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Chemical-Soil Stabilization for Runway Shoulder Widening at Singapore Changi Airport

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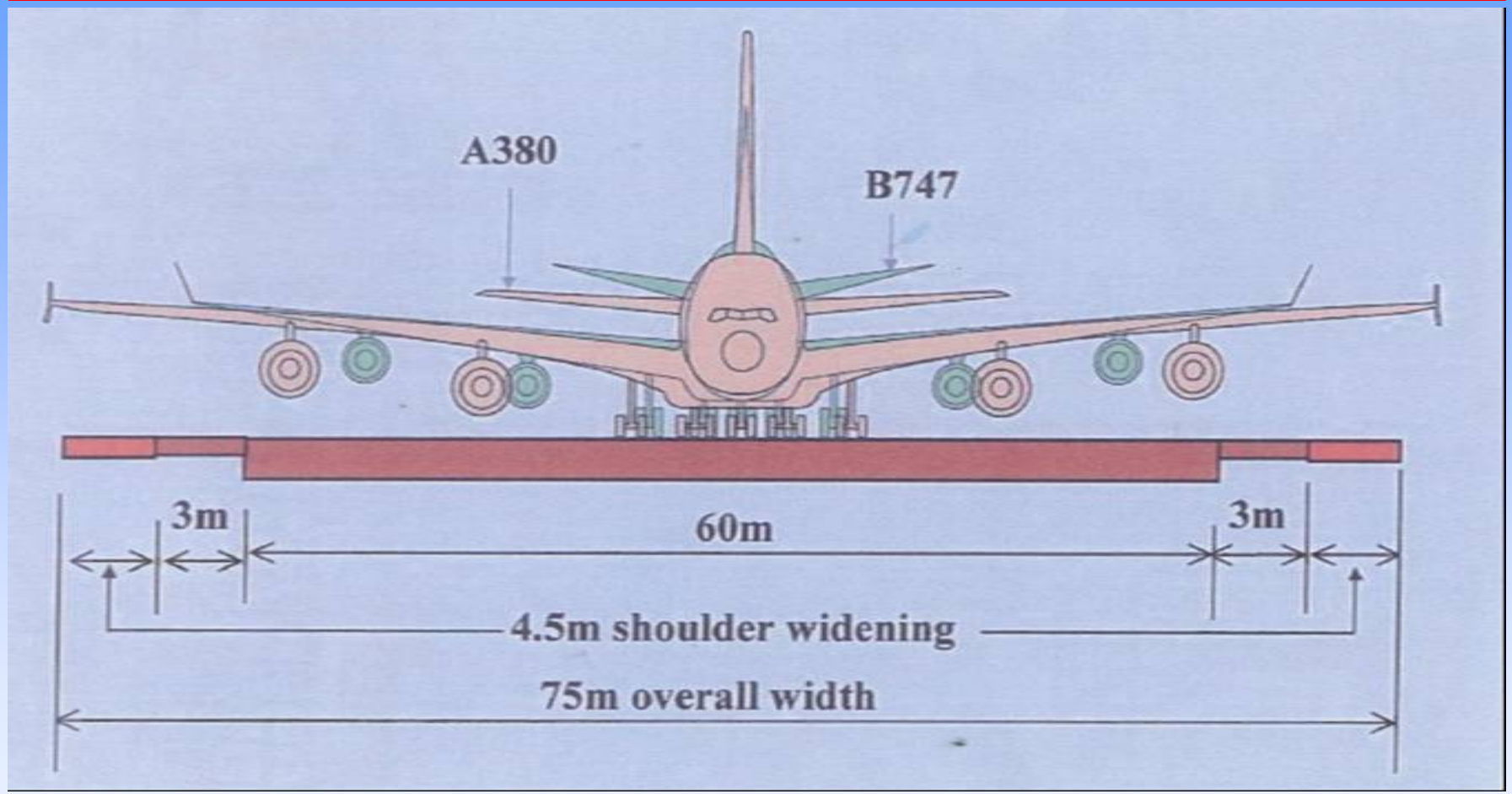
1. Introduction

* **Airbus A380 is the largest commercial aircraft built to date.**
* **The runway shoulders have to be widened to support A380 operations.**

Fig. 1. Airports Ready for the Airbus A380

* **SIA is the launch customer for A380.**
* **CAAS has begun planning for upgrading. including runway shoulders widening since the late 1990's.**

1. Introduction



* **Existing runway width: 66m**
* **Widened runway width: 75m**
* **How to do widening in a busy airport?**

2. Evaluation Criteria

* **CAAS evaluated various technical proposals with following major considerations:**

2-1 Ability to Meet Airport Operational Restrictions

2-2 Construction Speed

2-3 Structural Design

2-4 Environmental Impact

2-5 Cost Effectiveness

2. Evaluation Criteria

* **Final Decision**

  ☒ **Replacement method – Conventional pavement construction**

  ☑ **Non-replacement method – In-situ chemical-soil stabilization**

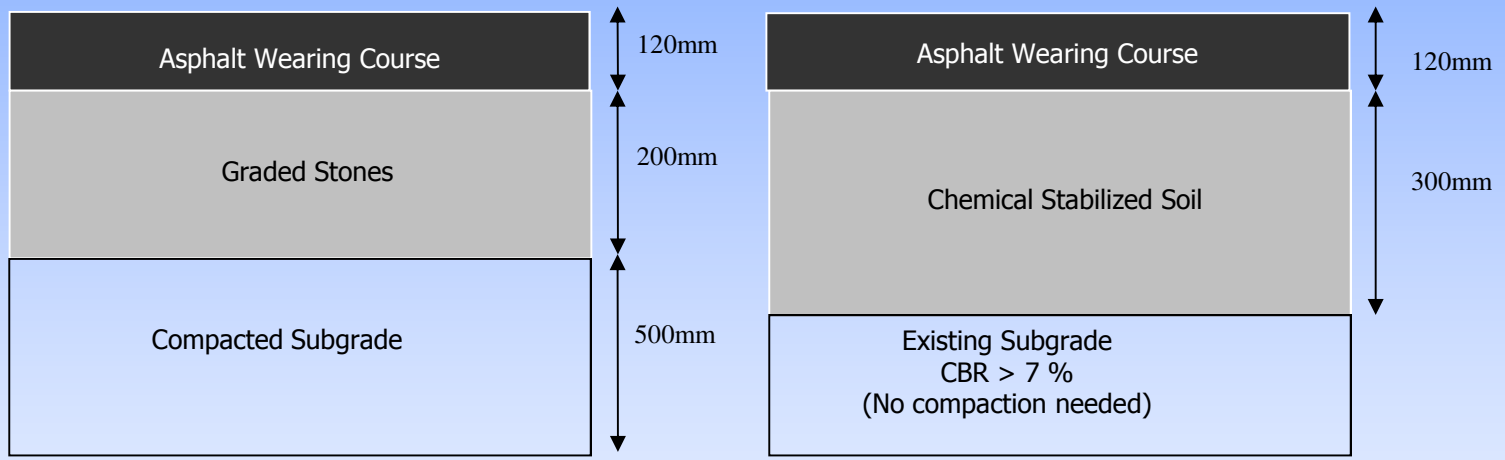


Fig. 3. Cross Section of Existing Runway Shoulders vs. Widened Section by Chemical Stabilization

- **A polymer modified cementitious chemical stabilizing agent be used for base course topped by asphalt concrete**
- **Offering comprehensive advantages and benefits**

3. Chemical–Soil Stabilization

* **Definition:**

  "Mixing proper chemicals with in-situ soils to improve/strengthen the soil properties through chemical reactions for engineering purposes."

* **The selected chemical stabilizing agent has successfully been applied in Asia, especially in South-East Asia region for more than 10 years.**

* **A specially designed version of chemical agent was used to stabilize:**

  - ❑ **Clayey soils**
  - ❑ **Sandy soils**
  - ❑ **Crushed stones**
  - ❑ **Their mixtures**

3. Chemical–Soil Stabilization

* **Design requirements:**
  - ❑ UCS ≥ 1.5 ~2.0 MPa (7-d)
  - ❑ CBR ≥ 90% (7-d)
  - ❑ M_R ≥ 3,000 MPa (28-d)
* **Chemical Dosage : 3.75% for all widened base course**
* **Major Stabilization Process**

1st step: Spreading

2nd step: Mixing

3rd step: Compaction

4. Runway Shoulder Widening Process

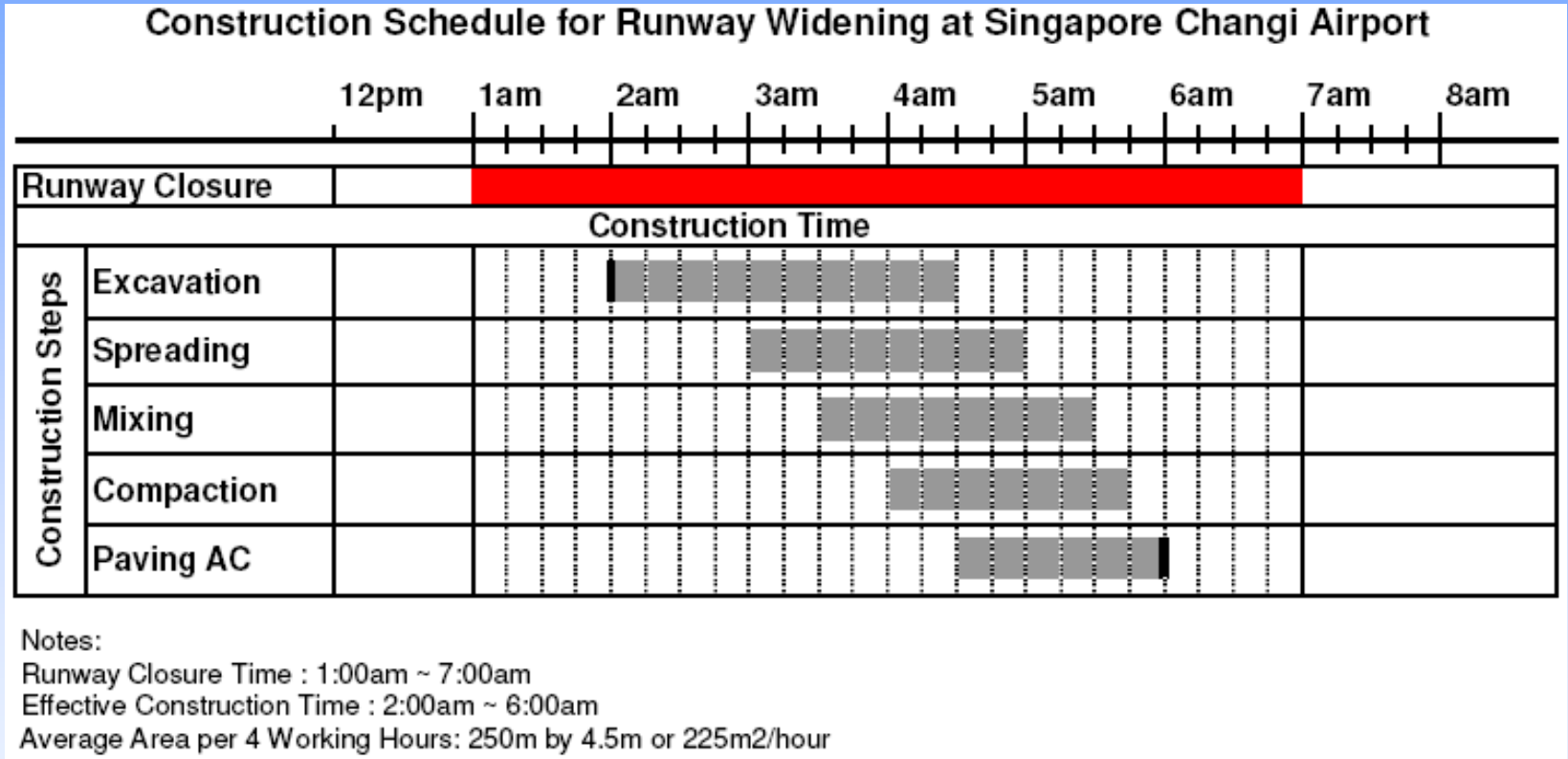


Fig. 4. Typical Construction Procedure of New Shoulders

4. Runway Shoulder Widening Process

Photo 1. Excavation

Photo 2. Spreading

4. Runway Shoulder Widening Process

Photo 3. In-Situ Mixing

Photo 4. Compaction

4. Runway Shoulder Widening Process

Photo 5. Paving Asphalt Concrete

Photo 6. Completion of Widening

4. Runway Shoulder Widening Process

Table 1. Comparison of Planned and Actual Construction Period for Runway Shoulders Construction using Chemical Soil Stabilization Method

Runway	Planned Construction Period	Actual Construction Period	Actual Working Days	Remarks
I	90 days	(31/05/05~11/07/05) 42 days	31 days	Ave. 208 m/day
II	90 days	(08/03/05~29/04/05) 53 days	29 days	Ave. 226 m/day
I & II	180 days	95 days	60 days	Ave. 217 m/day (Total:13kmx4.5m)

5. Quality Control

Photo 7. Spreading Rate Check

Photo 8. Preparations of Specimens

Photo 9. UCS Test

Photo 10. CBR Test

Photo 11. Nuclear Density Test

Photo 12. Resilient Modulus Test

5. Quality Control

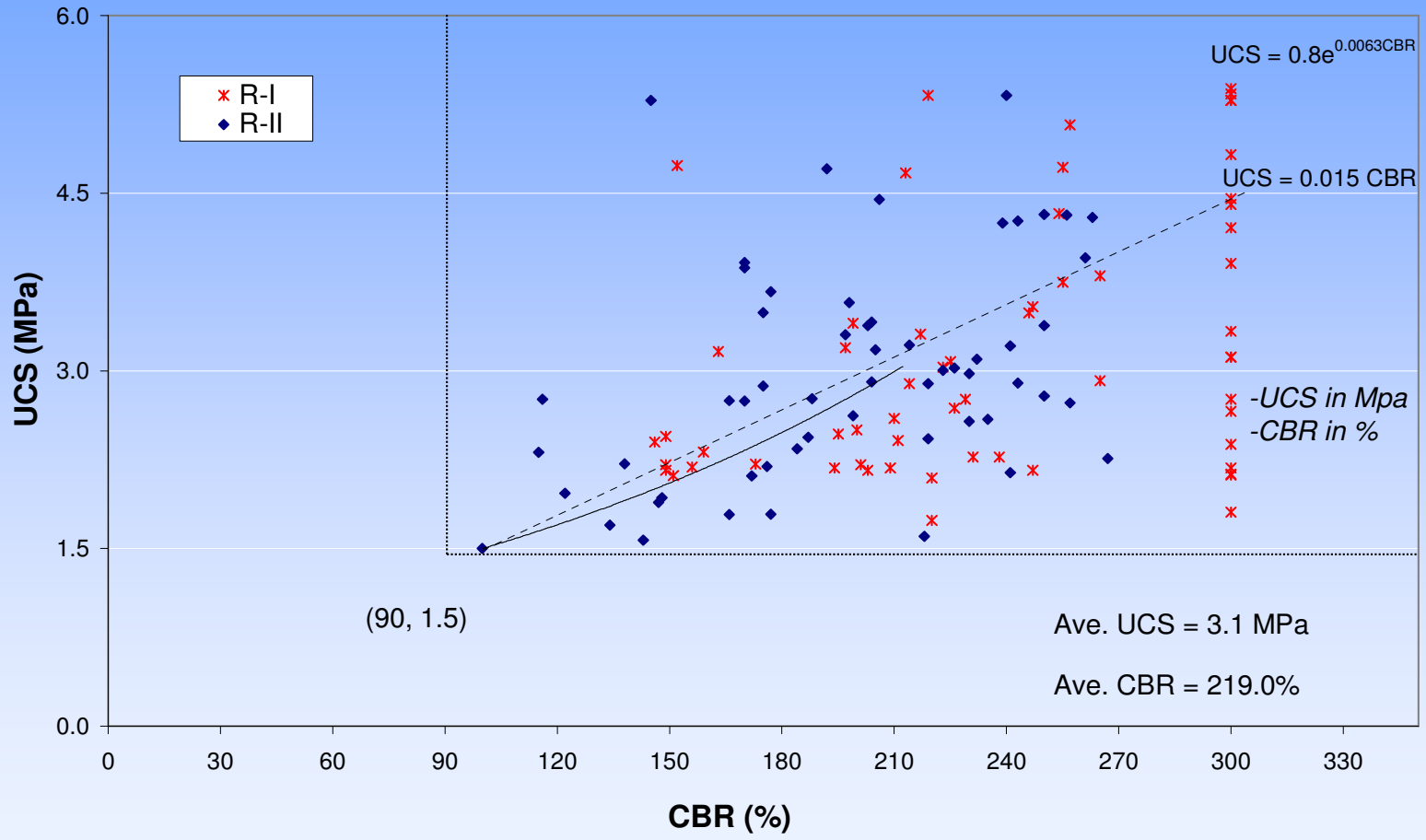


Fig. 5. UCS and CBR Testing Results

PROJECT RECORD

CAAS Permit No.: FPT/T1-065/05; FPT/T1-072/05

—Design & Build Contract for Widening of Runway Shoulders & Associated Works at Singapore Changi Airport

(CAAS Project — CAA000/EN/NLA/2004/1)

INSTEK HOLDING PET LTD
36 TANJONG PENJURU, SINGAPORE 609031
TEL: 62522201 FAX: 62527886
http://www.chemilink.com.sg

6. Benefits of Chemical–Soil Stabilization in the Airport Environment

Comparison Item (Daily basis and for base course only)	Conventional Replacement Method	Chemical-Soil Stabilization
Transportation (in & out, 10t truck)	> 100 trips	About 20 trips
Construction Rate (by 4.5M)	< 75M	Average: 250M
Security Clearance Time	9 hours	Within limited and acceptable time

* Chemical-Soil Stabilization
  - ❑ Manpower: < 50 workheads
  - ❑ Machinery/ Vehicles: < 20 units
  - ❑ Re-opening time: 30 minutes
* 2.5 months ahead of the 6 months schedule

6. Benefits of Chemical–Soil Stabilization in the Airport Environment

- Better Environment Protection
- Limited Disturbances to Airport Operations
- Higher Airport Safety Assurances
- Simple and Faster Construction and Less Materials Transportation
- Better Technical Performances
- Cost Saving and Overall Cost Effectiveness

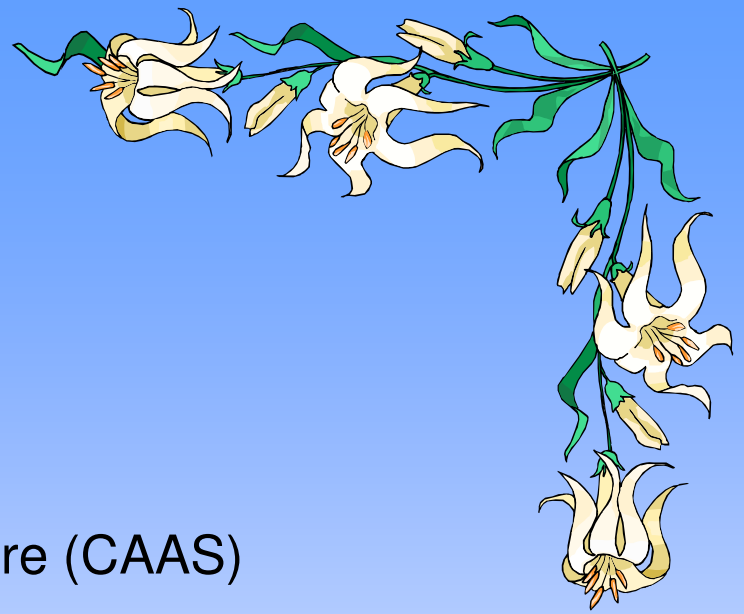
7. Conclusions

1) Widening has successfully been completed for Singapore Changi International Airport ---One of the 1st international airports to be ready for A380

2) Comprehensive project planning and methodology evaluation are critical for the smooth and on-time project completion.

3) The Chemical-Soil Stabilization Method is applicable with significant advantages and benefits

4) Technical performance to-date is satisfactory



Acknowledgements

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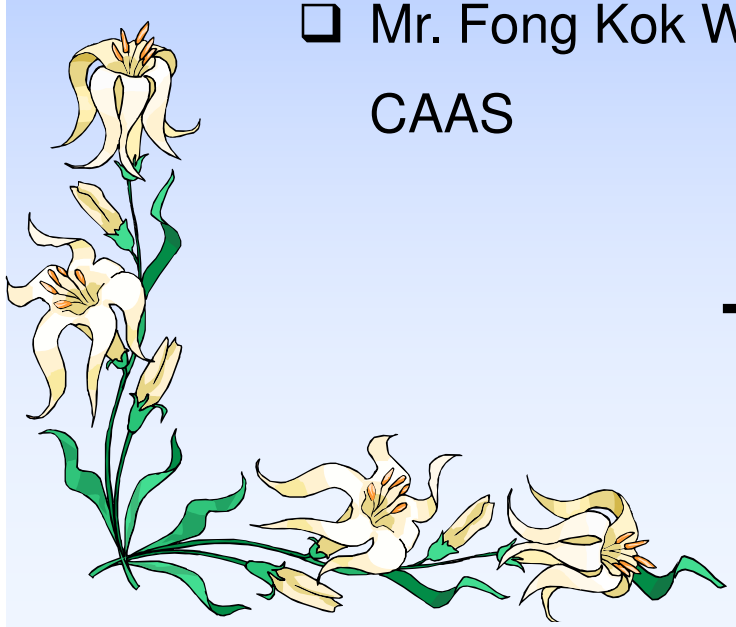


Thanks for Your Attention!

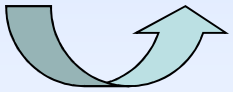
RUNWAY 2 AFTER 17 MONTHS

RUNWAY 2 AFTER 17 MONTHS

RUNWAY 1 AFTER 14 MONTHS

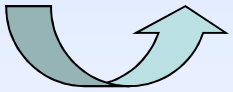
2-1 Ability to Meet Airport Operational Restrictions

- One of busiest airports in the world with 2 runways
- Limited runway closure time from 1:00 am to 7:00 am
- Effective construction time is only about 4 hours
- Runways re-opening within 30 minutes



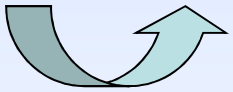
2-2 Construction Speed

- Higher construction unit rate
- Shorter project duration
- Safer construction activities



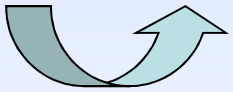
2-3 Structural Design

- ICAO requirements
- Latest recommendation from Airbus
- Sub-grade conditions – reclaimed land
- Proven technology and product in tropical region with a long history



2-4 Environmental Impact

- Less excavation and backfilling
- Less ground movements caused by vehicles, machines and manpower
- Less airport control and coordination works
- Environment friendly



2-5 Cost Effectiveness

❖ **Overall Costs**

- ❑ **Construction cost & related costs**
- ❑ **Long-term maintenance costs and related costs**