ACTS
ADVANCED CONSTRUCTION
TECHNOLOGY SERVICES

Special Construction Considerations in the Middle-East

Outline

- Origin
- Middle-East Construction Challenges and special considerations
- Case Study 1: Kuwait International Airport Project
- Case Study 2: King Abdulaziz International Airport Project
- Conclusions

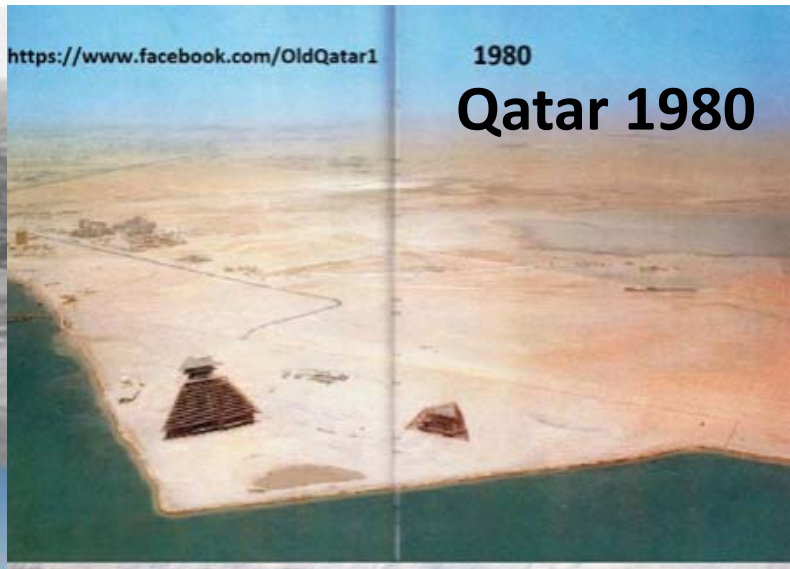
Origin

- Fast development and growth of the demand for construction starting year 1970 with several planning for large scale projects. The construction industry adopted the available information and used it.
- This information was in several instances not relevant (MEA is well outside the range of earlier hot weather experience and can be classified as "Severely Hot" or "Hyper-arid“)
- Workmanship restrictions created many deficiencies especially in durability.
- Some of the structures surveyed on or near the coast would reach a terminal condition as early as 12 to 15 years.

Origin

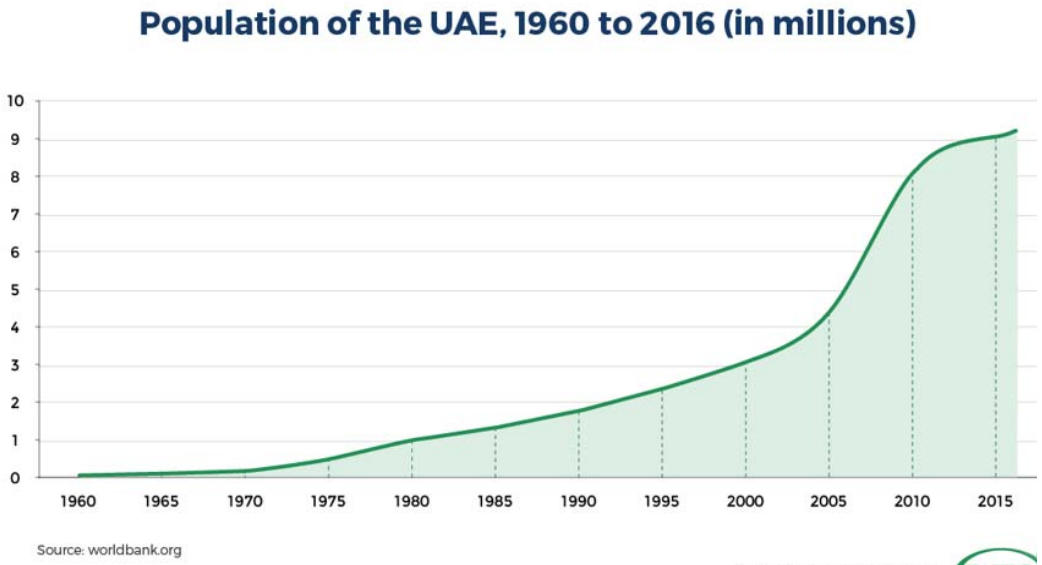

DUBAI 1990

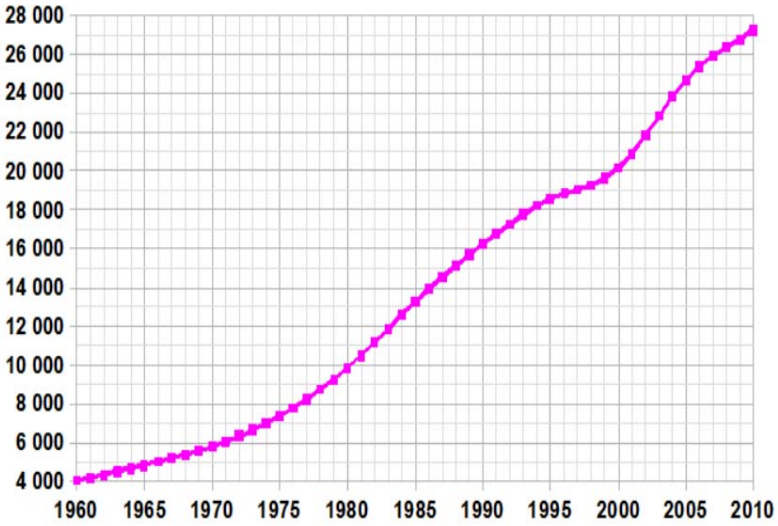

DUBAI 2015


https://www.facebook.com/OldQatar1
1980
Qatar 1980

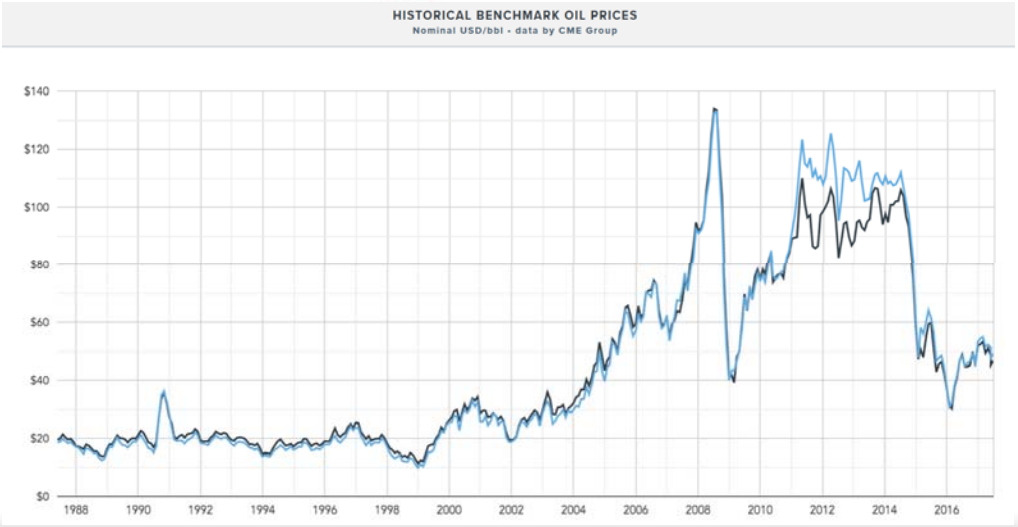

Qatar 2013
2013

Origin





Demographics of Saudi Arabia, Data of FAO, year 2005 ; Number of inhabitants in thousands.



Middle-East Construction Challenges

Severe Environment

Lack of Quality Materials

Lack of competent workmanship and quality control

Nature of surface soils and groundwater

Large Scale and Fast Track Projects

Environmental Challenges

High Temperatures with high daily and seasonal temperature range

Evaporation has led to a substantial buildup of salts in the ground.

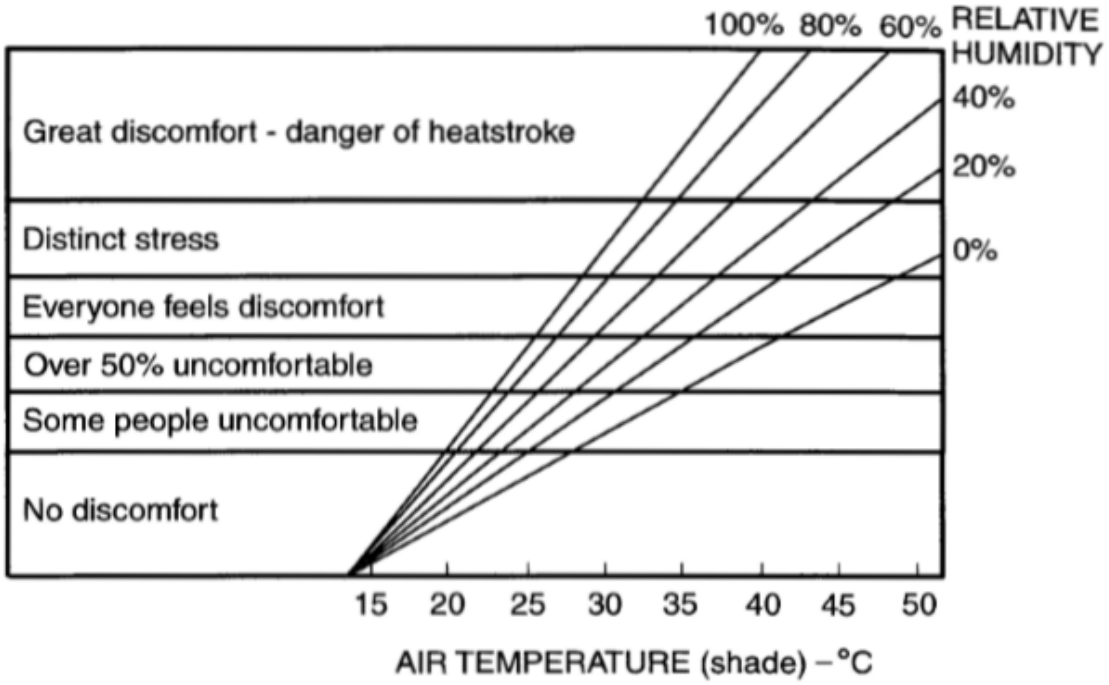
Salt Contamination in coastal regions and some inland areas.

Windborne Contaminated dust

Fluctuating high humidity

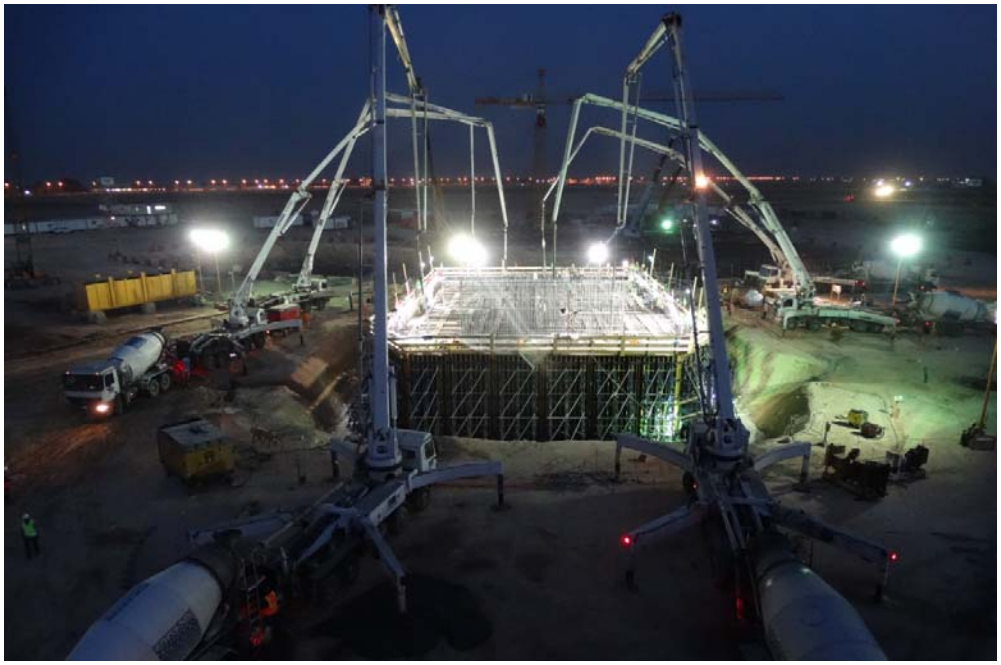
High rate of evaporation

High solar radiation



Environmental Challenges

Stringent hot weather concreting practices	Workmanship comfort	Durability requirements



Materials Quality

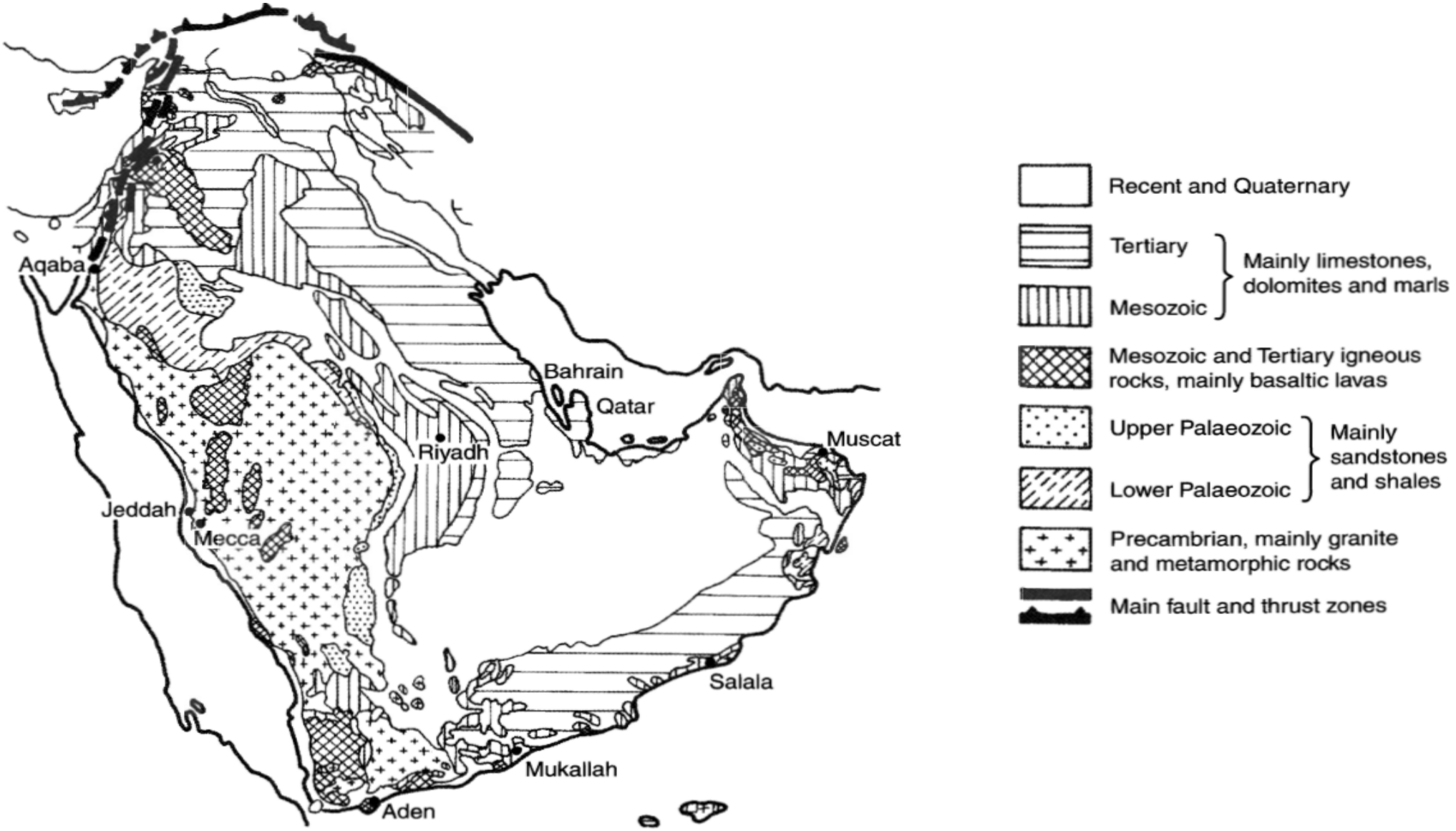
Some natural materials are contaminated (sulfate chloride) or unsuitable for concrete: Poorly graded sands, soft aggregate particles, high dust content, high water absorptions, and variations of the properties from one single source.

Groundwater is contaminated with salt that are aggressive to the concrete and potable water is expensive

Expensive transport of aggregate and good materials.

Major variations in clinker and cement properties

Materials Quality

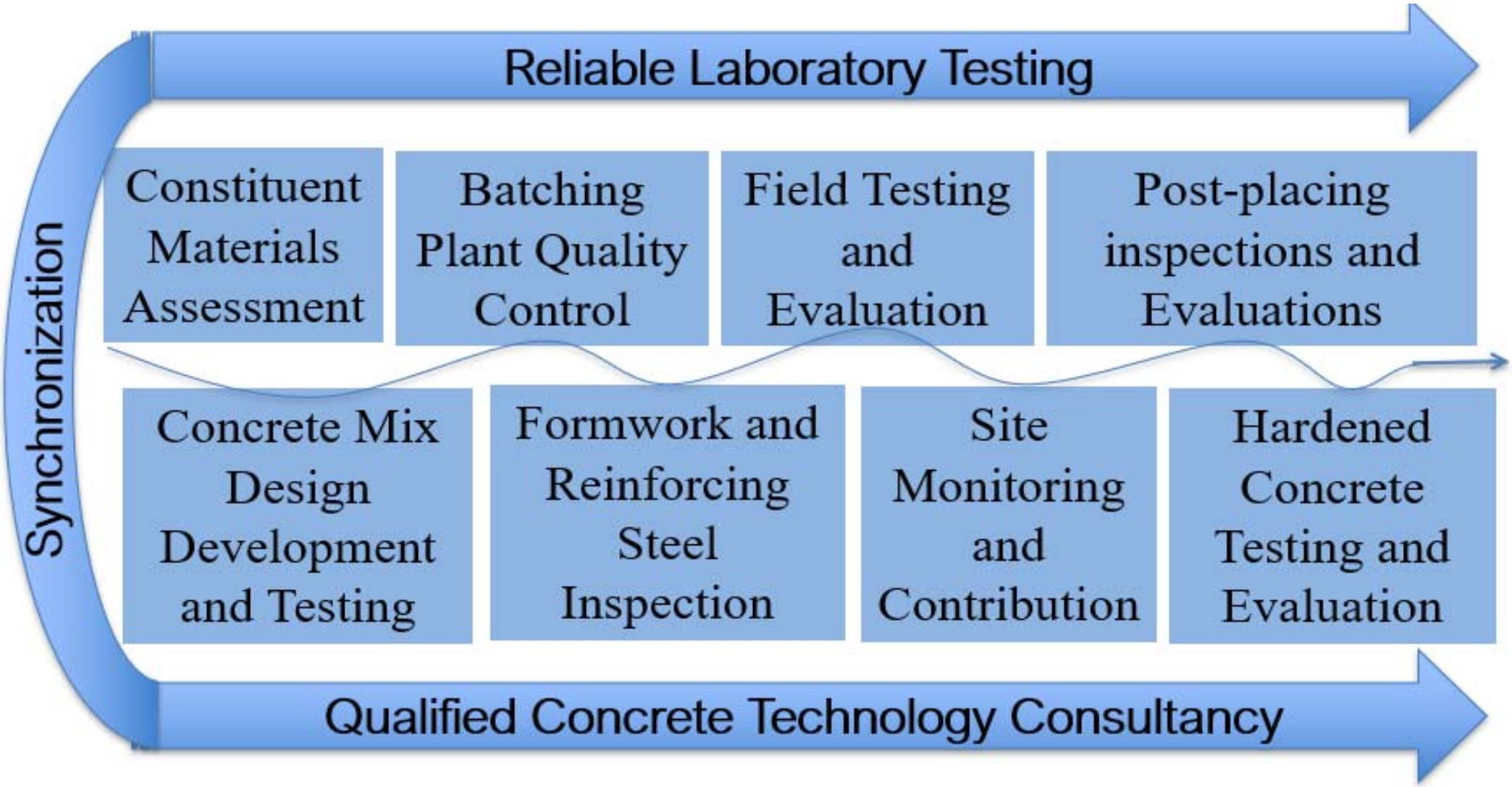


Bedrock geology of the Arabian Peninsula (after Fookes and Higginbottom, 1980a).

Materials Quality

Lack of Competent workmanship and Quality Control

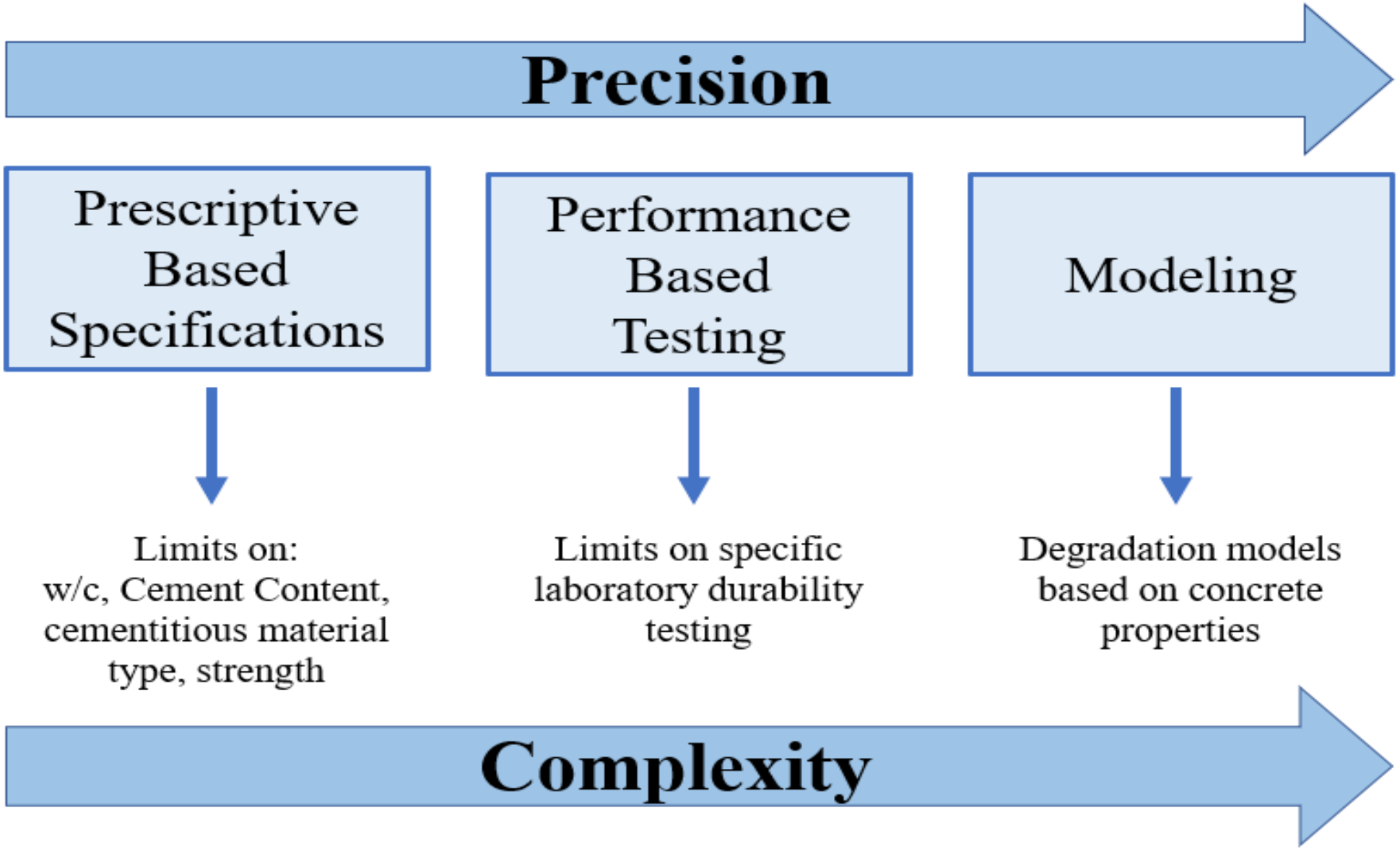
QCS Large Scale and Fast Track Projects



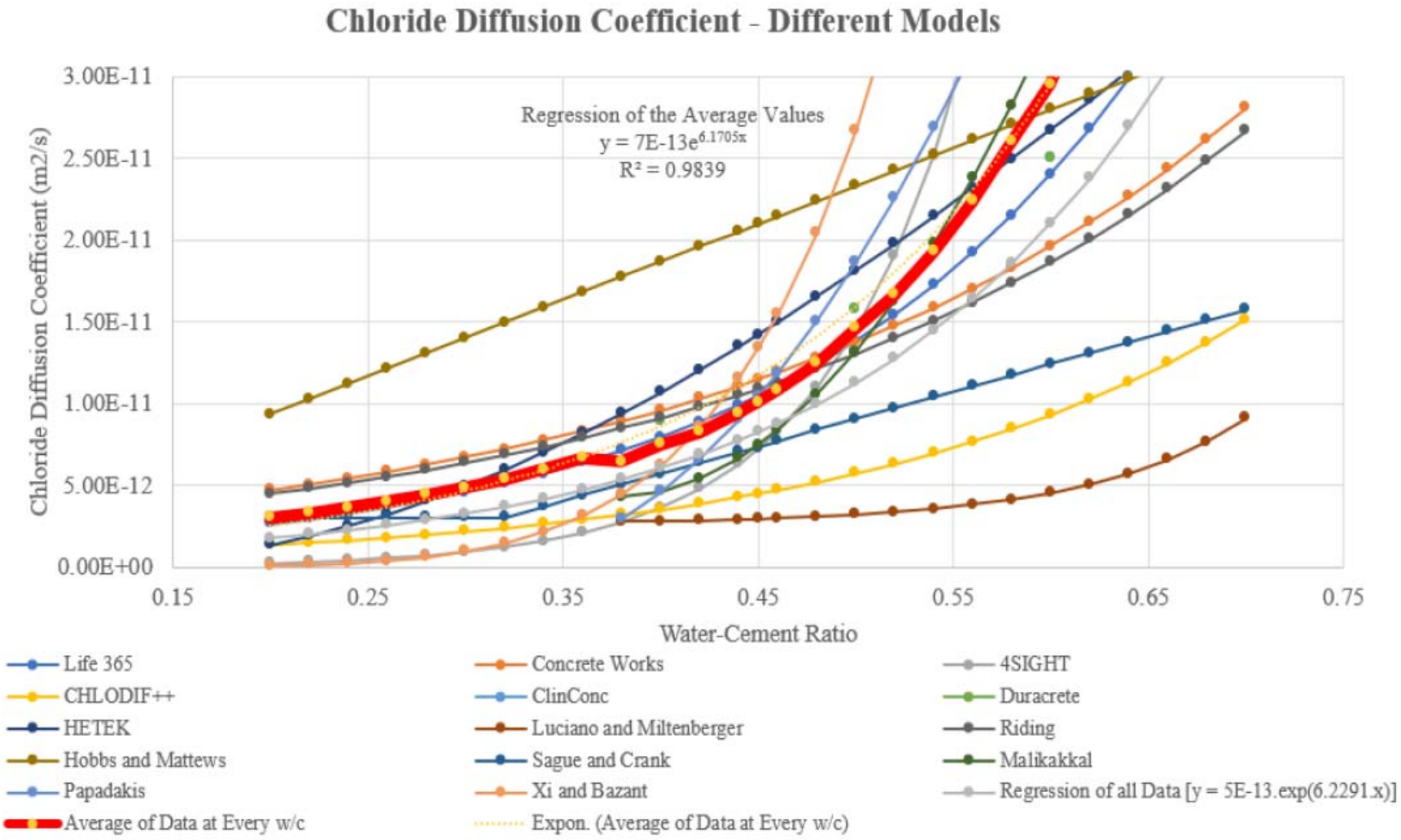
QCS Large Scale and Fast Track Projects

Developing Online Quality Control Applications

Durability Design



Durability Design



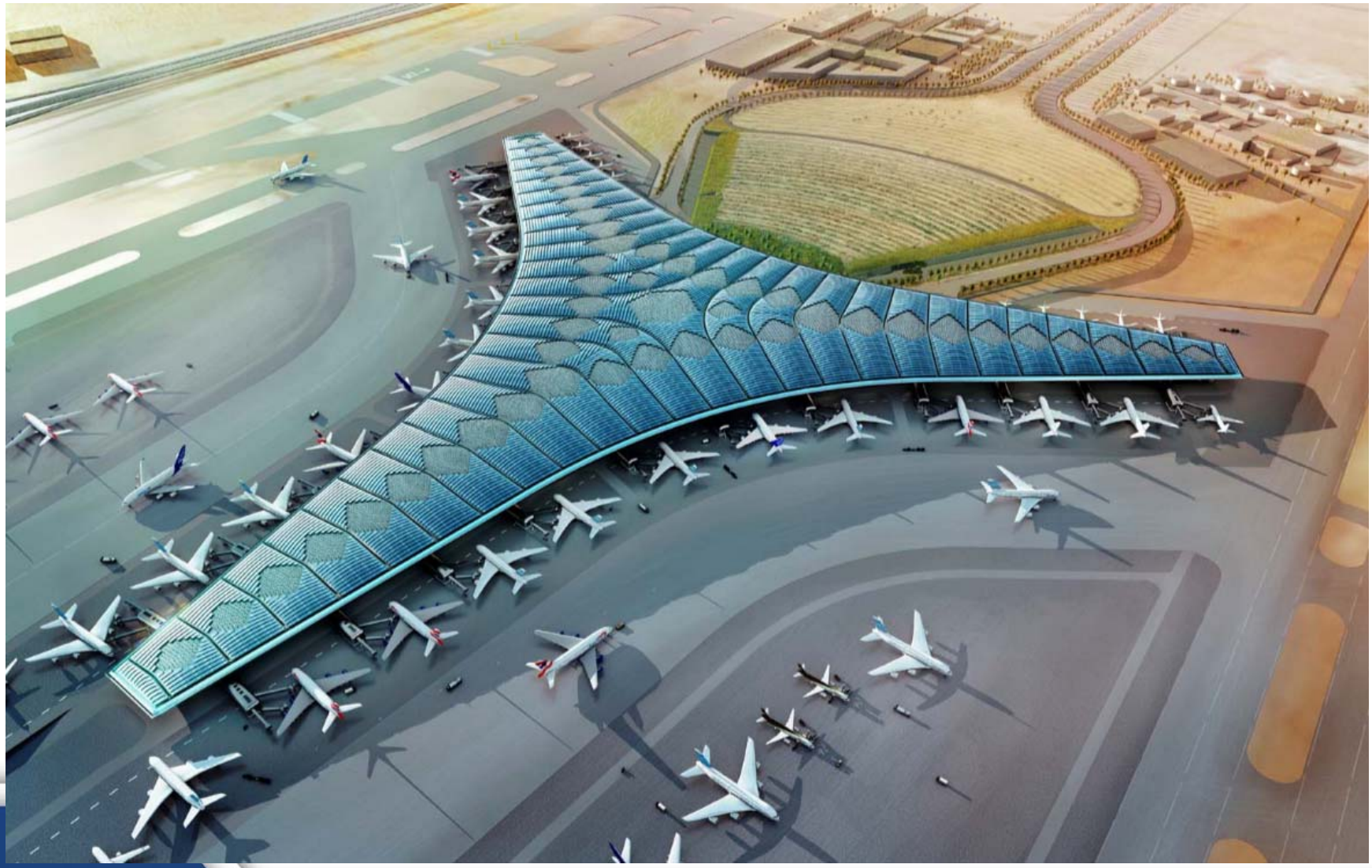
Durability Design

$$D_c = D_{c,ref}.f_1(T).f_2(h).f_3(x).f_4(CA,Hy).f_5(C3A).f_6(Cs).f_7(Mi).f_8(CW,w/c)$$

- Environmental input parameters
  - Temperature
  - Age
  - Relative humidity
- Concrete properties input parameters
  - Water-cement ratio
  - Cementitious materials content
  - Cementitious materials replacement percentage (Fly ash, silica fume, slag)
  - Cement Density
  - Cement Surface Area
  - Alite Percentage in Cement
  - Belite Percentage in Cement
  - Aluminate Percentage in Cement (C3A content)
  - Ferrite Percentage in Cement
  - Aggregate content and properties
  - Hydration Coefficient
- Workmanship input parameters
  - Curing time
  - Initial Mixing Time
  - Consolidation Degree
- Post-placing input parameters
  - Crack Width

Case Study 1:
Kuwait International Airport Project

Kuwait International Airport Project

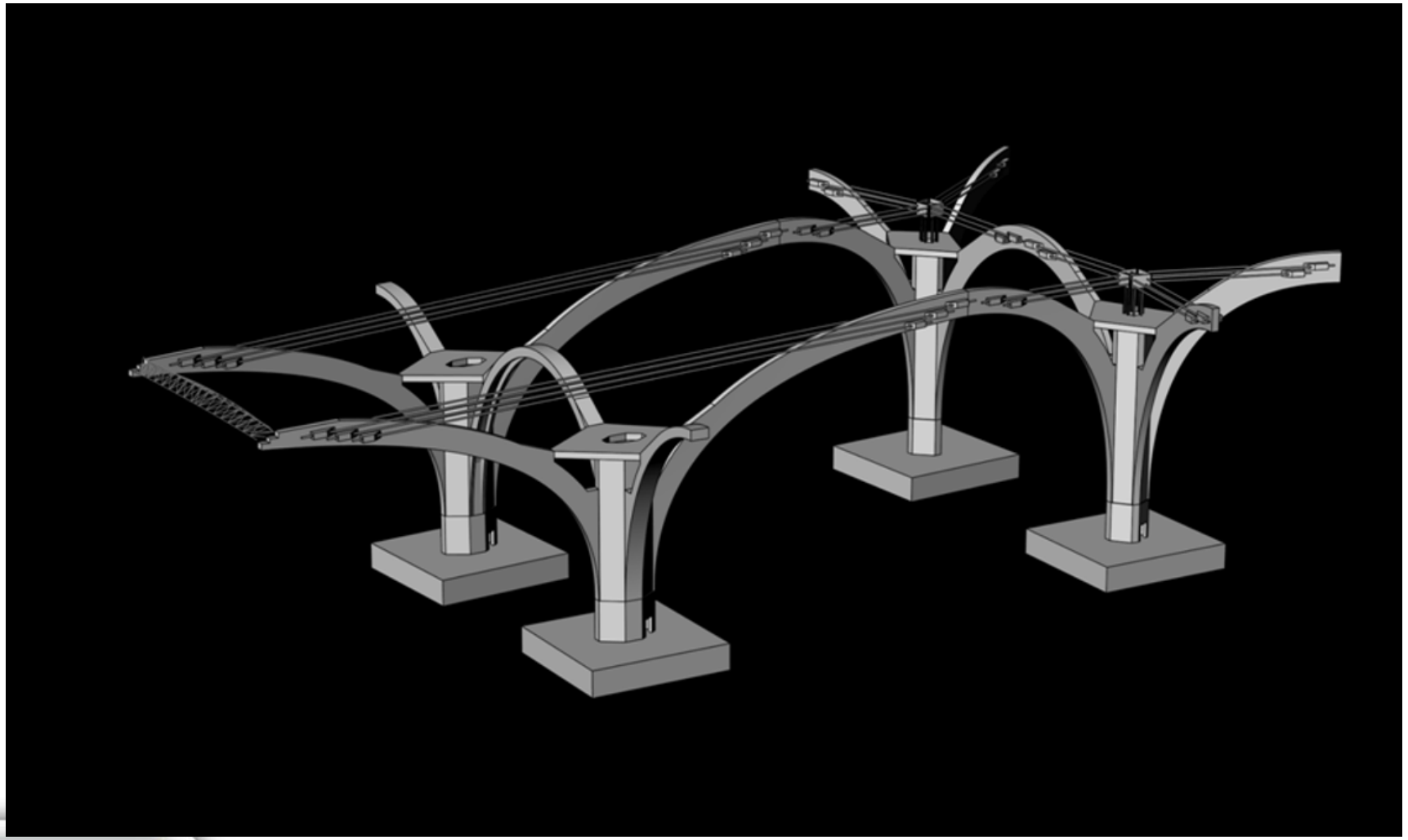


Kuwait International Airport Project

Kuwait International Airport Project

Kuwait International Airport Project

Kuwait International Airport Project

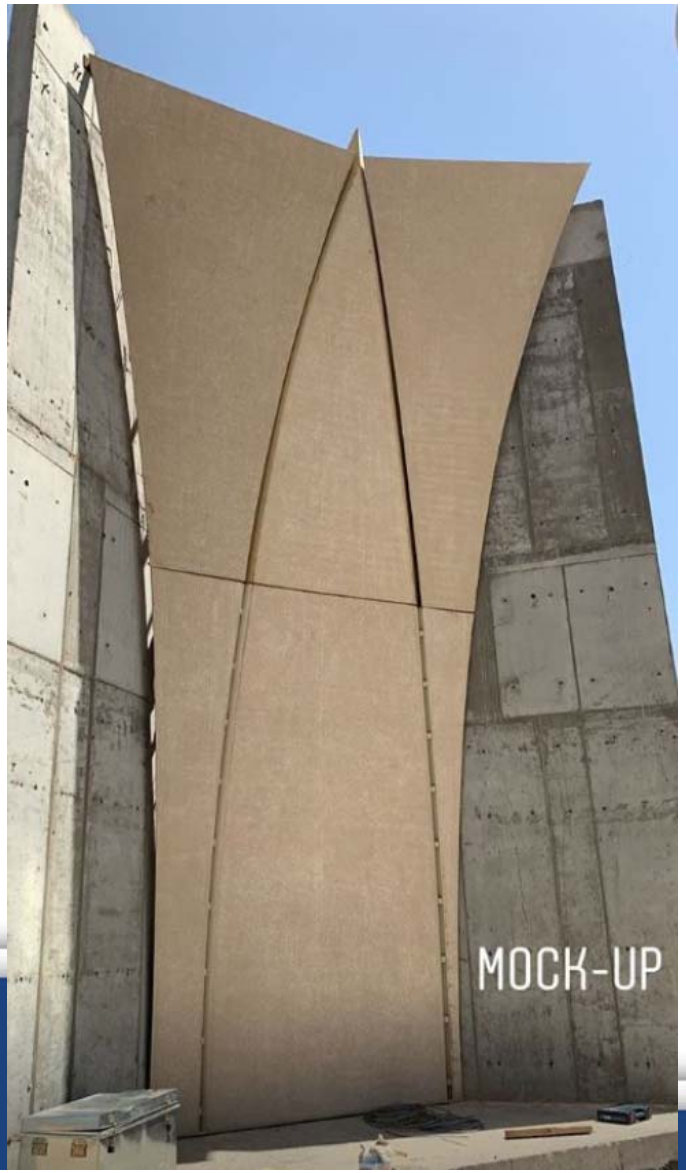


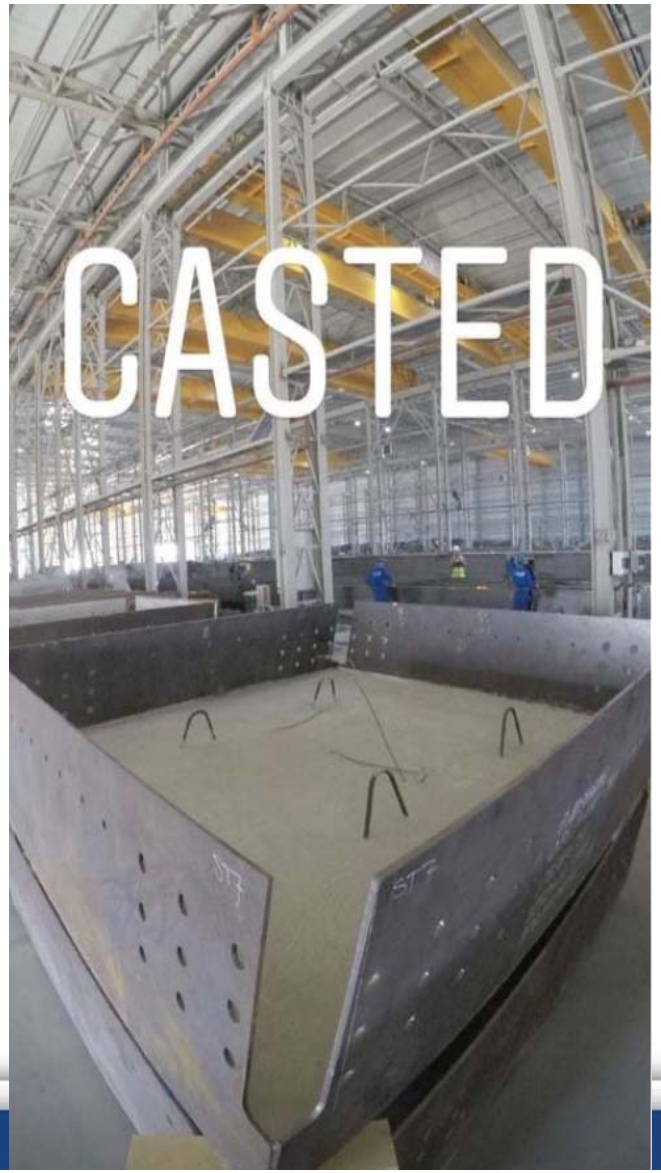
Kuwait International Airport Project

- Five site batching plants
- One sand washing plant
- Hot weather concrete practices
- Precast concrete design
- Self-consolidated concrete is used
- Online platforms for laboratory testing and Quality control
- Concrete durability design

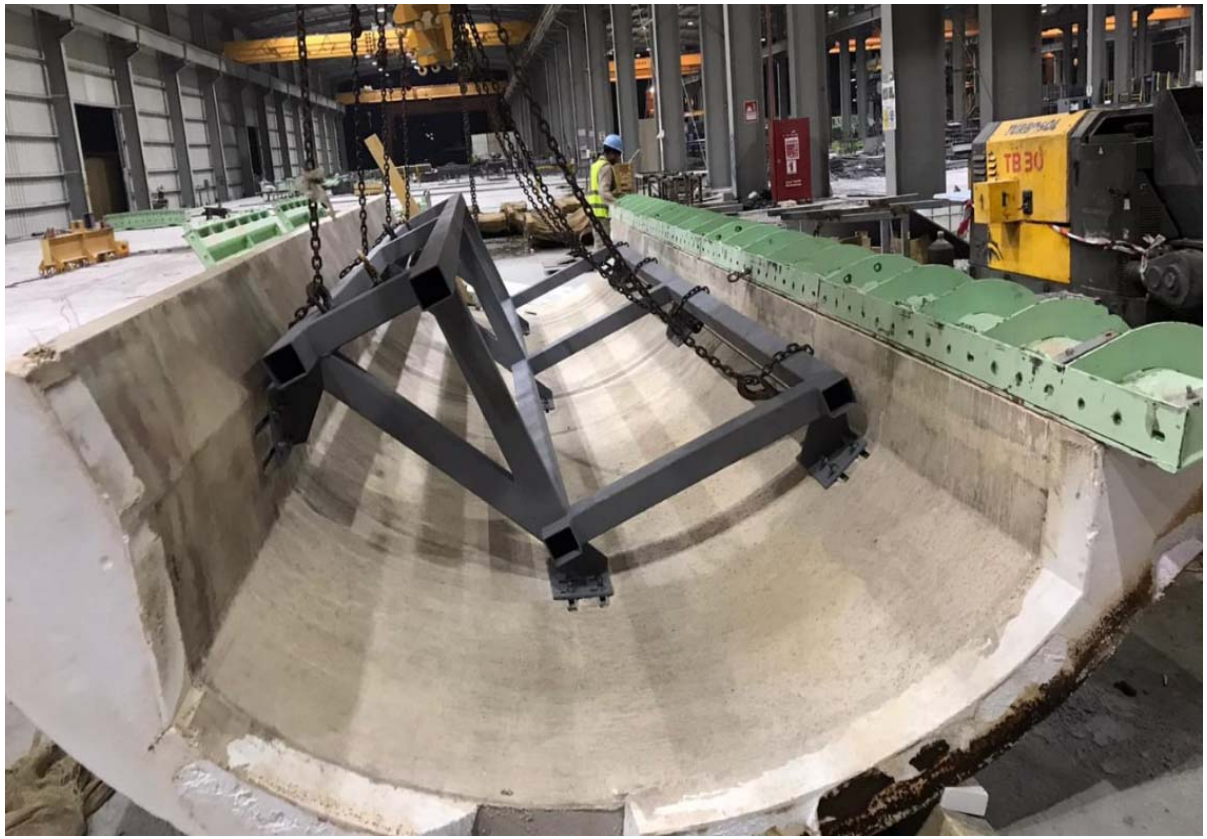
Kuwait International Airport Project

Kuwait International Airport Project

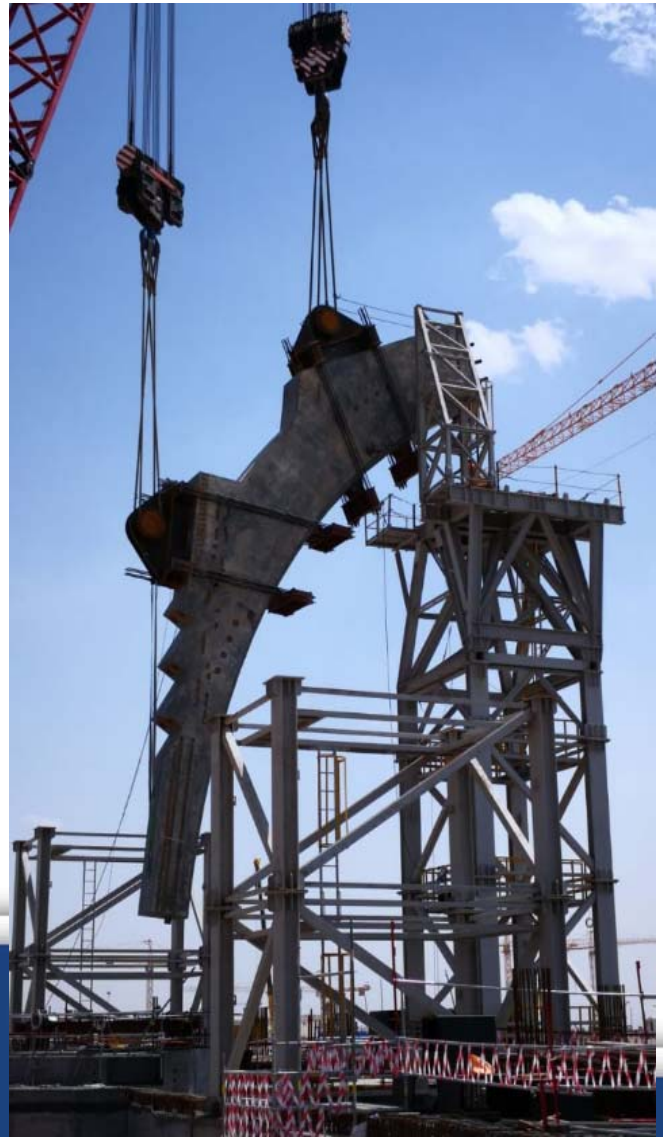


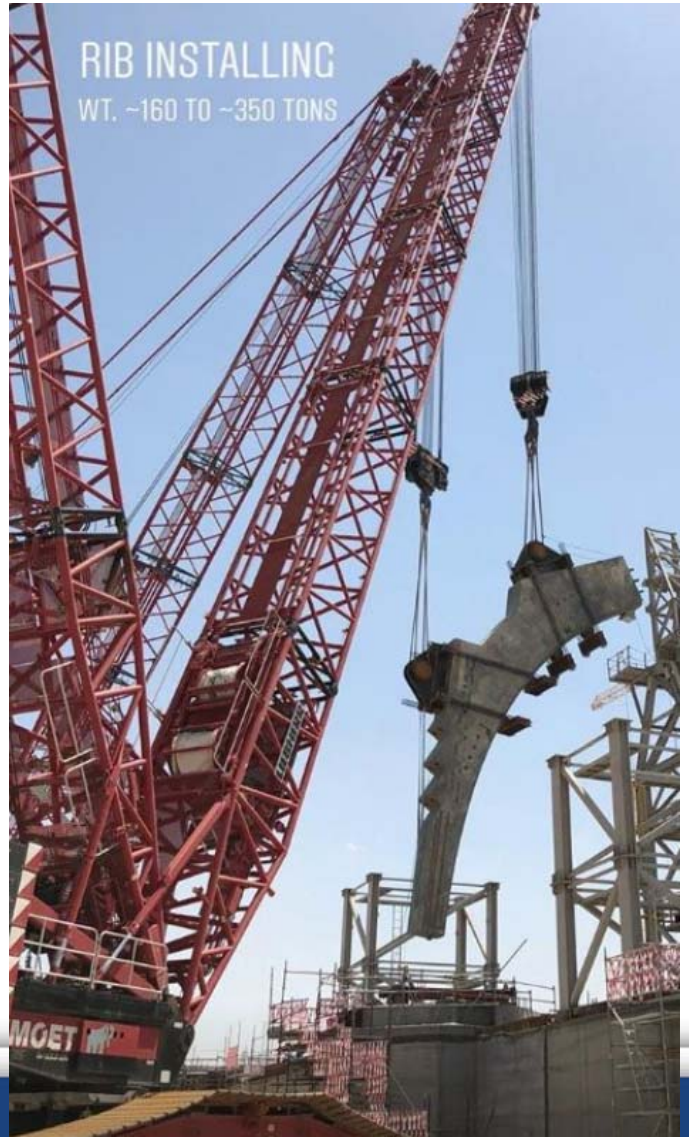


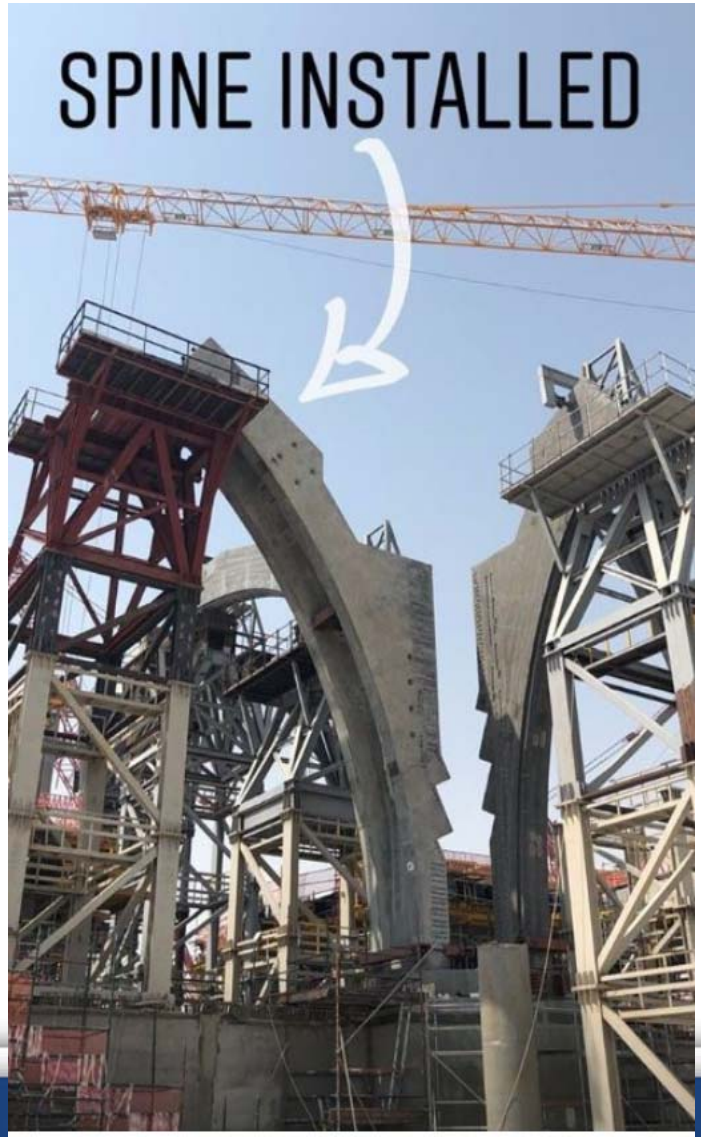
Kuwait International Airport Project



Kuwait International Airport Project







Kuwait International Airport Project

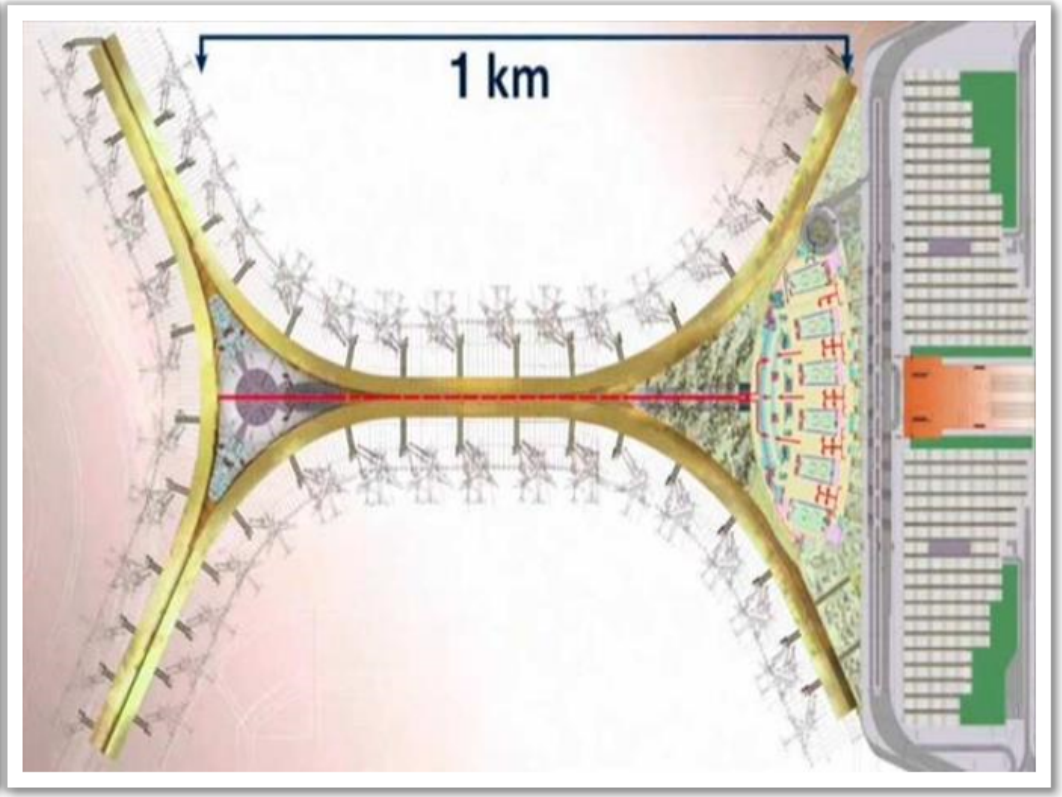
Kuwait International Airport Project

Case Study 2:
King Abdulaziz International Airport Project (Jeddah)

King Abdulaziz International Airport Project (Jeddah – KSA)

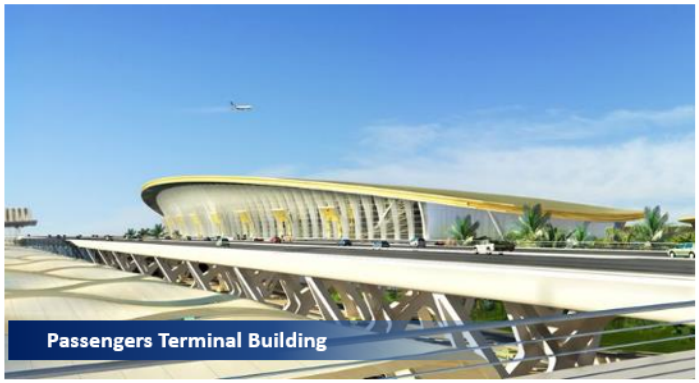
Phase 1: Volume of Concrete 6,000,000 m^3

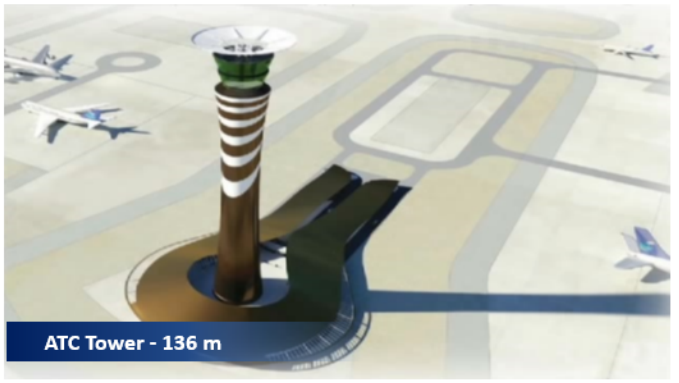
- The terminal will include 46 additional departure gates, 96 airway bridges 200 new counters.



King Abdulaziz International Airport Project (Jeddah – KSA)

KAIA Project - Phase 1

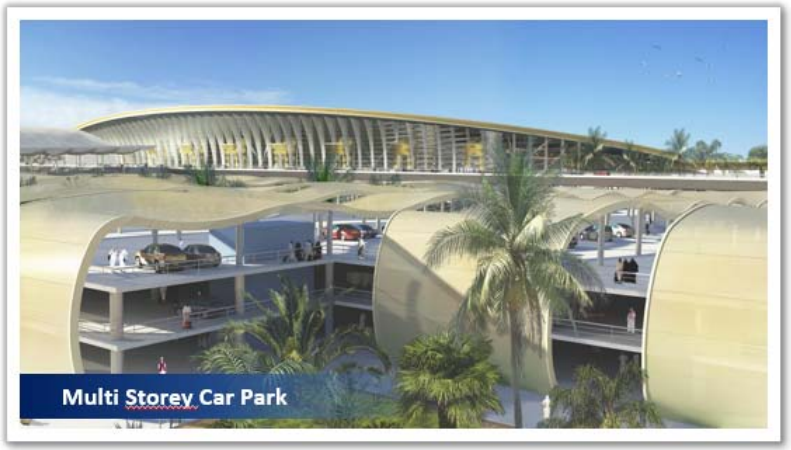

Passengers Terminal Building


ATC Tower - 136 m


Data Centers


Main Rescue & Firefighting Building

King Abdulaziz International Airport Project (Jeddah – KSA)


Multi Storey Car Park


Haramain Railway Station in Airport


Mosque

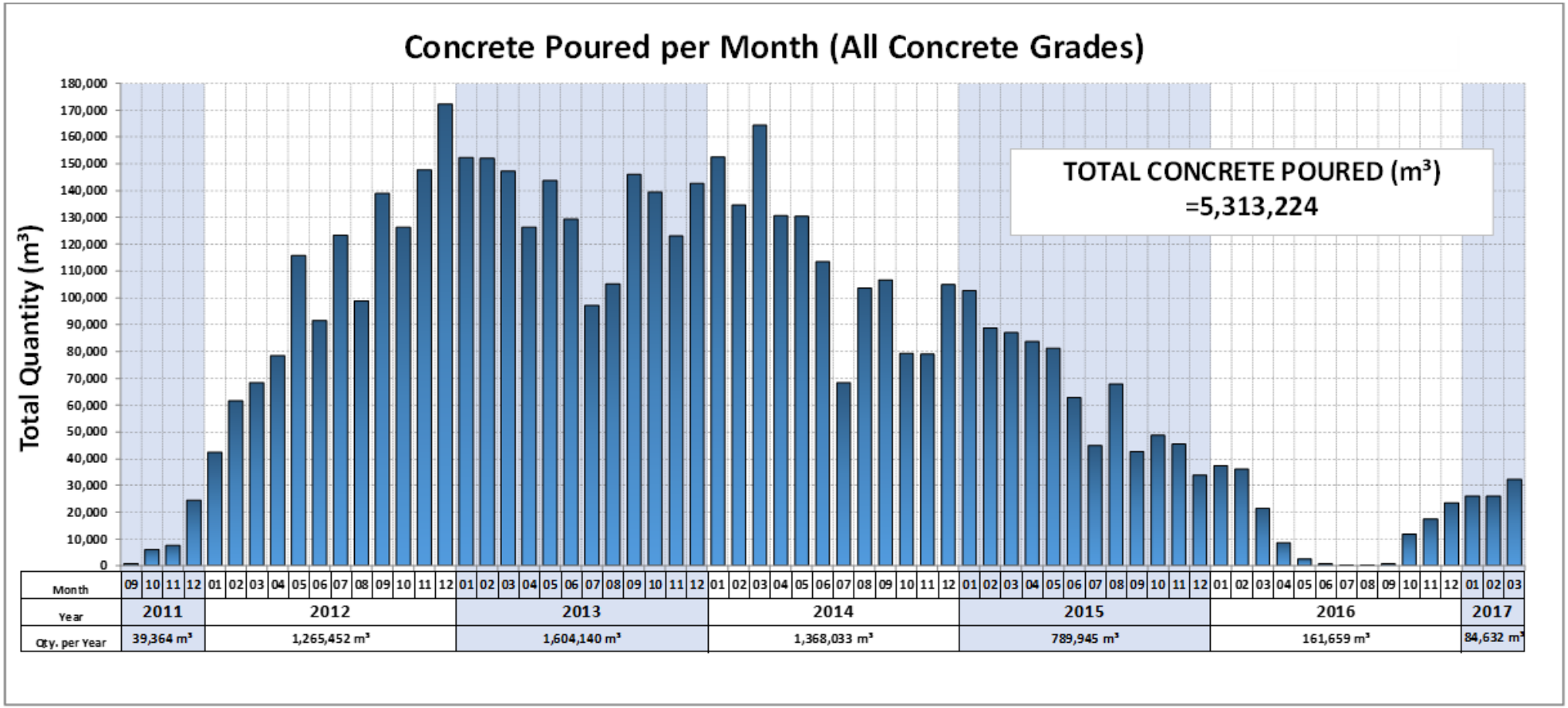

Transportation Center

King Abdulaziz International Airport Project (Jeddah – KSA)

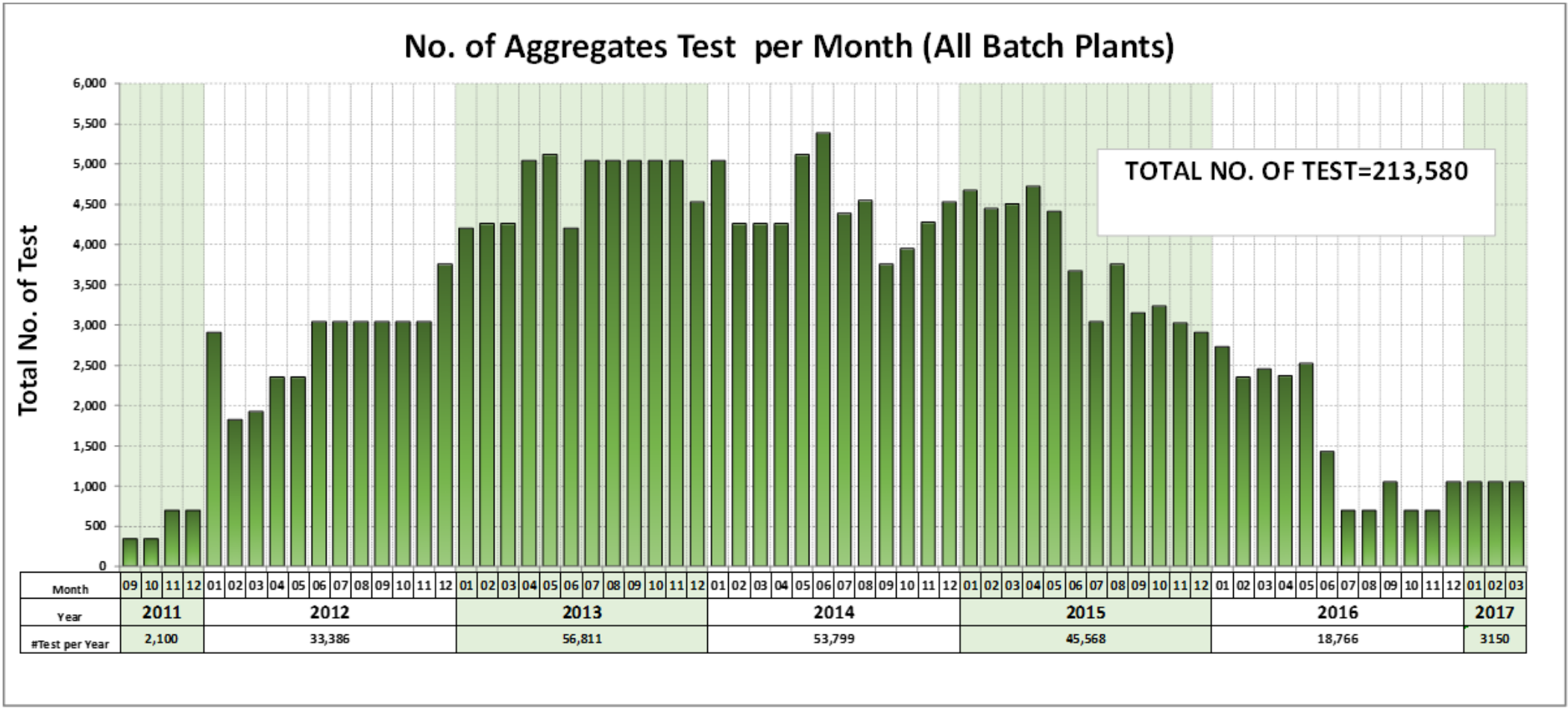
SCC – Self Compacted Concrete / Viaduct Arches

- Volume (60,135 m^3)

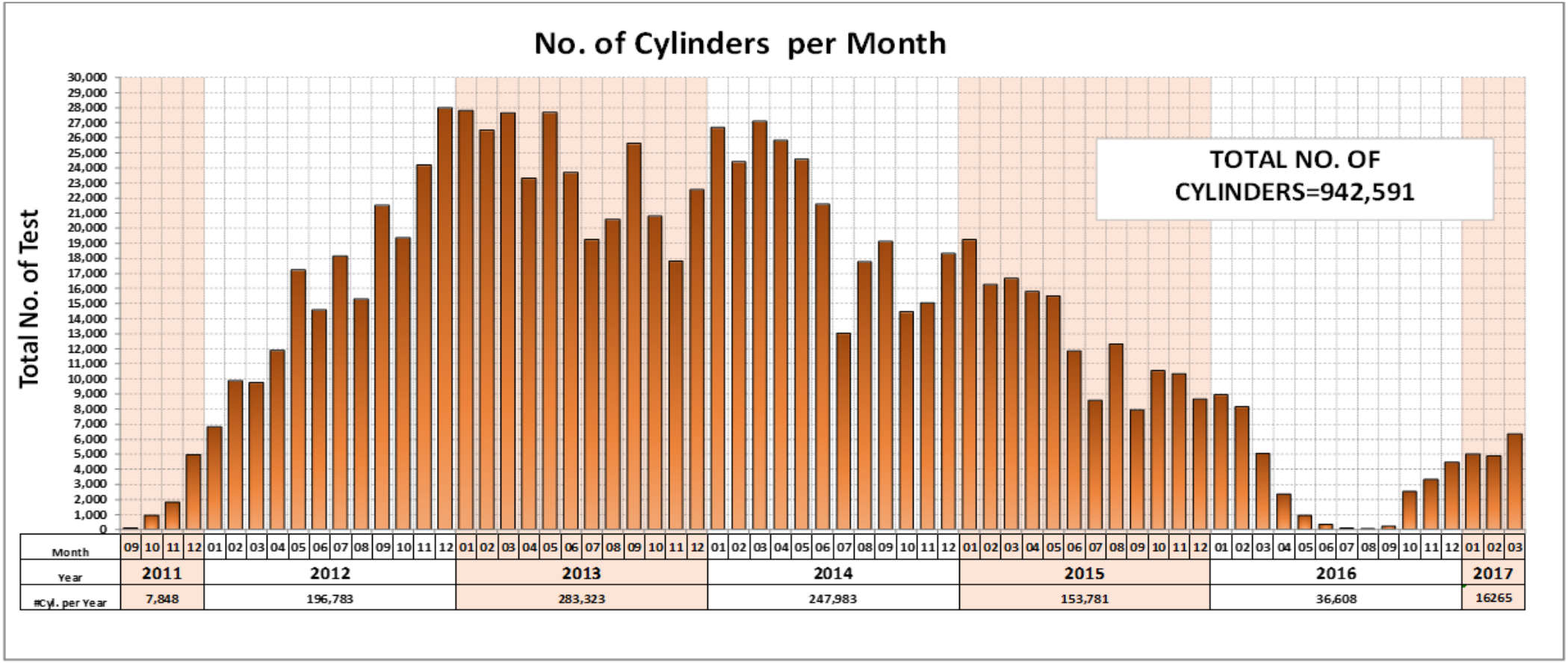
King Abdulaziz International Airport Project (Jeddah – KSA)



King Abdulaziz International Airport Project (Jeddah – KSA)



King Abdulaziz International Airport Project (Jeddah – KSA)



Month	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03
Year	2011				2012												2013												2014												2015												2016												2017		
#Cyl. per Year	7,848				196,783												283,323												247,983												153,781												36,608												16265		

Conclusions

- The special construction considerations in the Middle East are related to the severe environment, lack of quality materials, lack of quality control, and large-scale fast track projects.
- These considerations include additional schemes for hot weather concrete practices, laboratory testing, concrete quality control, and durability design.
- These schemes were successfully applied in large scale projects in the Middle-East, notably KIA and KAIA.

Thank You

Advanced Construction Technology Services (ACTS)
Hamra, Aresco Palace, 9th Floor, Beirut - Lebanon
Telephone: +961 1 753100 - Fax: +961 1 753200 - P.O.Box: 14-5918
marketing@acts-int.com
www.acts-int.com
Lebanon - Qatar - KSA – UAE – Kuwait - Oman