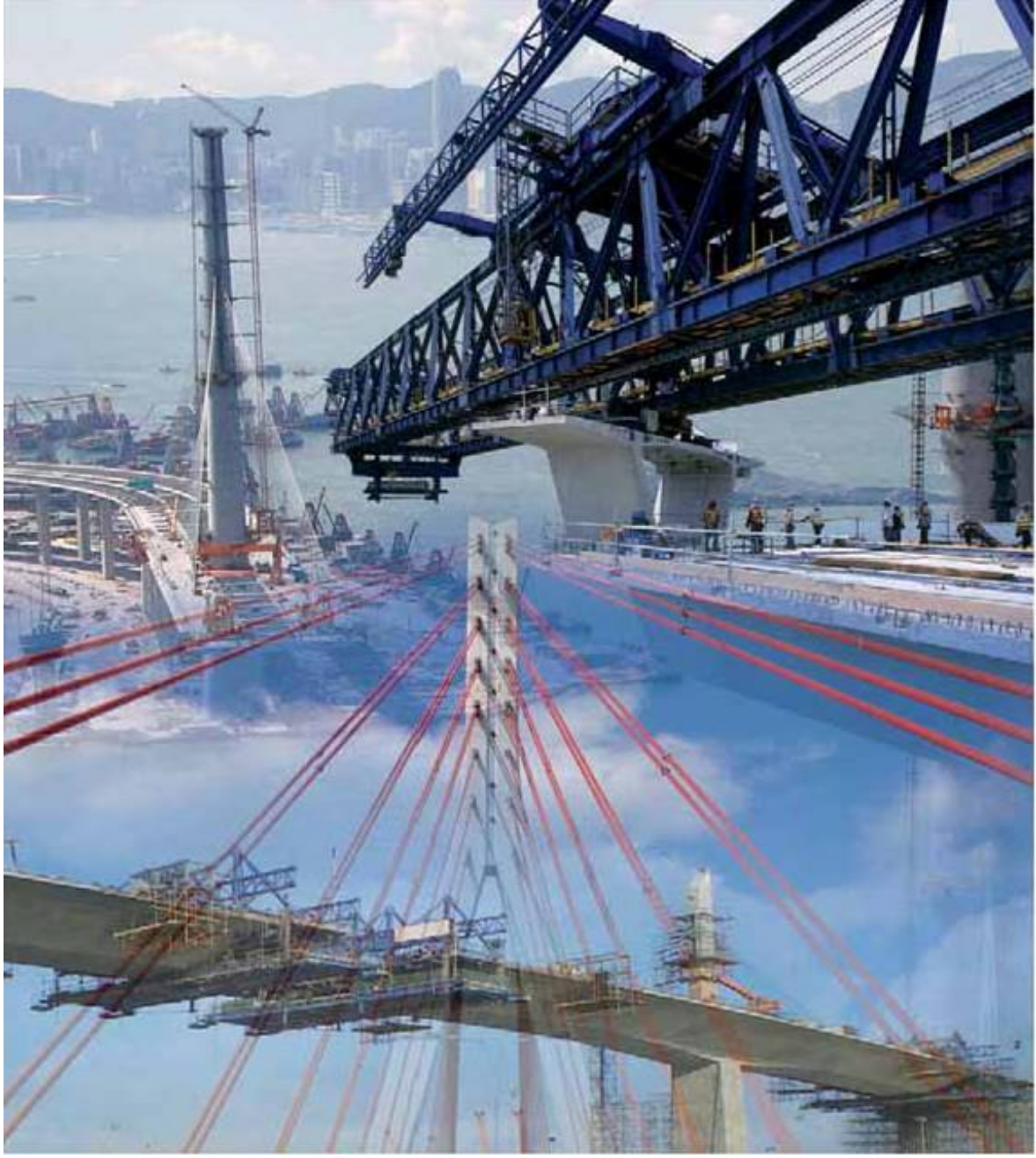
Segmental Bridge Construction Techniques



Presented by: Bob Sward

2012 PTI Convention

Nashville, TN

May 7, 2012

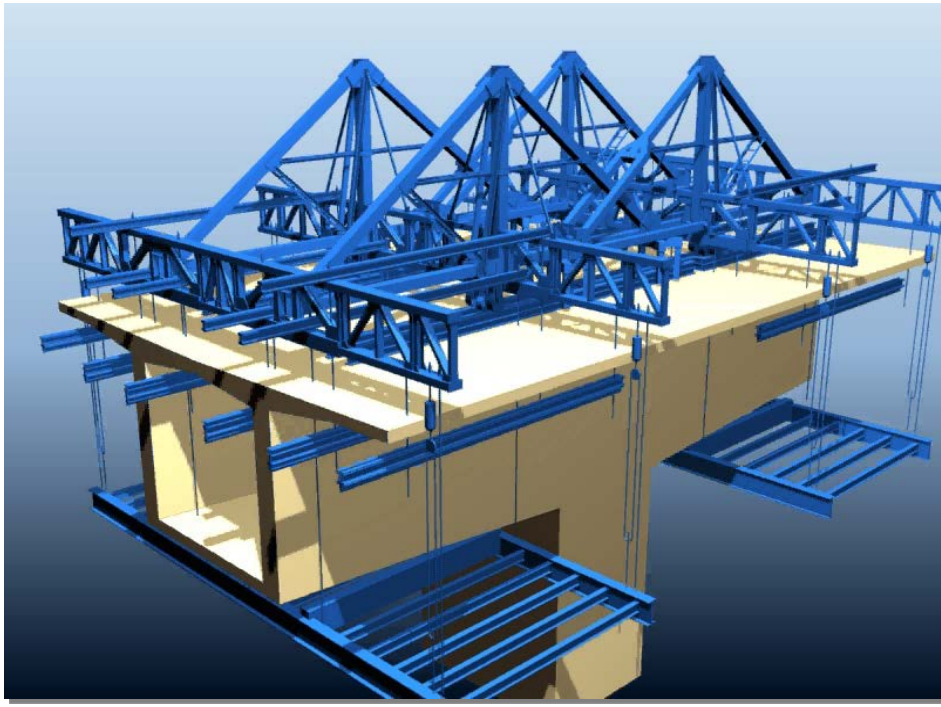
structural TECHNOLOGIES VSL

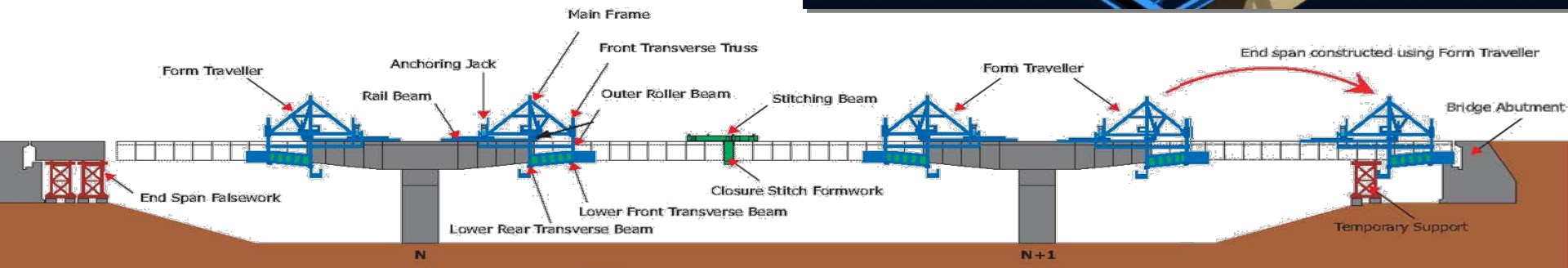
Segmental Bridge Construction Techniques

- Cast In Place
  - Travelers
  - Incremental Launching
- Precast Segmental
  - Casting Yard
  - Cantilever Construction
  - Span by Span
  - Full Span

Cast in Place Segmental - Cantilever

- Span Length 300 to 800 ft
- Typical Segment Length 16 ft
- Non Linear Construction
- Minimal Crane Capacity
- Composite Crew - Efficiency
- Typical Cycle Time – 5 days





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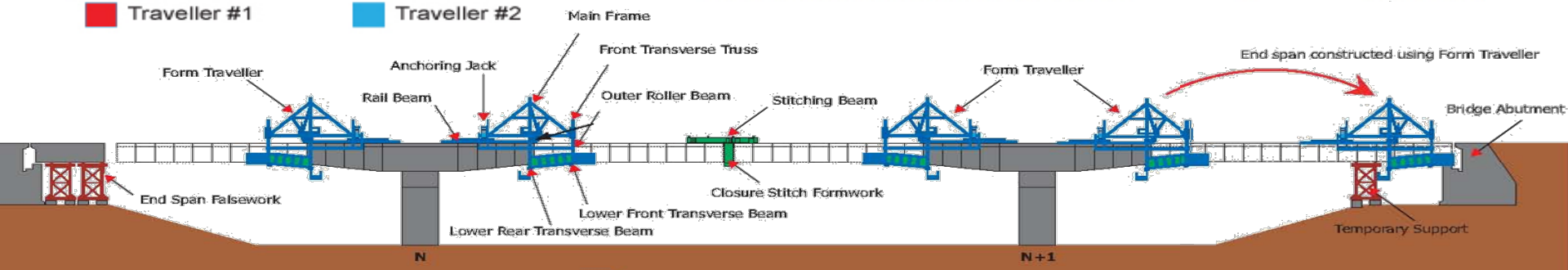
Cast in Place Segmental - Cantilever

Typical Construction Cycle	Duration: 5-day cycle, 12 hours per day
Description	Day 1 (8 9 10 11 12 1 2 3 4 5 6 7) · Day 2 (8 9 10 11 12 1 2 3 4 5 6 7) · Day 3 (8 9 10 11 12 1 2 3 4 5 6 7) · Day 4 (8 9 10 11 12 1 2 3 4 5 6 7) · Day 5 (8 9 10 11 12 1 2 3 4 5 6 7)
Removal of stop end form and form ties	
Installation of strand	
Stressing of cantilever P.T.	
Stripping of outer, inner, bottom form	
Launching and fixation of rail beam	
Launching and fixation of main frame	
Cleaning of form panels	
Rolling back of inner web forms	
Adjust / Close outer and bottom forms	
Placing P.T. ducts / inserts for bottom slab / webs	
Launch inner web forms, adjust / close inner web forms	
Placing reinforcement / P.T. ducts / insert for upper deck and cantilever wing	
Final survey / check of level / alignment	
Pour concrete	
Curing - Traveller #1	
Curing - Traveller #2	

Traveller #1 Traveller #2



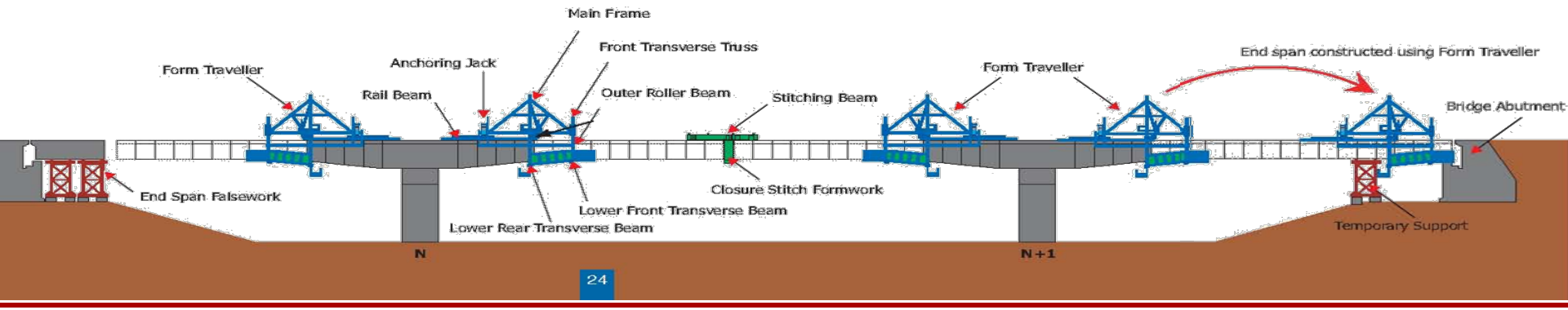
structural TECHNOLOGIES VSL

Cast in Place Segmental - Cantilever

4th Street Bridge – Pueblo, CO

Ilan Bridge, Taiwan
(Max. segment weight 120t, FT steel weight 55t)

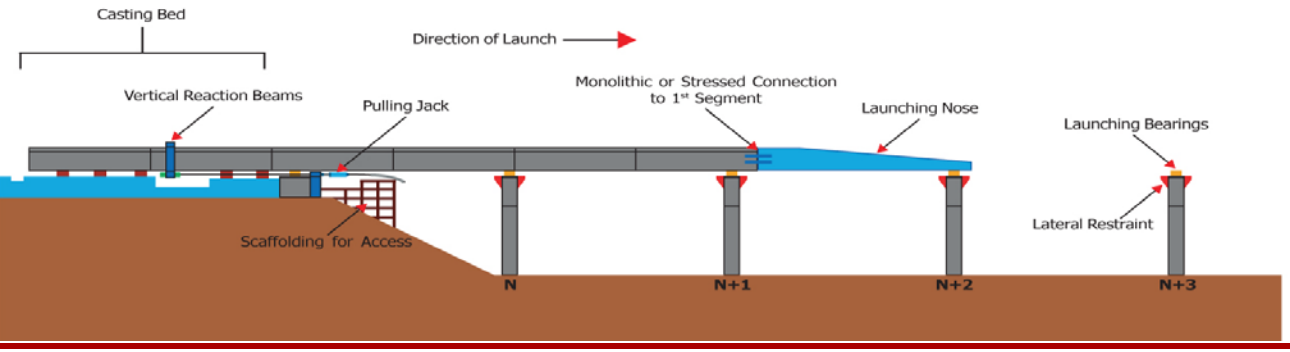
H-3 North Halawa Valley Viaduct - Hawaii
(1990-1992)

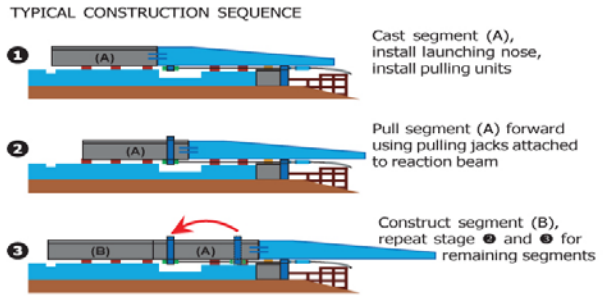


structural TECHNOLOGIES VSL

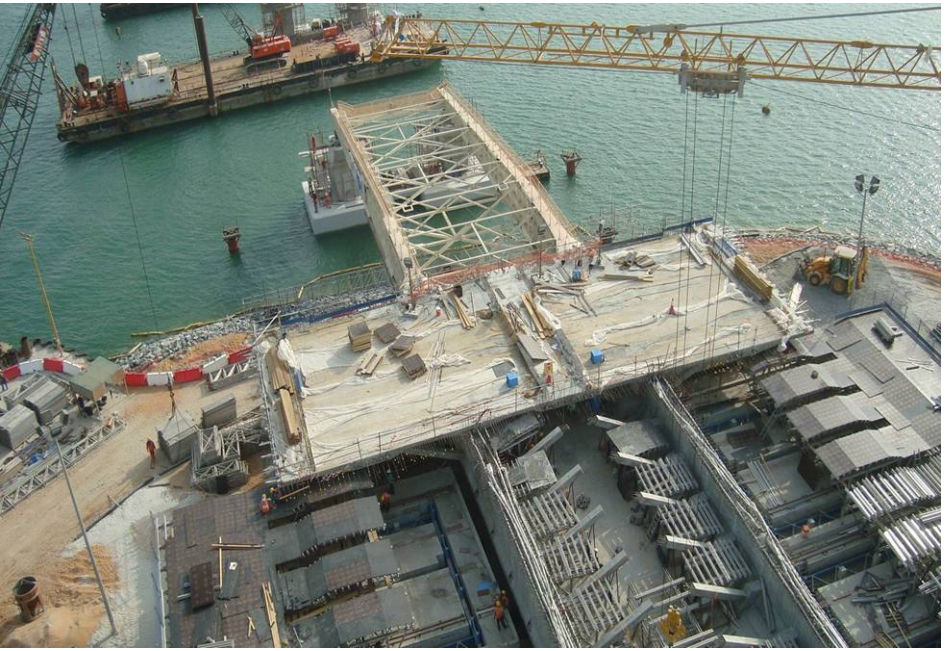
Cast-in-Place – Incremental Launching

- Span Lengths 200’ – 350’
- Casting/launching from end of bridge working from the ground
- Relatively standard forming
- 7 day cycle per launch

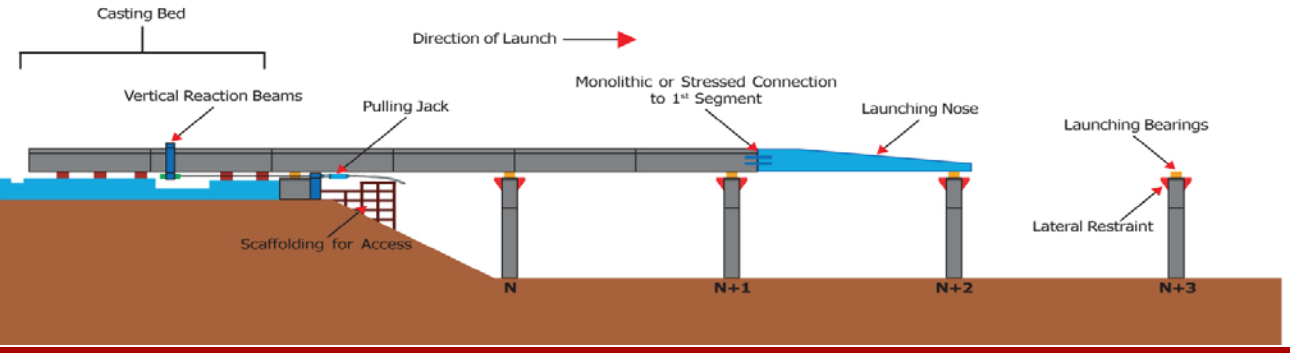


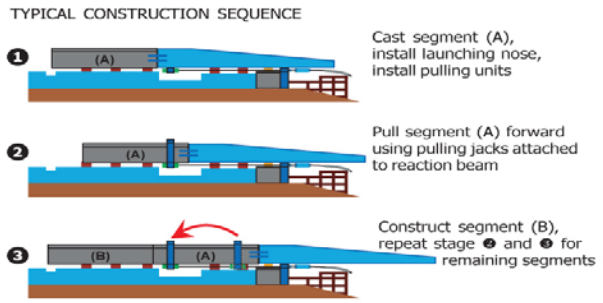


Cast-in-Place – Incremental Launching



Typical Construction Cycle	Duration: 8-Day Cycle (Days)							
Description	1	2	3	4	5	6	7	8
Launch Segment								
Strip and Clean Forms								
Install Base and Web Rebar								
Install Web Forms								
Concrete Base and Webs								
Install Inner Forms								
Install Top Slab Rebar								
Concrete Top Slab								
Curing								
Stress P.T.								





Precast Segmental

- Segment Casting

Precast Segmental

- Casting Yard

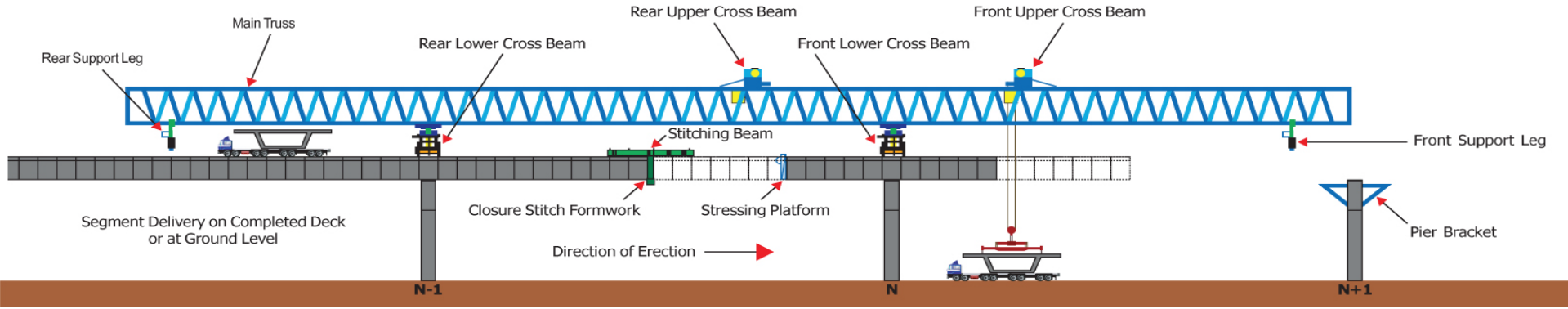
DUBAI METRO PROJECT

- One of the largest pre-casting yards in the world
- 9 tower cranes, 11 gantry cranes, 64 casting forms, 2,500 segment storage
- Camp for 3,500+ staff & crew

Precast Segmental – Cantilever

Erection with Launching Gantry

- Span up to 350 ft±
- Speed of Erection (up to 6 pairs of segments)
- Delivery from behind or below
- Overhead Construction
- Self Launching – min. crane support
- Parallel Structures Simultaneously
- Temp loads directly into Piers
- Limited horizontal curvature



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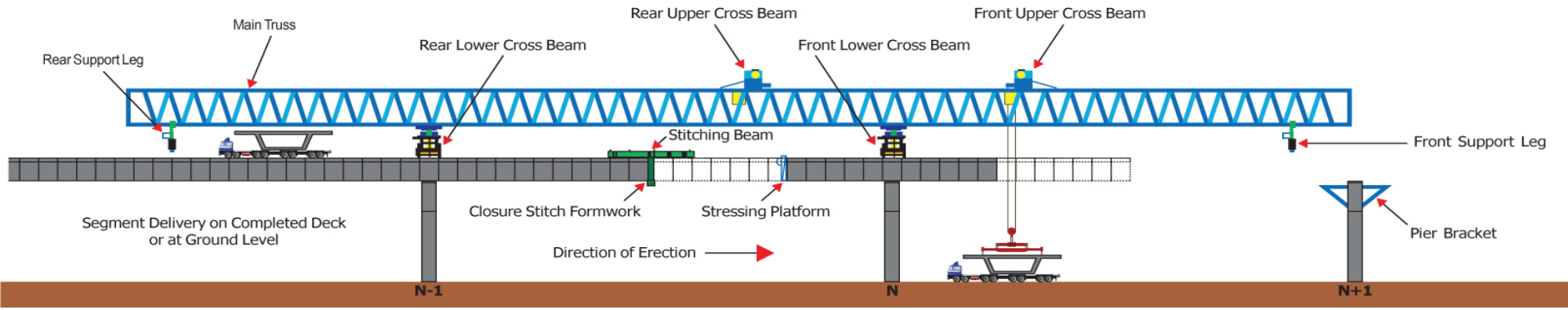
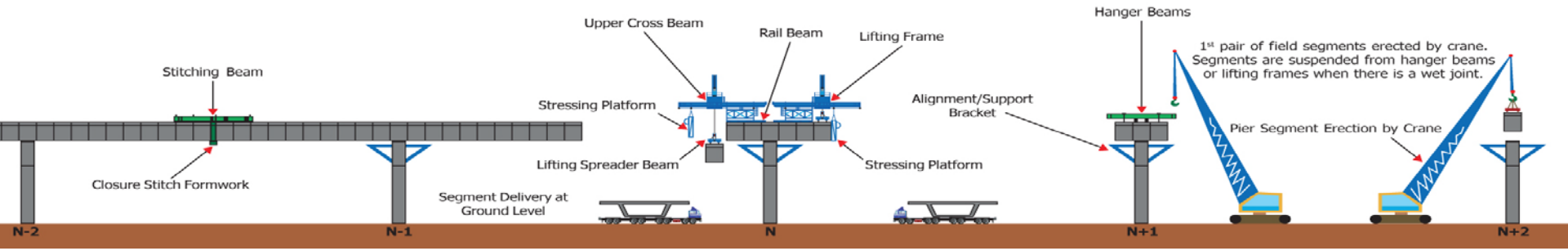
Typical Erection Cycle	Duration: 6 Shifts					
Description	1	2	3	4	5	6
Span N-1						
Curing of Stitch (Overnight)						
Continuity P.T.						
Span N						
Launch Gantry to Span N						
Segment Erection Span N						
Stitch N to N-1						
Span N+1						
Erect Pier Segment						
Align Pier Segment						
Place Reinforcement						
Place Formwork						
Cast Insitu Diaphragm						
Curing Pier/Column Joint						



Precast Segmental – Cantilever

Erection with Lifting Frames

- Longer Span Lengths
- Larger Segments
- Deck Construction can be non-linear (multiple work fronts)
- Simple Erection Works
- Rapid Construction



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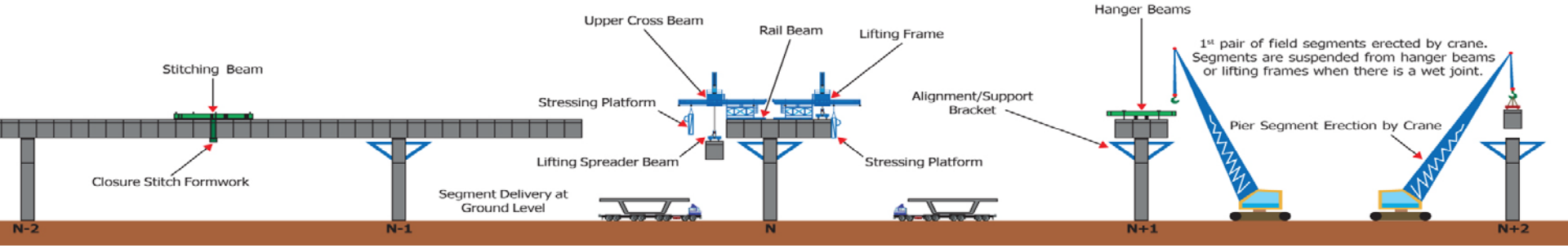

Precast Segmental – Cantilever

Erection with Lifting Frames

- Longer Span Lengths
- Larger Segments
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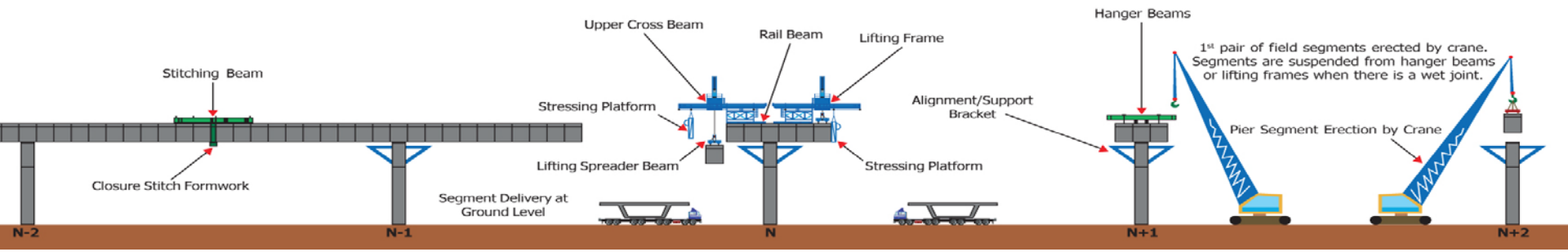
- Simple Erection Works
- Rapid Construction

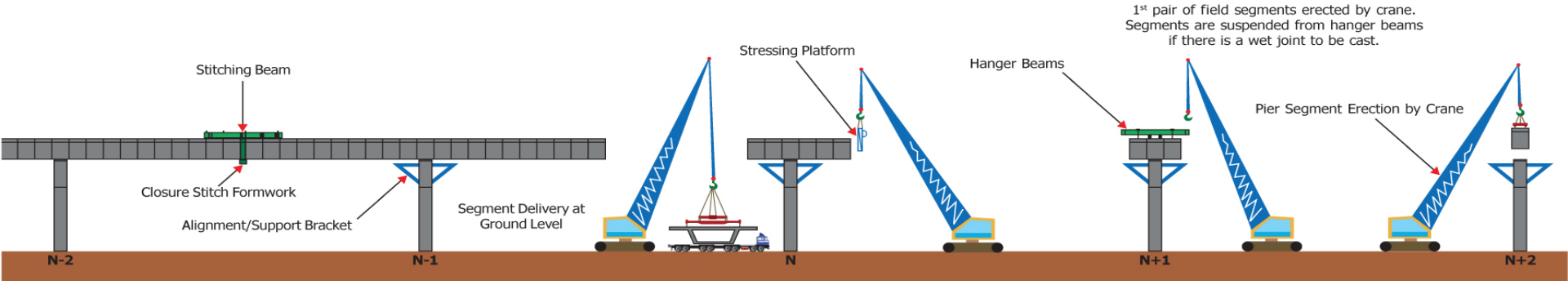
Typical Erection Cycle	Duration: 13 Shifts												
Description	1	2	3	4	5	6	7	8	9	10	11	12	13
Erect & Assemble Lifting Frames & Brackets on Pier Head													
Segment Erection - Pair 1													
Wet Joint Construction													
Wet Joint Curing													
Segment Erection - Pair 2-3													
Segment Erection - Pair 4-5													
Segment Erection - Pair 6-7													
Segment Erection - Pair 8-9													
Segment Erection - Pair 10-11													
Segment Erection - Pair 12-13													
Remove Lifting Frames													



Precast Segmental – Cantilever

Erection with Cranes

- Longer Span Lengths
- Smaller Segments
- Deck Construction can be non-linear (multiple work fronts)
- Readily Available Equipment
- Rapid Construction
- Small Erection Crew

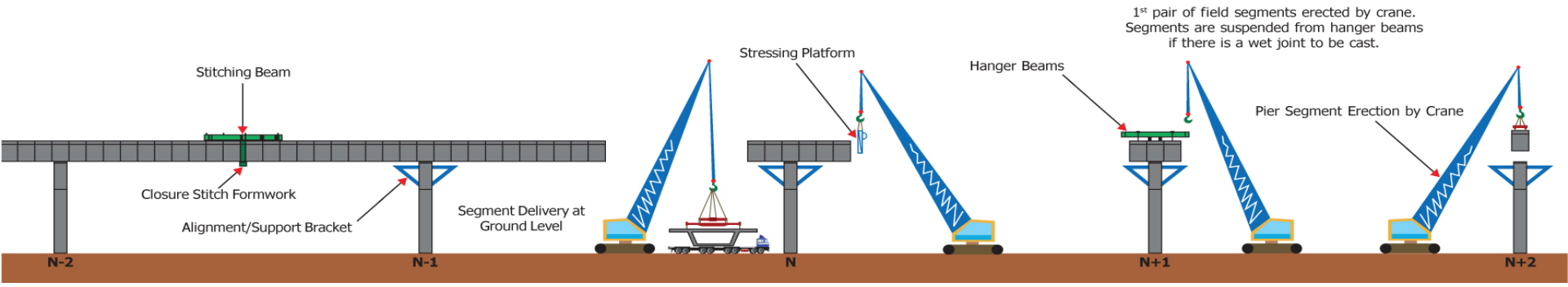


Precast Segmental – Cantilever

Erection with Cranes

- Longer Span Lengths
- Smaller Segments
- Deck Construction can be non-linear (multiple work fronts)
- Readily Available Equipment
- Rapid Construction
- Small Erection Crew

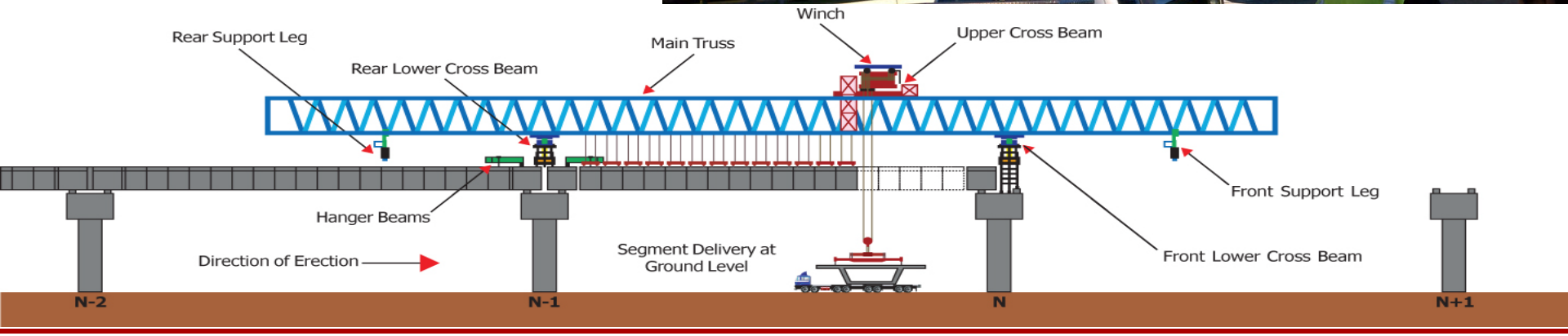
Typical Erection Cycle	Duration: 8 Shifts							
Description	1	2	3	4	5	6	7	8
Installation of Pier Segment Support Brackets								
Installation of Pier Segment								
Segment Erection - Pair 1-3								
Segment Erection - Pair 4-6								
Segment Erection - Pair 7-9								
Segment Erection - Pair 10-12								



Precast Segmental – Span-by-Span

Erection with Launching Gantry (Overhead or Underslung)

- Spans typically < 170 ft
- Speed of Erection
  (1 span per day possible)
- Small Crew
- Delivery from behind or below
- Temp load directly into Piers

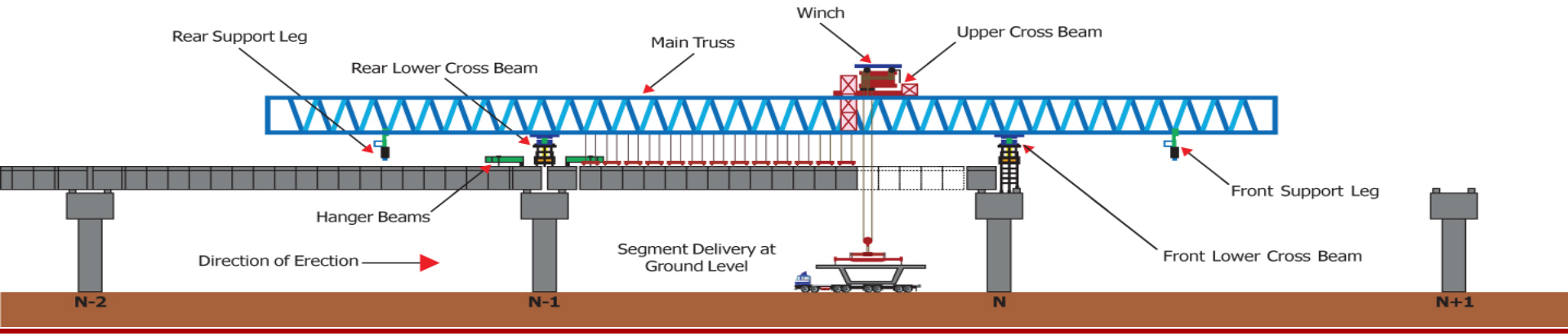


Precast Segmental – Span-by-Span

Erection with Launching Gantry (Overhead or Underslung)

- Spans typically < 170 ft
- Speed of Erection (1 span per day possible)
- Small Crew
- Delivery from behind or below
- Temp load directly into Piers

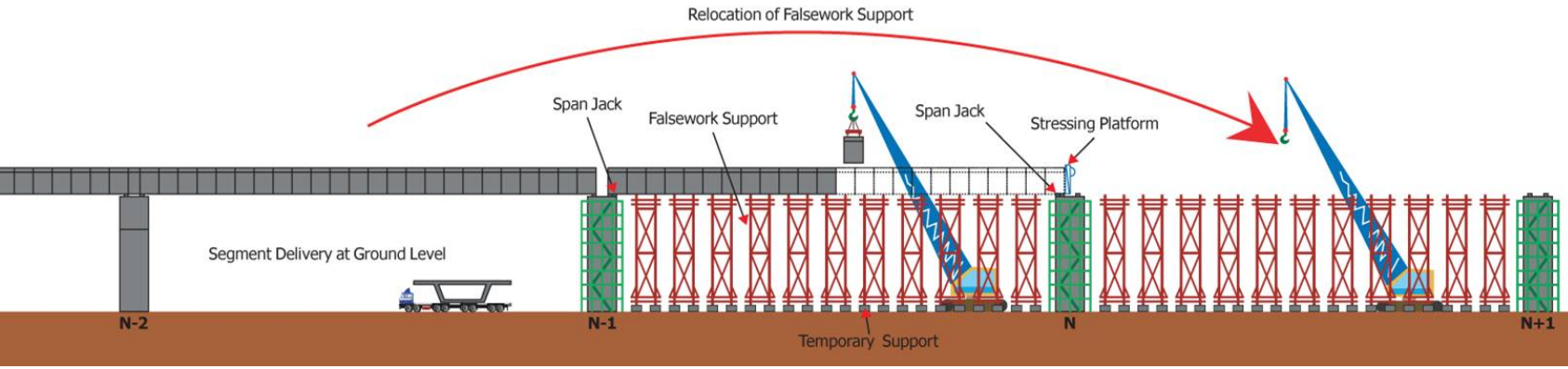
Typical Erection Cycle	Duration: 4-Day Cycle							
Description	1		2		3		4	
	D/S	N/S	D/S	N/S	D/S	N/S	D/S	N/S
Launching of Gantry								
Segment Placing								
Segment Alignment / Gluing								
Wet Joint Casting								
Curing (Overnight)								
Installation of External P.T.								
Stressing of External P.T.								



Precast Segmental – Span-by-Span

On Falsework

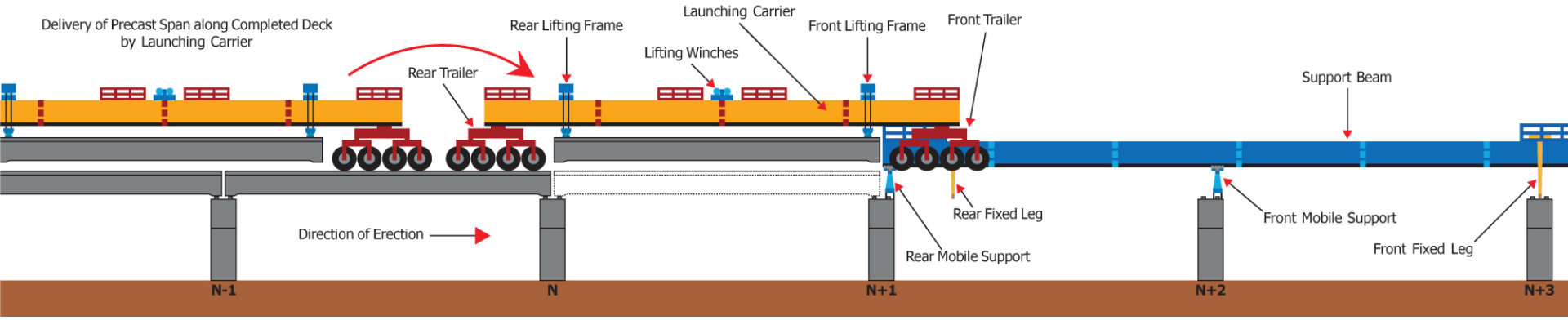
- Locally available equipment
- Multiple work fronts
- Typically smaller project



Precast Segmental – Full Span

Erection with Launching Gantry

- Typically short spans
- Very high rate of erection
- Factory casting environment - Very high quality
- Min follow up work
- Large temporary loads

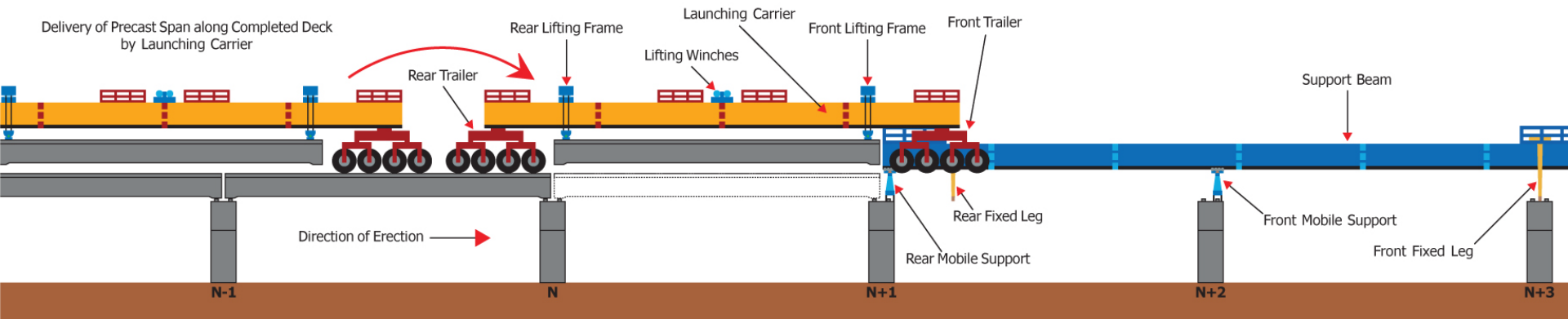


Precast Segmental – Full Span

Erection with Launching Gantry

- Typically short spans
- Very high rate of erection
- Factory casting environment - Very high quality
- Min follow up work
- Large temporary loads

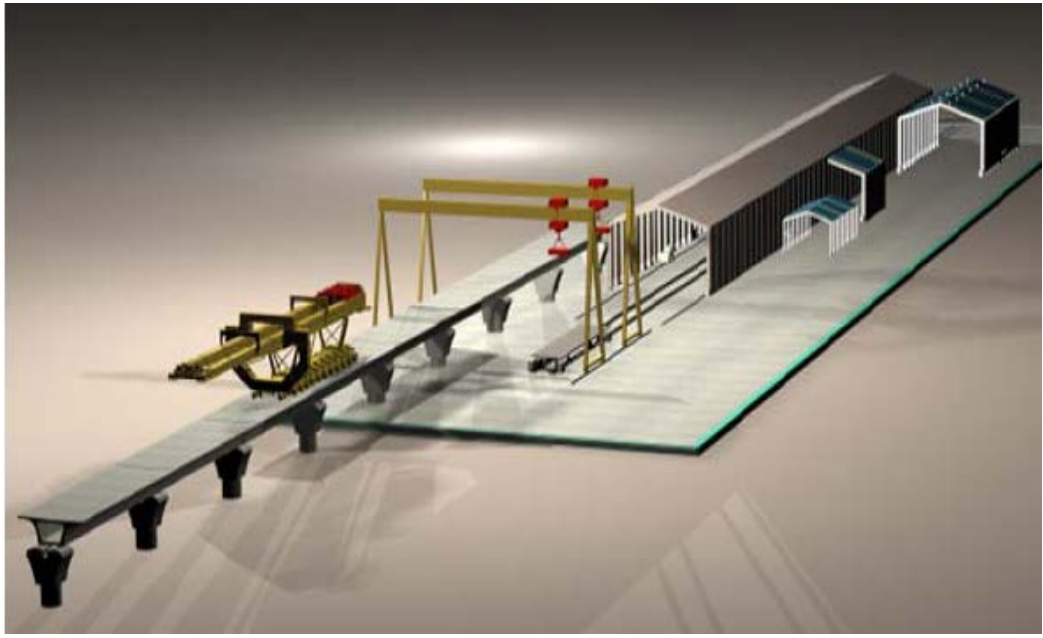
Typical Erection Cycle	Duration: 1-Day Cycle (Hours)																		
Description	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Delivery New Span from Yard to Erection Site																			
Erection of New Span																			
Return Launching Carrier to Yard																			
Launching Carrier Available for Yard Handling																			
Load New Segment into Launching Carrier																			
Load Transfer from Temporary to Permanent Bearings																			
Prepare Permanent Bearings for Grouting																			
Grout Permanent Bearings																			

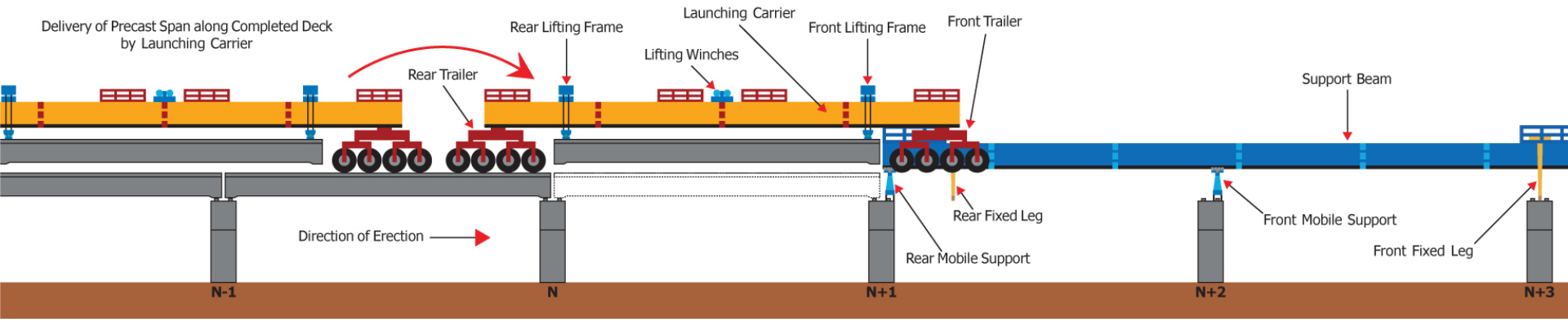


Precast Segmental – Full Span

Erection with Launching Gantry

- Typically short spans
- Very high rate of erection
- Factory casting environment - Very high quality
- Min follow up work
- Large temporary loads
- Limited storage (possible)





Precast Segmental – Full Span

Erection with Launching Gantry or Heavy Lift

- Marlins Stadium
- Seven Mile Bridge
- Jamestown Rhode Island

Segmental Construction

- Speed of erection
- Crew efficiency
- High quality
- Many options
- Top down erection possible minimal disruption to traffic and surface operations
- Efficient use of forms

All Possible Through the innovation of Post-Tensioning