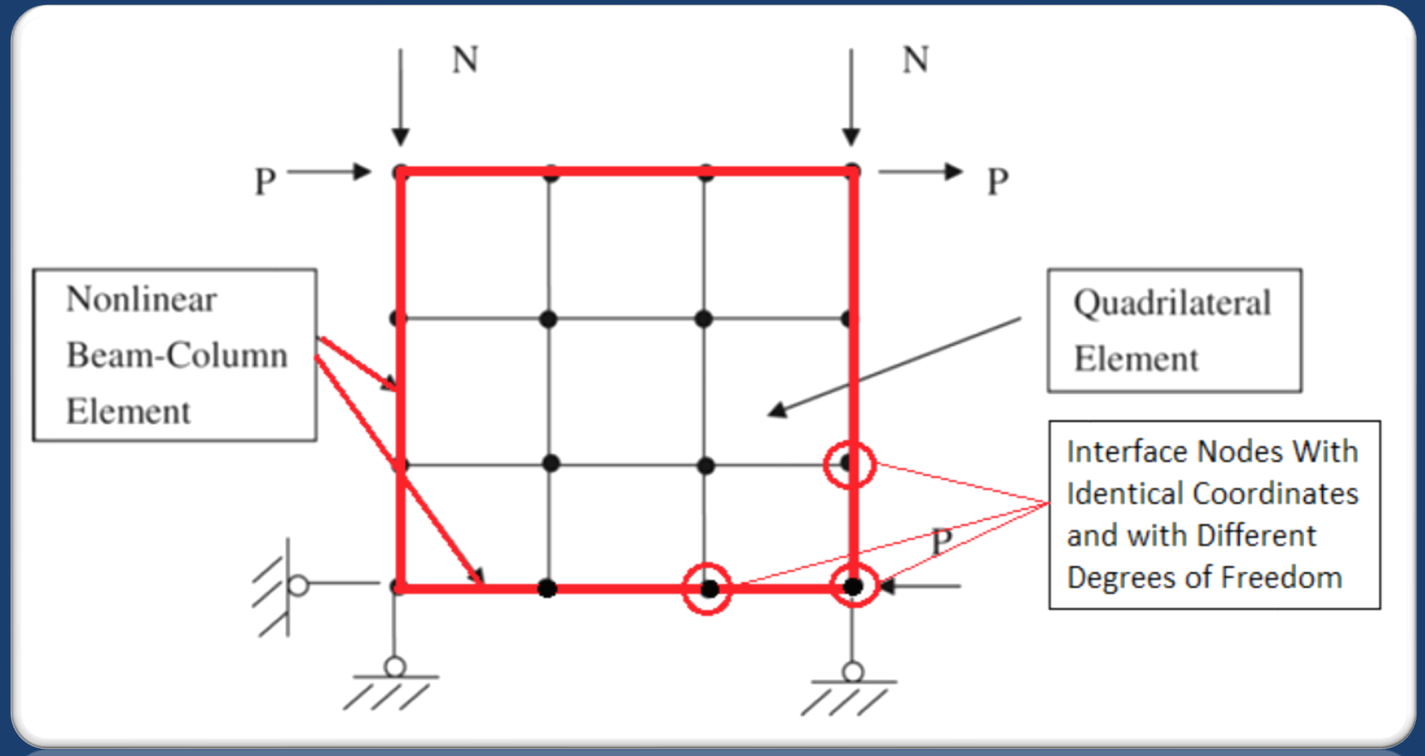
Modeling Shear Walls

Modeling boundary elements by fiber method and considering cross-sectional components including enclosed and non-enclosed concrete, steel armatures, and polymeric molds.



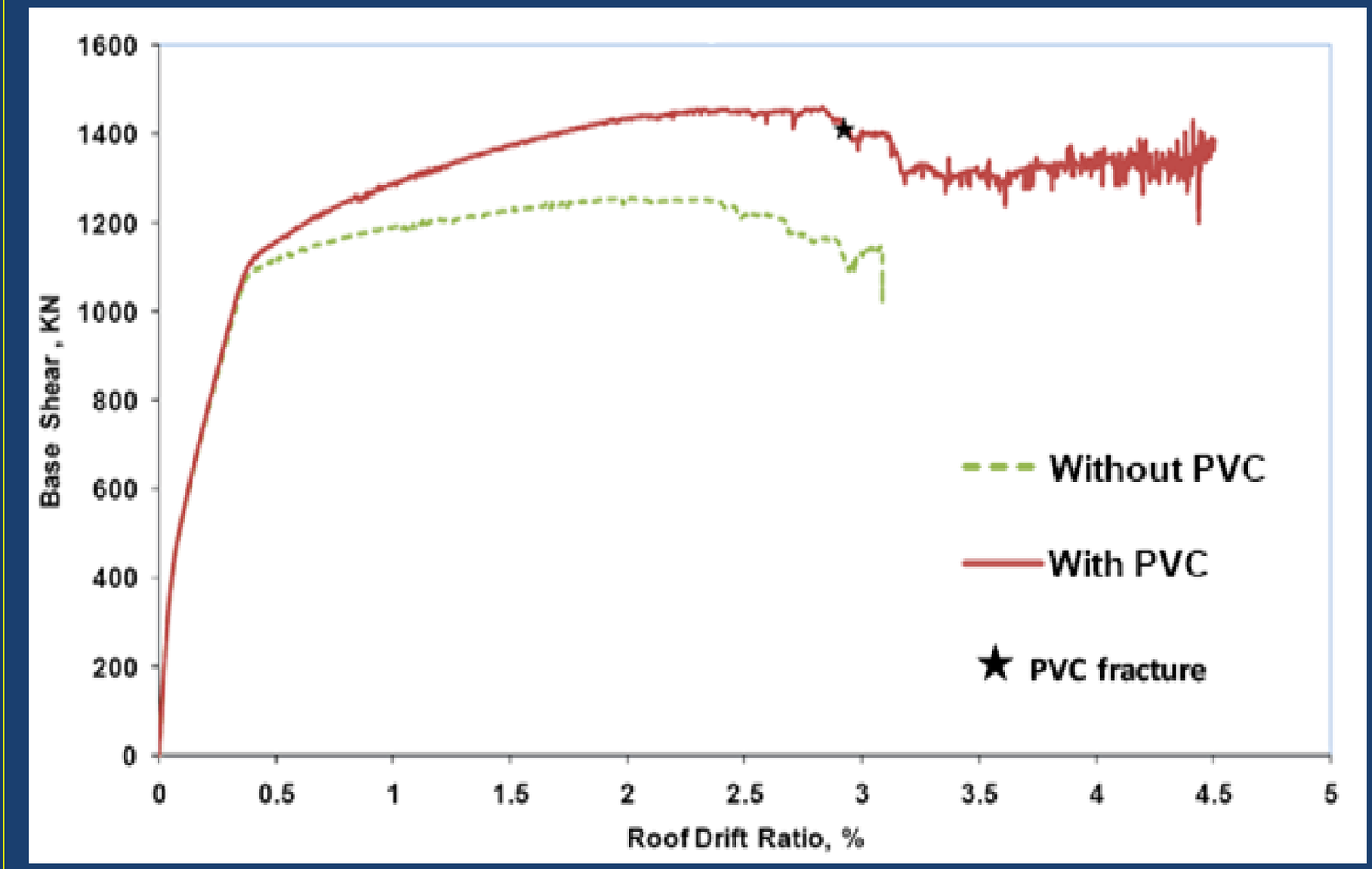
Modeling Shear Walls

Modeling the interaction of shear and flexural behavior of the wall by definition of common nodes and dependence of nodes displacement.



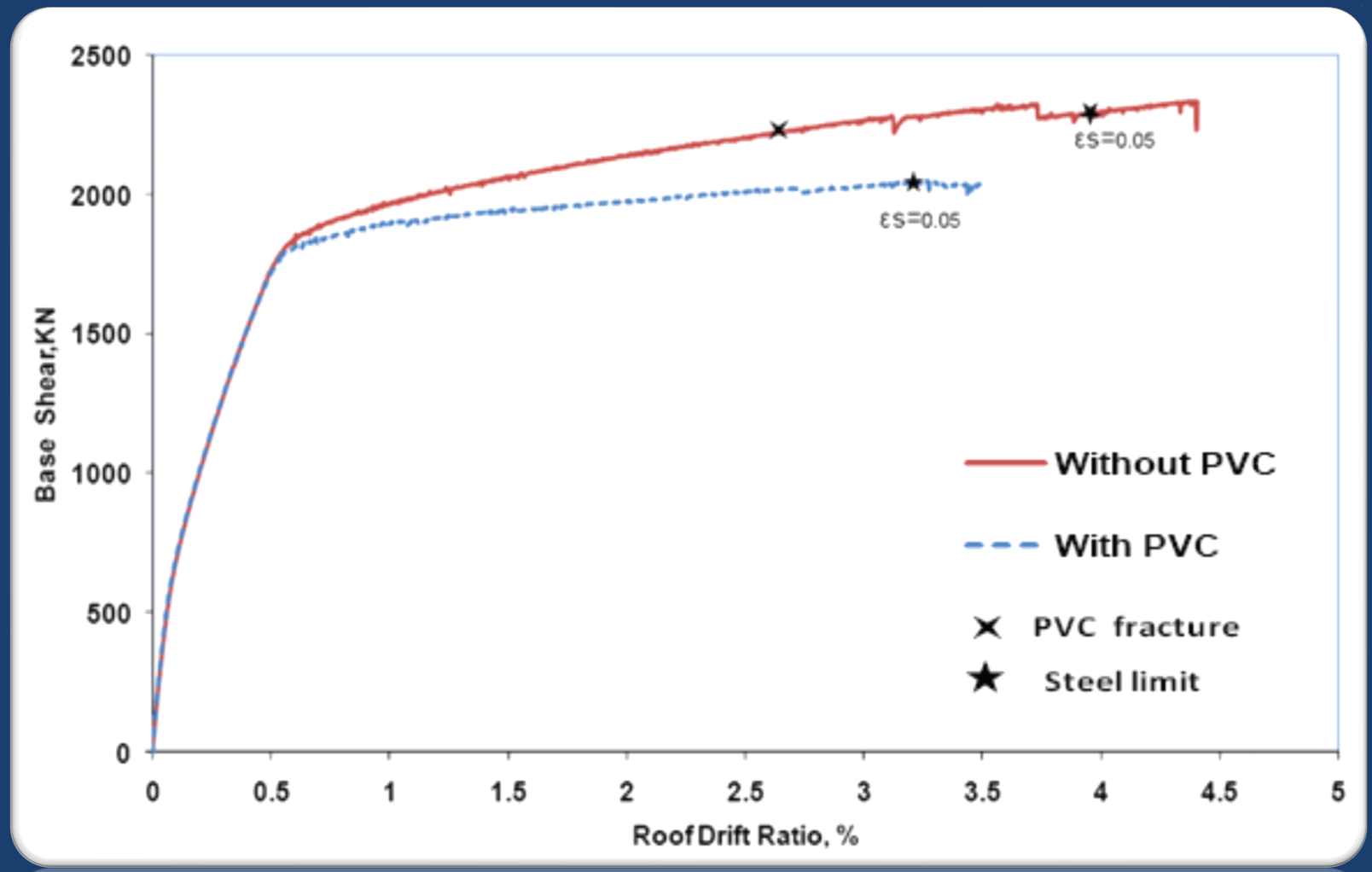
Nonlinear Static Analysis Results

Base shear-Roof drift ratio for 3-storey frame



Nonlinear Static Analysis Results

Base shear-Roof drift ratio for 6-storey frame



Nonlinear Static Analysis Results

Maximum base shear per kN for frame with and without PVC

Number of Floors	Wall without PVC Mold	Wall with PVC Mold	Increase Percentage
	(1)	(2)	$\frac{(2)-(1)}{(1)} \times 100$
3	1255	1460	16.33
6	2053	2335	13.74

Nonlinear Static Analysis Results

Maximum of roof-drift (mm) for frames with and without PVC

Number of Floors	Wall without PVC Mold	Wall with PVC Mold	Increase Percentage
	(1)	(2)	$\frac{(2)-(1)}{(1)} \times 100$
3	278.35	405.11	45.54
6	585	720	23.08

Nonlinear Static Analysis Results

The coefficients of behavior of the frames with and without PVC calculated by FEMA p695

Number of Floors	Wall without PVC Mold	Wall with PVC Mold	Increase Percentage
	(1)	(2)	$\frac{(2)-(1)}{(1)} \times 100$
3	5.96	7.23	21.31
6	6.76	7.76	14.79

- ✓The presence of polymer molds in the reinforced concrete shear wall due to the reinforcing effect on tensile area concrete increases the wall base shearing capacity.
- ✓Also, the participation of these components in tolerance of tensile stresses can delay the surrender of stretched steels and thereby increases the wall forming capacity.

Company`s Operational Readiness

Master thesis at Amirkabir Industrial University

Pars Royan Co, is ready to manufacture with the following specifications:

- ✓At least 5,000 square meters substratum
- ✓20 units per district
- ✓Location according to the buyer in Fars Province

Company`s proposed price for RBS buildings from raw material to full delivery with keys for up to 500 units is 12,000,000 Tomans, and for 500 units and over is 11,500,000 Tomans.

USE OF RBS IN DIFFERENT TYPES OF APPLICATIONS

TYPES OF USES: INDUSTRIAL

TYPES OF USES: INDUSTRIAL

TYPES OF USES: COMMERCIAL

TYPES OF USES: COMMERCIAL

TYPES OF USES: COMMERCIAL

TYPES OF USES: SERVICE

TYPES OF USES: ENTERTAINMENT

TYPES OF USES: RESIDENTAL

TYPES OF USES: EDUCATIONAL-ADMINISTRATIVE

TYPES OF USES: EDUCATIONAL-ADMINISTRATIVE

TYPES OF USES: EDUCATIONAL-ADMINISTRATIVE

TYPES OF USES: AGRICULTURAL

TYPES OF USES: AGRICULTURAL

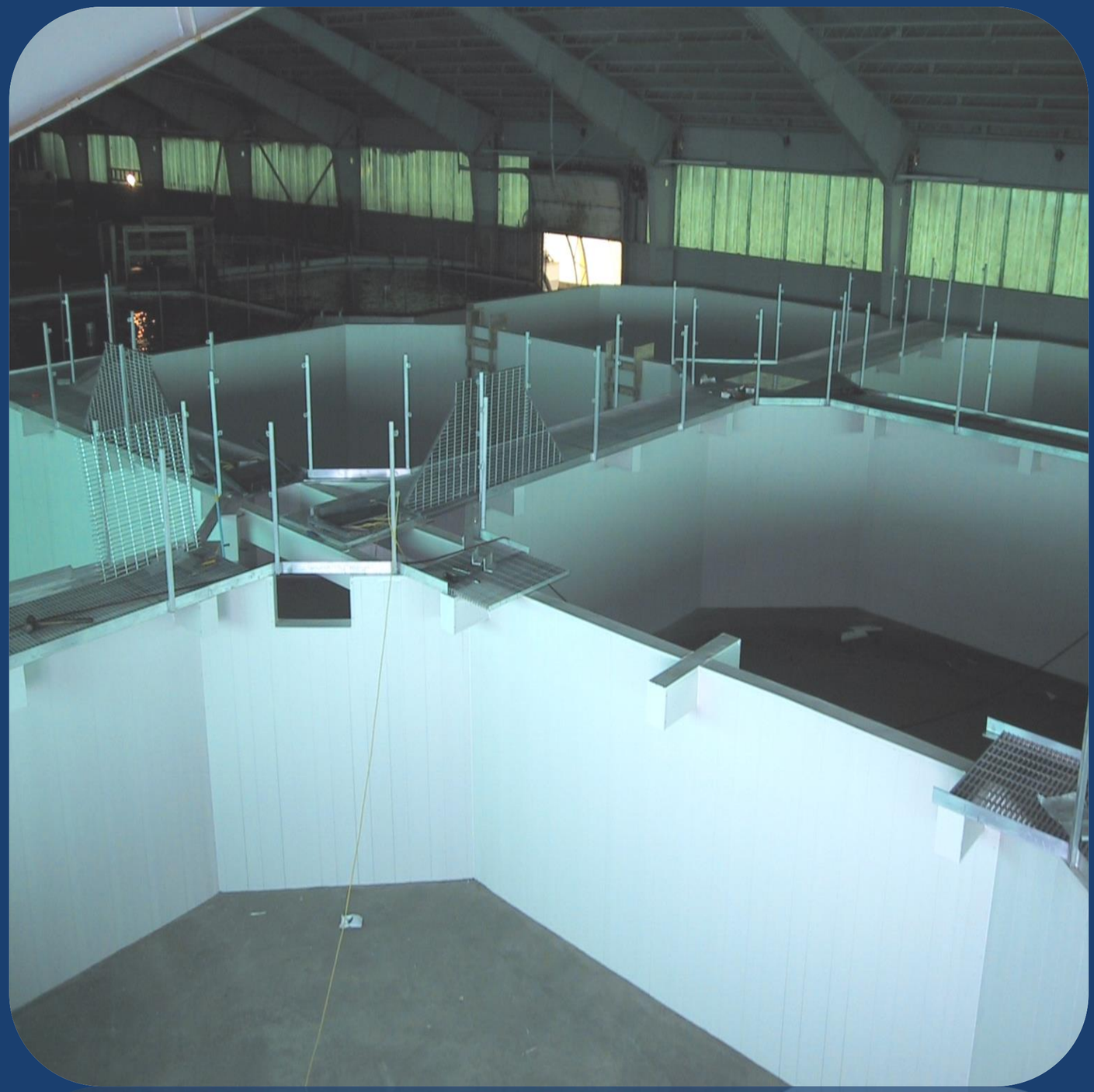
OTHER USES: TELECOMMUNICATION STATIONS

OTHER USES: RADAR STATIONS

PORTABALE USES

PORTABALE USES

WATER TANKS



RETAINING WALL

FENCE

FENCE

Video

WITH THANKS FOR YOUR ATTENTION