Mechanised Construction
Agenda

• New Challenges

• Introduction to Mechanised Construction

• Case Studies of New Methods
  – Buildings
    • Cathay Pacific Air Cargo Terminal
    • HK Airport Authority Midfield Passenger Terminal
  – Bridges
    • TMCLK, Marine Pile Caps

• Summary
New Challenges

1. Programme
2. Cost of labour
3. Shortage of skilled labour
4. Health and Safety / CDM
5. Environmental issues
6. Tender scoring
INTRODUCTION TO MECHANISED CONSTRUCTION
Examples

1. Precast concrete production
2. Jumpforms and slipforms for building core and wall construction
3. Travelling forms for cantilevered bridge deck construction
4. Table forms for slab construction
5. TBM & earthworks equipment
6. Segmental bridge deck construction
Precast Yard
Building - Core Jump Form
Bridge - Travelling Form
Bridges – Deck Erection

**Stonecutters Bridge**
Strand jacks used to lift 4,000 ton prefabricated deck from ground level, up 80 meters and skidding horizontally into final position

**Shenzhen Bay, Deep Bay Link Bridge**
Launching gantry used to erect 250 ton precast concrete, bridge deck segments

**Kap Shui Mun Bridge**
Incremental launching of concrete deck, produced in two stage casting bed
More Mechanisation

Move the factory to the construction site

Recognised benefits:-

1. Speed
2. Consistent quality
3. Cost
4. Labour
5. Safety
6. Can enable construction in difficult conditions
CASE STUDY

BUILDINGS – CX & MIDFIELD TERMINALS
Floor Slab Construction
Buildings

• Cathay Pacific - Air Cargo Handling Terminal
  In-situ beam and precast floor construction

• HK Airport Authority – Midfield Concourse
  In-situ beam and precast floor construction
Cathay Pacific Air Cargo Terminal
Precise In-situ Beam Construction
Precise Pre-cast Slab Construction
Clean Construction

Unrestricted site access
Safe Access for Multi-level Work Fronts
No Traditional Falsework

This generated a saving of 770 tons of timber at Midfield and 2800 tons of timber at CX that would otherwise have been consumed.

(6,300 trees saved)
## Construction Labour Market

**Trend of Skill Trades with Demand > Supply (With Training Output Considered)**

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<td>1</td>
<td>Bar Bender &amp; Fixer (or Steelbender)</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
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<td>Leveler</td>
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<td>9</td>
<td>Plant &amp; Equipment Operator (Load Shifting [or Plant Operator (exc. Driver, bulldozer driver, etc.)]}</td>
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<tr>
<td>13</td>
<td>Metal Worker</td>
<td>Yellow</td>
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* Exist (partially exist) in the list of shortage trades provided by Task Force on Short-term Labour Supply in February 2014.
Eightfold Increase in Safety

Cost Comparison

Less time & Less labour = More Safety

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<tr>
<th></th>
<th>Traditional</th>
<th>Mechanised</th>
<th>Comparison</th>
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</thead>
<tbody>
<tr>
<td>Days / use</td>
<td>27</td>
<td>7</td>
<td>1/4 of time</td>
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<tr>
<td>Labour (man hrs / use)</td>
<td>110</td>
<td>50</td>
<td>1/2 of men</td>
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</table>

8 times less man hours for same construction
CASE STUDY

BRIDGE – TMCLK VIADUCTS
Marine Pile Cap Construction
TMCLK – Marine Viaducts to BCF
TMCLK – Marine Viaducts to BCF
Traditional Methods of Marine Pilecap Construction
Sheet Pile Cofferdams with Temporary Struts

Multiple Strut Layers

Cap & Pier construction
Restricted by struts

Conventional Braced Cofferdam
Prior to Dewatering

Restrictive end bracing
Prior to dewatering
New Method for Marine Pile Cap Construction
Multi-Segment, Match-Cast, Shell Construction

- Pile caps up to 40m x 22m with 14No. of 2.5m Dia. bored piles are constructed using this method.

- These larger pile caps are constructed by installing up to 9 No Match-Cast shell modules and stressing them together.

- The scheme in the view shows the largest pile cap (E12)

- This pile cap will support 4 Seagull Piers
Segment Delivery
Multi-function Frame
Mechanised Assembly
Mechanised Assembly
Preparation of Piles
Unrestricted Access for Construction
Comparison with Traditional Methods
Programme and Cost

<table>
<thead>
<tr>
<th></th>
<th>45 No. Pile caps</th>
<th>Traditional Cofferdam</th>
<th>Marine Falsework</th>
<th>Precast Shells</th>
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</thead>
<tbody>
<tr>
<td>Construction Period</td>
<td>16.5 months</td>
<td>11.5 months</td>
<td>6.5 months</td>
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<tr>
<td><strong>Program Saving:</strong></td>
<td><strong>10 months less</strong></td>
<td><strong>5 months less</strong></td>
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Assuming 10 work fronts and one 500T heavy lift barge:
## Comparison with Traditional Methods

### Fivefold Increase in Safety

<table>
<thead>
<tr>
<th>Site work required to achieve dry working environment</th>
<th>Traditional Cofferdam</th>
<th>Marine Falsework</th>
<th>Precast Shells</th>
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<tbody>
<tr>
<td>45 No. Pile caps</td>
<td>4 months/pile cap</td>
<td>3 months/pile cap</td>
<td>15 days/pile cap</td>
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<tr>
<td>Construction Period</td>
<td>42,900 man-days</td>
<td>29,250 man-days</td>
<td>6,000 man-days</td>
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<tr>
<td>On-Site Work</td>
<td>42,900 man-days</td>
<td>29,250 man-days</td>
<td>6,000 man-days</td>
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<tr>
<td><strong>Time Saving:</strong></td>
<td><strong>36,900 man-days</strong></td>
<td><strong>23,250 man-days</strong></td>
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<tr>
<td><strong>7 times less</strong></td>
<td><strong>5 times less</strong></td>
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Implementation

Procurement Process

Design
- Arup (HK, UK, AUS)
  - Precast Shell Design
  - Design Packages: 15 No.
  - Drawings: 500 No.

Production
- Precast Supplier (PRC)
  - Shop drawings: 400 No.
- Precast Production: 25,000 Tons

Delivery

Marine Heavy Lifting Operator
- Installation:
  - 500Ton Barge Lifts: 200 No.

Lambeth
- Promotion of Method
- Reference Designs
- Design Programme
- Mock-ups
- Heavy Lift Designs

Approvals

Site Workshops

Aurecon (HK, THAI, AUS)
- Temporary Steelwork Design
- Design Packages: 12 No.
- Drawings: 300 No.

Steelwork Fabricator (PRC)
- Shop Drawings: 300 No.
- Steelwork Fabrication: 2,500 Tons
Summary & Discussion

• Similar projects can benefit

• More projects may also benefit:
  – Technology and automation is becoming more economically viable and reliable
  – Beneficial if mechanisation can be considered at early stages of design and tender.