



- Board of Directors 2017-2018
- Annual Awards 2016-2017
- Award of Excellence
- Special Award for Infrastructure Project
- Award of Achievement
- Technical Activities
- Museum of Image and Sound



Kuwait Chapter

Local Connection with International Links

■ Concrete News

Concrete News is published by ACI-Kuwait Chapter for sharing information, promoting exchange of technical knowledge amongst its membership, and enhancing the Chapter's position within Kuwait's engineering fraternity.

■ ACI Kuwait Chapter

The purpose of the Chapter is to help in furthering the chartered objectives of the American Concrete Institute. The American Concrete Institute (ACI), is a nonprofit international organization that promotes improved technology, technical competence, design, and construction aspects related to concrete for the benefit of society. ACI-Kuwait Chapter was established essentially

to promote education, standards of technical practice, scientific investigation and research in concrete technology. The Chapter also aims to channel efforts of its members towards a non-profit public service in collecting, correlating and disseminating information for the improvement of design, construction, manufacturing, utilisation and maintenance of concrete products and structures.

■ Functions

ACI Kuwait Chapter is approved and authorized by the Board of Directors of ACI International to provide the means of furthering the chartered objectives of the Institute in the State of Kuwait. The Chapter is managed by a local Board of Directors whose members serve as Chapter Officers. Chapter membership is open to individuals and organizations with an interest in any aspect of concrete technology. The Chapter is operated through its committees, which are comprised up of volunteers from the membership. Programs are developed by the Committees to help achieve Chapter objectives and to meet the needs of its members. The Chapter may hold several meetings each year and engage in activities that may include:

- Sponsoring educational seminars, short courses or technical workshops.
- Organising or sponsoring training courses for examinations and certification.
- Publishing technical information and newsletters.
- Conducting awards programs for local concrete structures and related distinguished services.
- Special social events.

■ Benefits

- Chapter members can attend seminars, short courses and workshops organized at reduced fees.
- Free use of ACI publications supplied by ACI International, and which are kept in the Chapter library.
- A forum for members to interact with colleagues and identifying potential sources for cooperation in addressing specific technical problems.

■ Committees

The Chapter's affairs and activities are executed through its Committees, which include:

- Technical Committee
- Membership Committee
- Publication Committee
- Social Committee
- Nomination Committee
- ACI-KC Students' Committee

■ Joining ACI Kuwait Chapter

To become a member of ACI Kuwait Chapter, please contact the Chapter Office Manager on the numbers shown below; or download an Application Form from our website. Different categories of membership are available. You will receive a copy of the Chapter Bylaws upon becoming a member. The functioning of ACI Kuwait Chapter is based on mutual interest and voluntarily effort. Its success depends upon the active participation of its members.

ACI Kuwait Chapter

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■ President's Message



ACI-KC President, Mr. Aziz Mamuji

The past few months have indeed been very eventful, and I am delighted that ACI-Kuwait Chapter is growing in strength. Our individual and corporate membership numbers are increasing, and we are exploring different initiatives for delivering on our objective to promote improvements in concrete technology and construction aspects.

During last year's well-attended and highly successful Annual Awards Banquet, presided over by His Excellency the Minister of Public Works, Eng. Abdul Rehman Al Muttawa, three major awards were presented.

The Award of Excellence was given to the New Headquarters of Central Bank of Kuwait; Dr. Naji Al Mutairi received the Award of Achievement; and a Special Award for Infrastructure Project was presented to the Jahra Road Project.

The function, ceremonies and awardees are covered in this issue of ACI-KC's Concrete News, which also

reports on the Chapter's other activities, including the election of its Board of Directors for 2017-2018. The new Board is committed to encouraging more support from consulting firms and construction companies, because the Chapter's effectiveness can only be enhanced through active participation by its members.

We are also keen on introducing more variety in our technical activities, and a programme of presentations has been initiated whereby local Consultants present their significant and landmark projects to ACI-KC members.

An event to look forward to is this year's Award Banquet which will be held in May. In addition to the two main awards, for a merited building and an exceptional personality, a special award will be given to a sustainably designed project.

The Chapter has a lot to offer, and in hoping that 2018 will be beneficial to all our members, I wish you all good health and continued success.

■ Board of Directors 2017 - 2018

ACI-Kuwait Chapter's Board of Directors for 2017-2018 was elected and formalized during the Annual General Assembly held on 22nd May, 2017. The Board of Directors comprises eleven officials who are elected by the Chapter's general membership, after being nominated by the Nomination Committee. The President and the Vice-President serve in their positions for one year. Directors are elected every year to serve three-year terms. The members of the Board of Directors for the year 2017-2018 are :

■ Board of Directors 2017-2018

President	: Mr. Aziz Mamuji
Vice President	: Dr. Saud Al Otaibi
Past President 1	: Dr. Bader Al-Salman
Past President 2	: Dr. Moetaz El-Hawary
Past President 3	: Mr. Mousa Al-Sarraf
Director /Treasurer	: Mr. Abdul Wahab Rumani
Director/Secretary	: Mr. Mansoor Rao
Director	: Dr. Khaldoun Rahal
Director	: Dr. Hassan Kamal
Director	: Dr. Zafer Sakka
Director	: Dr. Hisham Abdelfattah

■ Executive Committees

The Chapter's affairs and activities are managed and executed by various Committees, which include:

- Technical Committee
- Membership Committee
- Publication Committee
- Social Committee
- Nomination Committee
- ACI-KC Students' Committee

■ Technical Committee

Chairperson: Dr. Moetaz El-Hawary

- Identifying technical topics of interest to Chapter Members and arranging seminars, short courses and workshops on various topics.
- Reviewing and submitting to Chapter Members and ACI International, committee reports on subjects of relevance to Kuwait.
- Reviewing proposed revisions of ACI Standards and submitting comments to the Chapter's Board of Directors for submission to ACI International.
- Serving objectives of the Chapter by organizing training courses and technical workshops.
- Promoting local research and testing programmes to resolve technical issues of importance for durable concrete construction in Kuwait.

■ Nomination Committee

Chairperson: Mr. Bader Al-Salman

- Nominating individuals who have the interest, leadership qualities and willingness to serve the Chapter, for election to the Board of Directors.
- Submit names, prior to the Chapter's Annual General Assembly, for election by members.

■ Students' Committee

Chairperson: Dr. Moetaz El-Hawary

- Operates under the auspices of the Chapter's Technical Committee.
- Activities are generally in line with ACI-Kuwait Chapter objectives.
- Encouraging student participation in all activities of ACI-Kuwait Chapter.
- Student participation guided and organized by an elected Board of Directors, and sub-committees appointed from within their membership.
- Activities include technical and social events and further information can be found on www.ACIQ8.com.

■ Membership Committee

Chairperson: Mr. Mansoor Rao

- Recruiting new individual members and organizations.
- Issuing and renewing membership identity cards.
- Publishing and updating Chapter's membership directory.
- Facilitating interaction amongst members and communicating their concerns to the Board of Directors and other Committees.

■ Publication Committee

Chairperson: Dr. Saud Al-Otaibi

- Publishing periodic newsletters covering the Chapter's activities and providing general information of use to Chapter members.
- Printing and distributing copies of technical reports to Chapter members, as well as to interested individuals and concerned organisations.
- Preparing reports and Chapter news for publication in ACI's Concrete International magazine.
- Managing the Chapter's Web-site.

■ Social Committee

Chairperson: Eng. Dana Drobiova

- Organizing the Chapter's annual events and programmes for members.
- Organizing field trips to major construction projects and industries.
- Arranging participation of the Chapter in selected national events.

■ Annual Awards 2016-2017

ACI-Kuwait Chapter's Awards Banquet is a highly anticipated and grand annual event during which the Chapter recognizes outstanding projects and individuals. Three honours were bestowed this year, the regular Awards of Excellence, Achievement and a special award for an Infrastructure project. This year's Annual Awards Banquet was held at the J.W. Marriott Hotel on 16th May, 2017.

The event was organized under the patronage of His Excellency, Minister of Public Works, Eng. Abdul Rahman Al Muttawa. The function was well attended by a large number of guests, ACI-KC members and representatives of Kuwait's building and construction industries.

■ Award of Excellence

The Award of Excellence is presented annually to a local project of outstanding merit. The award itself, comprising a trophy, plaque and certificate, is given to the Owners or developers of the project; and Certificates of Excellence and plaques are also presented to the general contractor; the design and supervision consultant; and the main concrete supplier.

This year ACI-KC honoured the New Headquarters of the Central Bank of Kuwait as "a sophisticated architectural Icon, combining advanced engineering systems and aesthetic elegance". The award was presented to the developers of the building, "The Central Bank of Kuwait".



His Excellency, Eng. Abdul Rahman Al Muttawa





Aziz Mamuji, ACI-KC Director: Master of Ceremonies

■ Award of Achievement

The Award of Achievement is presented to an individual to recognize outstanding contribution to development and research to the engineering community and in the State of Kuwait.

The Award this year was given to Dr. Naji M. Al Mutairi for his lifetime contribution towards promoting engineering and advanced technology research, development and practices within the state of Kuwait.

■ Special Award for Infrastructure Project

This year, ACI-KC decided to present a special award. It was presented to a major urban highway improvement project.

The Jahra Road Project was recognized for utilizing innovative concrete based structural technology, and for adopting complex logistical and implementing solutions. The award was presented to the developers, Ministry of Public Works.



His Excellency Eng. Abdul Rahman Al Muttawa, ACI-KC Board of Directors and Award Recipients

■ Award of Excellence 2016-2017

ACI-Kuwait Chapter presents the Award of Excellence to a project in recognition of, amongst other aspects, outstanding design using concrete, innovative architectural and structural design landmarks, and high standards of construction.

The Award of Excellence recognizes significant and deserving projects that are, amongst other considerations, outstanding examples of concrete construction practices; architecturally and structurally innovative; iconic landmarks; executed to high standards of construction and creative use of concrete; and generally appreciated by the public as buildings of merit.

ACI-KC's Award of Excellence for 2016 was presented to the Central Bank of Kuwait for their new headquarters. The CBK Headquarters building was honoured as a sophisticated architectural icon that combines advanced engineering systems with aesthetic elegance.

■ Background and CBK Objectives

The Central Bank of Kuwait was established in 1968, when by virtue of Law no. 32, it replaced the original



■ Development Scope

■ Site Area	: 20,000 m ²
■ Building Area	: 140,000 m ²
■ Multi-storey Car Park	: 45,000 m ²
■ Floors	
- Podium	: 5 levels
- Tower	: 42 storeys
- Mechanical	: 4 floors
- Basement	: 4 levels

Kuwait Currency Board that had been set-up in 1960. The new bank commenced operations on 1st April, 1969, and since then, and as would be expected, its operations have considerably increased. This resulted in the need for this important government body to build their new headquarters. They were





obviously undertaking an important venture, and, when commissioning their new headquarters building, CBK's well-considered brief called for an iconic world class building that would also stand out as a new landmark within the city's skyline. More importantly it had to symbolise Kuwait's significant economic power and contribution to the Gulf Region and beyond.

■ Conceptual Inspiration

An international architectural competition led to the appointment of HOK International Ltd., and Kuwait's PACE as the design, engineering and construction supervision consultants. Their conception for the building drew inspiration from the geometry of pyramids, characteristics of traditional Kuwaiti architecture and historical sailing ships.

■ Construction and Technical Features

The 20,000 m² site for the new headquarters is prominently located along Arabian Gulf Street. The visual impact of the building's triangular truncated pyramid and its geometric articulation are enhanced by the fortress like solidity of its south facades, and the contrasting lightness of its northern elevation that overlooks the Arabian Gulf.



■ Features

- Parking : 1300 cars
- Height : 240 m
- Offices : 39 floors
- Banking Hall
- Auditorium : 320 seats
- Ballroom
- Library
- CBK Banking Museum
- Enhanced Security Systems





■ Awardees

- Award of Excellence:
Developer: Central Bank of Kuwait
- General Contractor:
 - China State Construction Engineering Corporation
 - Mohamed Abdul Mohsen Al-Kharafi and Sons Company
- Design and Supervision Consultant:
 - HOK International Consultants
 - PACE, Kuwait
- Main Concrete Supplier:
 - Kuwait British Ready-mix

As the Designers say, while the building embraces innovation, it is wrapped in a permanent protective wall. The building comprises a large podium and 42-storey tower, a large multi-story car-park, an impressive banking hall, as well as extensive hard and soft landscaping, with a sizeable reflective pool.

There are various entrances and exits, and the premises accommodates 1300 cars. The tower, which is characterized by the building's distinct appearance, is accentuated on its north face by the 320 seat Auditorium that cantilevers 26 m out from it.

A combination vertical structural support system, comprised of concrete and steel members, helps achieve column free interior spaces for offices, meeting rooms and open-plan work stations.

The external glazed façade rests on the inner side of an inclined dia-grid steel tube system in which high strength K800 concrete mix was poured to achieve the required composite section capacity. The tower comprises one vertical main core, and two sloped cores.





Central Bank of Kuwait Representative,
Mr. Anwar Badr Al-Gaith, Executive Manager, Organisation and Administration
Department, receiving the Award of Excellence Trophy

■ Special Award for Infrastructure Project 2016

At its Awards Banquet held on 16th May, 2017, ACI-Kuwait Chapter presented one further award. This was a special award for an infrastructure project, and it was presented to a major urban highway improvement project.

■ Special Award

The special award was presented to the Ministry of Public Works for its Jahra Road Project, which was recognized as a major urban highway improvement scheme that utilized innovative concrete based structural technology, and involved complex logistical and implementation solutions.

■ Project Aims

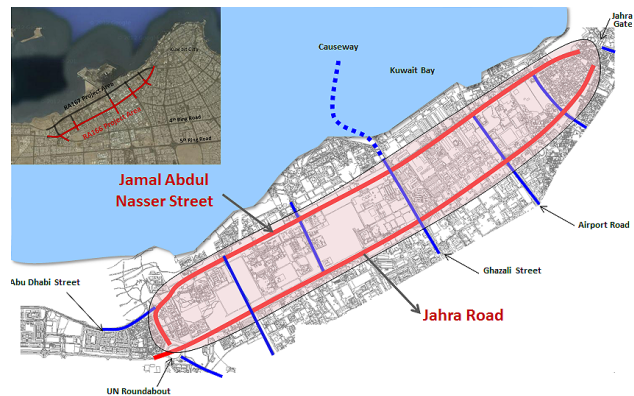
Drivers in Kuwait are familiar with the frustrations of negotiating congested roads, and amongst the many contenders for roadways with the worst traffic problems, were Jahra Road (Road 80) and Jamal Abdul Nasser Street (Road 85).

The Ministry identified these as high priorities and this led to an ambitious plan, worth almost KD 520 million, to undertake major upgrading and redevelopment of these two critical roadways.

The Jahra Road Project, for which this special award is being presented, extends from Jahra Gate (Sheraton Roundabout) to just after the United Nations Roundabout located at the western end of 4th Ring Road.

The development objectives were obvious in that MPW wanted to improve traffic flow and management by separating local and through traffic, introducing free interchanges, improve capacity, reduce congestion, introduce more safety for drivers, and generally raise levels of service for road users.

This became the design brief for the international and local design and supervision consultants appointed by MPW – namely Louis Berger Group Inc. and PACE of Kuwait.



■ Construction and Technical Features

Given the context within which Jahra Road is being upgraded and its route, various design solutions and components were introduced these included:

- Separation of through and local traffic
- Elevated Motorways
- Enhanced roundabouts
- Depressed roads
- Ramped connections on Elevated Motorways
- Use of precast segments for Elevated Motorways

A major component of these works is the segmental bridge, with the project comprising about 8400 precast

■ Project Scope

- Over 100 km of combined utility works
- 18 km of segmented viaducts
- 0.62 km of depressed roads
- 2 roundabout bridges
- 10 pedestrian bridges
- 5 km at grade roadworks
- 15 km of service roads
- 5 interchanges
- 7 roundabouts
- Utility works
- Box culverts : 3.5 km
- Water lines : 33 km
- Sanitary servers : 8.0 km
- Electric cables : 51.0 km
- Communication ducts : 12.0 km

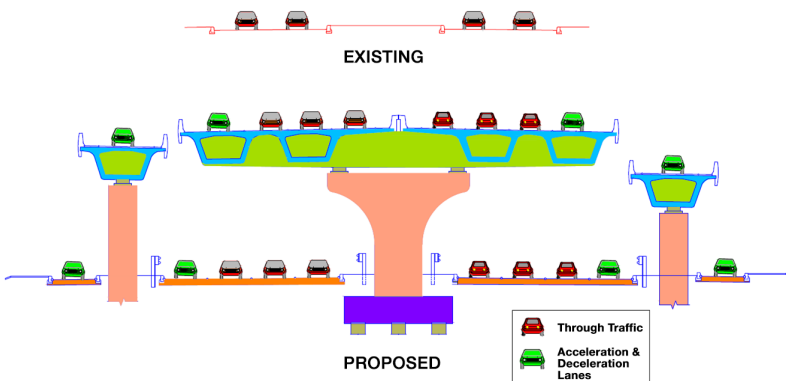


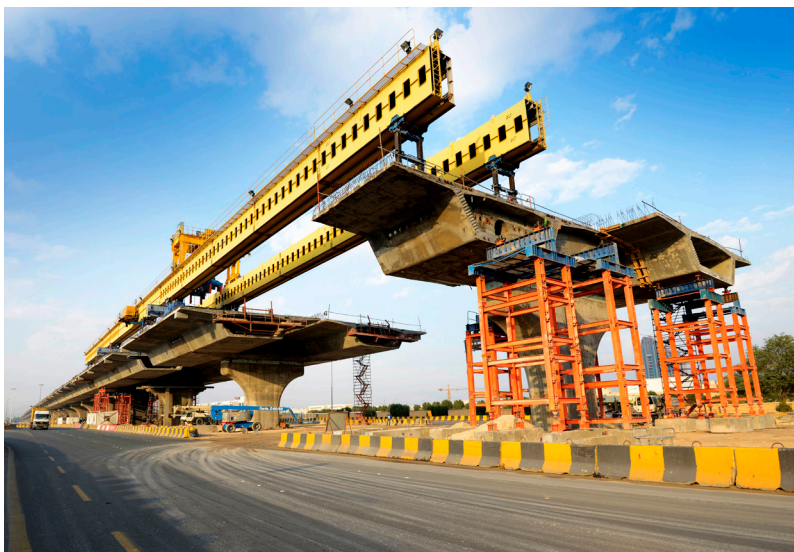
segments and about 4600 piers. The viaduct and bridges are built in short but huge sections called segments, which in turn come with complex logistical issues. Launchers or cranes hoist these segments on to cast-in-situ columns or piers; and post-tensioning is thereafter typically used to connect the individual elements and form a composite structure. Segments are sequentially erected on either side of the pier in cantilever and are held together with a combination of temporary and permanent post-tensioning.



■ Awardees

- Special Award for Infrastructure Project
 - Project: The Jahra Road Project
- Developer
 - Ministry of Public Works
- General Contractor
 - The Arab Contractors, Egypt
 - Kuwait Arab Contractors
- Design and Supervision Consultants
 - Louis Berger Group, Inc.
 - PACE, Kuwait
- Main Concrete Supplier
 - National Industries Company





His Excellency the Minister of Public Works, Eng. Abdul Rahman Al Mutawaa, receiving the Special Award for Infrastructure Project

■ Award of Achievement 2016-2017

The 2016 Award of Achievement was presented to Dr. Naji Al Mutairi for his lifetime contribution towards promoting engineering and advance technology research, development and practices within the State of Kuwait.

Academic Background



Dr. Naji Al Mutairi

He was born in Kuwait in 1959, and after finishing high school here, he started his university education with a pre-year at the University of Pittsburgh in USA. He then joined Brevard Community College in Florida, and moved on to the University of Miami.

There, in only 3 years, he topped his graduating class acquiring dual B.Sc. degrees, in Architectural Engineering and Civil Engineering. His Masters degree was obtained at the highly rated Pennsylvania State University, followed by, again the second time of only 2 years, with a doctorate in 1989 from University of Maryland. His Ph.D. focused on experimental work in bridge construction and new systems in welded-mesh technology.

■ KISR and 'Free Kuwait'

He then joined Department of Civil Engineering, at Kuwait Institute for Scientific Research, and while there he was selected for a management course at the famed Batelle Memorial Institute in Ohio. He travelled there with his family in July 1990, and they

were in USA when Kuwait was invaded. What followed was understandably a stressful time. But as a true patriot, he committed himself to the 'Free Kuwait' movement, ultimately joining the American Army and receiving training with the 22nd Platoon in Saudi Arabia.

Following the liberation of Kuwait, and his triumphant return, he rejoined KISR where he was involved



in conducting research on building materials and construction systems.

An early highlight of his time at KISR was the first post-liberation international conference which focused on sick-buildings, essentially examining the effects of the invasion, war and fires on buildings and oil containers.



■ KFAS

Following service at KISR as Director of the Engineering Division, and later of Environment and Urban Development, he joined Kuwait Foundation for Advancement of Sciences where he remained for seven years. At KFAS he was instrumental in the implementation of Dasman Diabetic Centre, and in reshaping and automising KISR's operational strategy and internal work systems.

It was while he was at KFAS that he also became the Founding Member of ACI-Kuwait Chapter.



■ Director General of KISR

In 2007, he was appointed Director General of KISR, and his major achievement here was to strategise a comprehensive change in the Institute's operations and objectives, by formulating a 20 year plan focusing on more research, international collaboration and increased training.

A particular highlight at KISR that he proudly talks about is his personal plea to His Highness the Amir, on a flight to Japan, to support Fukushima's renowned Aquarium that was damaged during the 2011 earthquake there. His Highness donated \$ 3.0 m for this project. He currently is the Principal Research Scientist at KISR.

Away from work he continues devoting time to voluntary work, professional organisation; youth development, environmental issues, and promoting education and training. He enjoys a range of sports, including camel riding.



The Award of Achievement being received by Mr. Abdullah Al Mutairi on behalf of his father Dr. Naji Al Mutairi

■ ACI-KC Technical Activities

■ Technical Seminar

A technical seminar entitled “Forensic Investigation and Remedial Measures for Groundwater Leakage in Basement of a Large Building Complex” was conducted by Dr. Muhammad Tariq Chaudhary of Kuwait University. The seminar was held at the Offices of Gulf Consult on 22nd March, 2017.

Dr. Chaudhary presented the forensic investigations that were undertaken to assess the structural integrity and functional viability of the basement of a 40,000 m² building complex that, after occupancy, was affected by a 3.0 m rise in groundwater level.

Visual observations, in situ testing of structural components, analytical studies using commercially available finite element analysis programs and sound engineering judgement were utilized to carry out the assessment and appraisal of structural integrity and condition.

Functional viability assessment of the impact of groundwater leakage was done based on BS 8102 guidelines. It was concluded that the basement structure had to be strengthened, in up to 25% of its plan area, to withstand the applied hydrostatic pressure.

Various options for retrofitting the deficient structural components and articulation details were examined; and technical details were developed for a cost-effective solution.

■ ACI International Certification

Due to the increase in the number of international construction projects in Kuwait, many companies showed interest in procuring ACI International Certification.

ACI-KC, in collaboration with Advanced Construction Technology Services (ACTS) organised two certification programmes, which were respectively



held on 3rd-4th October, 2017 and on 16th-17th October, 2017.

Each programme comprised of a day of training and one for testing. ACI-KC members were granted a 10% discount on the cost of the training. Eight Engineers were awarded ACI Concrete Field Testing Grade I Certificates.

■ Consultants' Projects

ACI-KC's current President, Aziz Mamuji, has initiated a seminar-cum-presentation programme, whereby local Consulting Offices are invited to present any one of their significant or landmark projects.

The presentations, either of projects under design or in the construction phase, are preferably to be made at the premises of respective Consulting Offices. The first presentation under this initiative was made by Gulf Consult on 20th November, 2017.

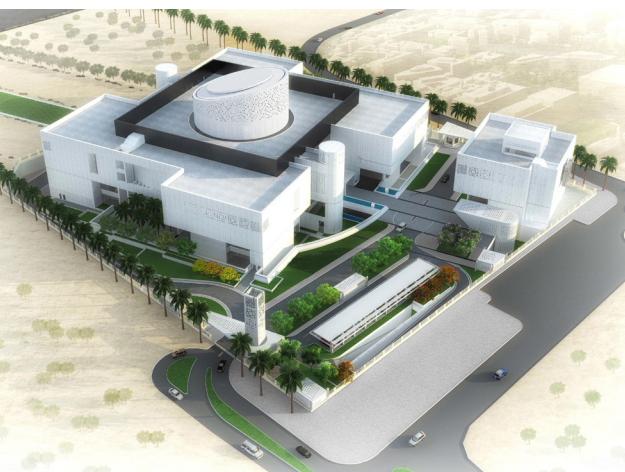
Aziz Mamuji outlined the background to the Seera Complex project, and traced its development from inception to completion of the design process.

The Seera Complex, a project initiated by Kuwait Awqaf Public Foundation (KAPF), is a museum and



research facility focusing on the life and times of the Prophet of Islam. The project involved extensive consultation with a committee of Islamic Scholars appointed by KAPF; as well as the creation of a wide range of exhibits to graphically.

In many cases, the key aspects of the Prophet's Life and his personal attributes are presented in an interactive fashion.



The Seera Project



■ Technical Article

This article has been reproduced from Concrete International, published by ACI International (Issue no. V.38 No.3 dated March 2016).

A case study on the architectural concrete columns for the Rio de Janeiro Museu da Imagem e do Som

The State Secretary of Culture for the city of Rio de Janeiro, Brazil, along with the Roberto Marinho Foundation (FRM), recently promoted an important international competition for the design of the new headquarters of the city's Museu da Imagem e do Som (Museum of Image and Sound [MIS-RJ]).

The ultimate goal was to make the MIS headquarters a globally renowned architectural icon for Rio de Janeiro.

The U.S.-based architectural firm Diller Scofidio + Renfro won the contest and the design was developed in Brazil by the renowned firm Índio da Costa Arquitetura, Urbanismo, Design e Transporte (Índio da Costa A.U.D.T.).

In this bold design, the design architects proposed the museum as a vertical boulevard, with seven stories, a continuous external promenade, and a display of sequential ramps and floors.

The new MIS-RJ headquarters, shown in Fig. 1, is being built by the construction company Rio Verde. Also, the construction works are being managed by Engineering S.A., a subsidiary of Hill International.

With architectural concrete finishes specified for its unique forms and oblique lines, this building's superstructure presented some special challenges - especially for the construction of inclined columns with high-performance concrete (the subject of this article).

In some cases, the columns had 6 m (20 ft) heights per segment. Further, the columns' unusual geometries required the use of metal formwork.

In addition to meeting aesthetic demands and compressive strength requirements (specified as a characteristic compressive strength f_{ck} of 50 MPa [7250 psi] at 28 days), the concrete placements were influenced by other factors, such as weather and logistics. The local climate is very hot, requiring



Fig. 1: The future MIS-RJ headquarters: (a) an architectural rendering; and (b) a work in progress, in December 2015

concreting operations during temperatures of about 35°C (95°F), and the concrete supplier's plant is 30 km (19 miles) away from the work site. Trucks had to pass through heavy traffic during business hours, so transit times of at least 1 hour were required.

The concrete type used, as well as some of the construction practices applied for casting the inclined columns, will be addressed in the following sections. For the most part, the procedures complied with requirements of Brazilian national standards - ABNT NBR 6118:2007,1 ABNT NBR 12655:2006,2 ABNT

NBR 14931:2004,3 and ABNT NBR 15823:20104; and recommendations in recognized technical literature—Neville and Brooks,⁵ Kosmatka and Wilson,⁶ and References 7 and 8.

■ Architectural Concrete Structural Elements

It is noteworthy that concrete, as a building material, is not the only factor affecting any project's aesthetic requirements.

The technical specifications must also include strict requirements for formwork, release agents, shoring systems, spacers, reinforcement, and construction practices to minimize effects of bugholes and cracking in the finished concrete surface.

A good architectural concrete surface finish (texture and homogeneity) is also related to the mixture design and the specific placing and consolidation procedures used on the project.

Furthermore, curing and form stripping time may also affect the finish significantly, with the latter related to stains and prominent color changes in the

elements. (9-11) Independent of the technical and practical construction knowledge required to produce architectural concrete, experience has demonstrated that site simulations and mockup studies are valuable and necessary tools in these types of projects.

Full-scale mockups, for example, correlate well with real conditions and allow teams to assess the combination of factors related to building materials used for casting of elements (concrete, release agents, and forms), as well as to the adopted procedures (placing, consolidation, curing, shoring, and timing of form stripping).

It should be also noted that the probability of completely avoiding superficial bugholes on a structural concrete element is null, considering that air is intrinsic to the material itself in the fresh state and is also introduced by the placement and consolidation processes.

The main objective is to design a material and a casting method that can minimize superficial bugholes. (12-14)

In this aspect, CIB Report No. 2415 presents an interesting classification system for bugholes in concrete surfaces.

Class 1 represents a low occurrence level—in other words, a significantly reduced frequency and quantity of superficial bugholes, acceptable for architectural concrete projects with strict aesthetic requirements.

This article addresses the procedures that were required to meet Class 1 requirements for inclined columns of the MIS-RJ, cast using high-strength self-consolidating concrete (SCC).

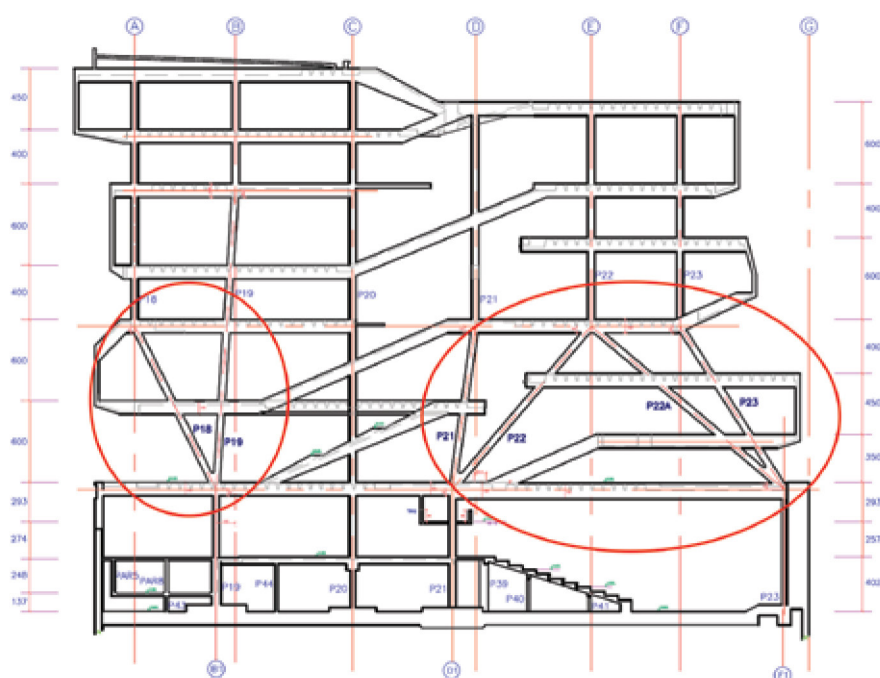


Fig. 2: Longitudinal section of the MIS-RJ structure showing inclined columns (circled in red)

■ Project Data, Materials, and Procedures

Basic design data

The MIS-RJ columns have inclinations varying between 40 and 90 degrees to the horizontal (these are circled in Fig. 2).

The structural design was developed by Escritório Técnico Julio Kassoy e Mario Franco Eng. Civis Ltda (JKMF). Stresses were calculated considering the actions of self-weight, other dead loads, wind, pretensioning, and post-tensioning.

The maximum axial load in the columns will be about 800 tonnes (1760 kip).

The longitudinal bars for the columns were arranged in layers, allowing the passing and positioning of post-tensioning tendons and bars from beams framing into the joints.

Because of the high percentage of steel in the columns, mechanical splices (nonaligned) were specified to minimize the effects of congestion on concrete placement and consolidation.

Mixture proportions and constituents

The mixture design process started in October 2011, approximately 20 months before the first concreting of the building's inclined columns, which occurred in June 2013.

Many mockups in different scales were tested during the design, and decisive factors affecting the concrete were evaluated. Simulations included having truck mixers affected by weather and logistics (route) as well as using various placement types, mixing energies, and pump types.

Full-scale mockup studies were also important for assessing the effects of column inclination and geometry, reinforcing percentage and positioning,

and lift height. The full-scale placements allowed the evaluation of fresh concrete conditions during placement, including its filling ability, as well as its compressive strength after hardening.

The concrete mixture proportions and sources of the materials are shown in Table 1. It must be observed that no mixing water was used other than the moisture in the sand (this amount was deducted from the total ice proportion).

The total free mixing water was replaced by ice cubes under an initial specified temperature of -10°C (14°F).

The technical specification for concrete acceptance was a temperature of about 20°C (68°F) to minimize thermal cracking. On very hot days, however, the concrete temperature was about 25°C (77°F) in practice. Based on extensive historical data, the sand moisture content was assigned as 5% of the total sand mass. Polypropylene fibers (12 mm [0.5 in.] length) were specified to minimize shrinkage cracking.

Inorganic iron oxide-based pigment (Bayferrox® 318) was specified to maintain aesthetic homogeneity.

Table 1: Mixture proportions for inclined columns of MIS-RJ (dry materials for 1 m³ of concrete by weight)*

Materials	Mass, kg/m ³
Cement CP III-40 RS (sulfate resistant—ABNT NBR 5735:1991 ¹⁶⁾)	472
Silica fume (ABNT NBR 12653:2014 ¹⁷⁾)	30
Water (from sand moisture only, mean value fixed at 5%—ABNT NBR 15900:2009 ¹⁸⁾)	42
Water in the form of ice cubes ²	144
Medium sand, natural (ABNT NBR 7211:2009 ¹⁹⁾)	700
Artificial sand, crushed sand Type II ¹⁹⁾	123
Crushed stone 0 ¹⁹⁾ (maximum aggregate size = 9.5 mm)	426
Crushed stone 1 ¹⁹⁾ (maximum aggregate size = 19 mm)	426
Polypropylene fibers (12 mm)	0.6
Pigment (Bayferrox [®] 318), simulated for 1%	4.7
Water-reducing admixture (Muraplast FK 110, MC Bauchemie—ABNT NBR 11768:2011 ²⁰⁾)	1.4
High-range water-reducing admixture ²⁰⁾ (Glenium [®] SCC 160 with incorporated antifoaming agent or Glenium [®] SCC 161, BASF)	4.7

* Designed for a characteristic compressive strength f_{ck} of 50 MPa (7250 psi) at 28 days and slump flow of 660 to 750 mm (26 to 29.5 in.), the mixture's water-cementitious materials ratio (w/cm) was 0.37

Notes: 1 kg/m³ = 1.7 lb/yd³; 1 mm = 0.04 in.

(Brazilian standards allow Type CP III cement to comprise 35 to 70% slag amount, which can result in variations in the tone of the concrete).

(texture and homogeneity) and the aesthetics of the structural elements. The most important requirements were related to concrete placement and consolidation.



Fig. 3: Various simulations and mockups used to establish materials and methods incorporated in the building construction: (a) cubic specimens in the laboratory of the concrete supplier, October 2011; (b) vertical wall cast at the jobsite, February 2012; (c) inclined wall (45 degrees) cast at the jobsite, February 2012; and (d) full-scale mockup cast in the courtyard of the concrete supplier's plant, July 2012

Construction Requirements

Construction was performed per Brazilian Norm ABNT NBR 14931.

In addition to the basic principles covered in this standard, detailed techniques and improvements were specified to ensure the quality of the concrete finishes



Fig. 4: Casting the inclined column mockup helped in the evaluation of various factors: (a) metal forms and inclined reinforcement projected from a previously cast base joint; (b) a drop tube was used to deliver concrete from the concrete bucket to the base of the column form; and (c) a bottomless pail acted as a funnel and reservoir for concrete, allowing a vibrator to be inserted into the drop tube without overflow

Mockups

After the development of the concrete mixtures, focus shifted to designing mockups for the evaluation of several technical and aesthetic actors.

Initially, during mixture design, small cubes were cast to evaluate the type of release agent and the formwork panels on concrete coloration.

Different pigment contents were tested (at dosages of 0, 1, and 1.5% by weight of the cement) to maintain the natural tonality of the concrete. Then, a vertical wall was cast at the jobsite in January 2012.

The filling ability of the SCC was evaluated to determine the minimum number of pump discharge points required for adequate placement (that is, limiting the occurrence of bugholes).

Further, inclined walls were cast for evaluation of the same parameters.

The boldest event was the construction of three large-scale mockups in the courtyard of the concrete supplier. These mockups were designed to allow clear



Fig. 5: Mockup finishes: (a) sides; (b) sides and lower region at joint; (c) detail at base and joint; and (d) overview of upper inclined region

assessment of different formwork systems and SCC finishes in walls cast at various inclinations (in addition to the other factors already mentioned).

Those walls were also used to verify some procedures for application of concrete coating systems. The different types of concrete specimens and mockups can be seen in Fig. 3. The wall mockup was very

important for evaluation of several factors; however, it did not simulate an inclined column.

To test procedures for the columns, a full-scale mockup of two inclined columns that intersected at the base was also cast at the concrete supplier's plant.

One of the columns was inclined at 40 degrees to the horizontal and represented the worst case for the project (Fig. 4(a)).

Before the mockup placement, additional rules were made with respect to the SCC and placement procedures to cast these

architectural concrete elements with minimal bugholes and cracking.

First, a special biodegradable release agent based on aliphatic hydrocarbons (DESFORM 70 supplied by Grace/ Rheoset) was used to prevent superficial bugholes.

To help avoid segregation, the maximum drop height was set at 2 m (6.5 ft). Also, a drop chute (tube) was used to help ensure that mortar reached the base of the element without losses due to impact with reinforcement or forms.

To help ensure consistent flow, a "bottomless" metal pail was adapted as a funnel and reservoir at the top of the delivery tube (Fig. 4(b)).

The concrete was placed using a bottom-up approach, helping to prevent the introduction of air into the concrete and thus minimizing bugholes.



Fig. 6: Actual inclined columns in the building exhibit the high-quality finishes required of the exposed structural and architectural elements

To further minimize bugholes, concrete placement progressed at a slow speed, in small portions, and using 10 L (2.6 gal.) buckets (Fig. 4(c)).

The delivery tube was inserted in the column form so that its discharge end was about 400 mm (16 in.) from the bottom of the form. A 35 mm (1.4 in.) diameter vibrator was inserted in this tube until its head contacted the base of the form.

When concrete covered the entire length of the vibrator head, the concrete was vibrated briefly to ensure its full contact with reinforcing bars and with previously placed concrete. Although the SCC mixture had sufficient cohesion to withstand slight vibration without segregation, the vibrator was used in cycles of only 5 to 10 seconds.

This procedure was repeated in successive turns until concrete reached the middle of the column element.

Then, the tube was removed and the remaining height was placed (still using buckets) in lifts of 300 to 400 mm (12 to 16 in.), using the length of the vibrator head as a reference.

Each lift was vibrated slightly. It is important to note that concrete placement was stopped whenever the vibrator was being used. Placement resumed only after vibration was completed. Simultaneously, workers tapped softly on the outside of the steel forms using rubber mallets. This effort helped to minimize pockets of air in the concrete in contact with the forms.

Finally, the fresh concrete was allowed to overflow the top level of the form, eliminating bleed water and fines, and allowing the concrete to adequately reach the upper form level. The completed inclined column mockup is shown in Fig. 5. As shown in Fig. 5, the finishes are very good.

Bugholes are minimal, indicating that the completed surfaces would satisfy Class 1 requirements per CIB Report No. 24.

Also, none of the mockups exhibited any type of cracking. The procedures were therefore deemed suitable for actual placements.

■ Integrity and Aesthetics

Figure 6 shows some of the inclined columns in the building. The finishes are of similar quality to the finishes obtained in the mockups. Developing and evaluating an appropriate concrete mixture design, creating many mockups, and adjusting the procedures provided in ABNT NBR 14931 were decisive actions that allowed the execution of inclined architectural concrete columns of the MIS-RJ project. The final results are sound structural elements with high aesthetic form.

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■ ACI-KC Students' Chapter

The ACI-KC Students' Chapter continues to be active. Operating within the Civil Engineering Department of Kuwait University, the Chapter has over the past few years organised many technical activities, concrete and engineering related seminars, and a variety of social events aimed at promoting better engineering practices and general awareness.

■ Board Members

The activities of the Chapter are currently managed and organized by an enthusiastic Board of Directors, which for the year 2017-2018 comprises:

President	: Abdullah Al-Mutairi
Vice Presidents	: Bashayer Al-Musallem Khaled Al-Hendi
Treasurer	: Fahad Al-Khudari
Secretary	: Abdulrahman Al-Saty

The activities of ACI-KC Students Chapter are supervised by Dr. Moetaz El-Hawary, Past ACI-KC President and Chairperson of its Technical Committee.

■ Activities

The activities carried out by the enthusiastic students included:

- A workshop and training on the use of Autocad was presented by Eng. Anwar Alsuraij on 31/10/2017.
- A workshop and training on the reading of Engineering Drawings was presented by Eng. Anwar Alsuraij. The workshop was held in March 2017 and repeated on October 2017.
- ACI-KC Students Chapter took part in the National Celebrations.
- Breast cancer awareness program and activities were arranged during the International Breast Cancer week.
- A tutorial on Capstone projects and requirements was presented by Eng. Anwar Alsuraij on February 2017.
- A seminar on Recycled Concrete in Kuwait: opportunities and Challenges was presented by Dr. Khaldoun Rahal was held on 13th April, 2017.
- A large group of students visited Sheikh Jaber Al-Ahmad Al-Sabah Causeway Project was held during November, 2017.



Field Visit to Sheikh Jaber Al-Ahmad Al-Sabah Causeway

■ Social Activities

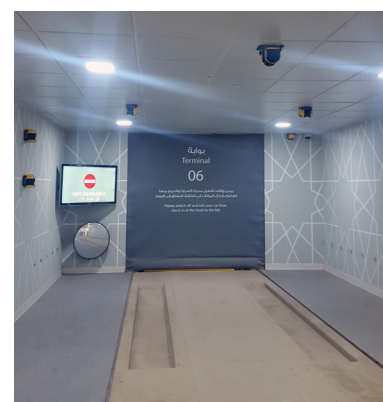
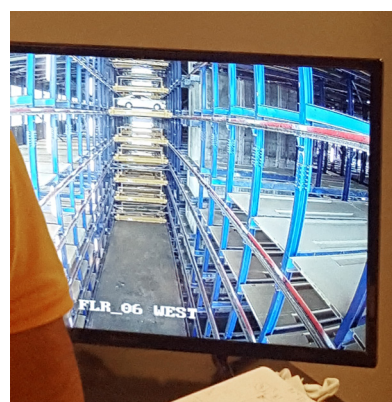
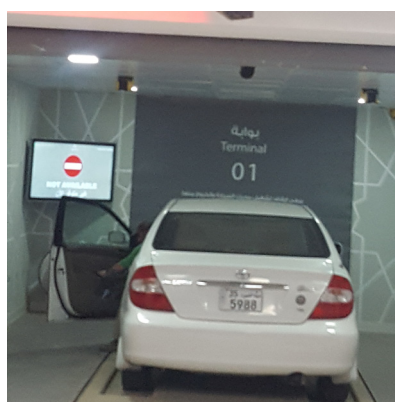
■ Site Visit

ACI-KC's Social Committee, which is chaired by Ms. Dana Drobiova, organized a visit to the new Automated Car Park that has been built for Jahra Court Complex. The field visit took place on Saturday, 22nd April, 2017 and was attended by a large number of Chapter members.

The company that provided and installed the automated systems, ACICO gave a brief presentation on how the car park works, and this was followed by a demonstration. Members saw the automated system in operation, from the point where vehicles were registered at the point of entry, to how the cars were then mechanically stacked, and then ultimately retrieved.

Members also visited the control room from which the entire automated process is monitored. The fully-automated multi-storey car park is the first of its kind in the GCC region. The facility, which can accommodate over 2900 cars comprises three basements, ground floor, 4 parking floors for ordinary cars, and 14 further separate levels of parking spaces equipped with special security provisions.

About 93 spaces are allocated for judges, prosecutors and high-level officials. The visit was indeed informative, and the ACI-KC Social Committee wishes to thank Mr. Shahed Hussain who coordinated the arrangements for the visit, and ACICO for the technical details and explanations.



Sponsors

ACI-KC appreciates the support of various Consultants and Companies in Kuwait.



