LARGE INFRASTRUCTURE PROJECT CONFERENCE 2018

BUILD FOR LIFE
Tom Wenzel is the Regional Business Development Manager of Freyssinet's Asia Structure Repairs business. With close to 30 years’ experience in structure remediation, strengthening, life extension, protection, maintenance and durability planning, he is one of Freyssinet’s global experts in the field of infrastructure repairs. Mr Wenzel has a Bachelor Degree in Civil Engineering from Monash University, Melbourne, Australia and is a Chartered Professional Engineer and Member of the Civil and Leadership & Management Colleges of Engineers Australia. First joining the Freyssinet Group in 1999 as General Manager, Southern Australia, he has held a range of other positions within Freyssinet Australia including Design Manager for the AUD $120M MLC Tower Facade Maintenance D&C Contract, Acting Manager of Freyssinet New Zealand, National Technical & Business Manager – Remedial, National Remedial Services Team Leader and member of the Freyssinet Australia and New Zealand Leadership Team. He has been based in Freyssinet’s Regional Asia office located in Singapore since 2017 and is responsible for strategic growth of repair activities in the Freyssinet’s Asia region businesses.
Sustainable road & bridge construction and trends for future megacities

TOM WENZEL
Regional Business Development Manager ASIA
Freyssinet International
Sustainable Road & Bridge Construction and Trends for Future Megacities
Soletanche Freyssinet 3 business segments

Specialist Contractors

VINCI

SOILS

NUCLEAR

STRUCTURES

SOLETANCHE BACHY

menard

FREYSSINET

TERRE ARMEES

VINCI CONSTRUCTION
Soletanche Freyssinet Group

- 2016 Revenue: 3.2 B€
- Employees: over 22,000

- **Soletanche Bachy**: Deep Foundations, Underground Works, Tunneling
- **Menard**: Soil Improvement
- **Terre Armee**: Reinforced Walls, Precast Arches
- **Freyssinet**: New Structure Repair & Maintenance, Nuclear maintenance Technologies and Innovations
- **NUVIA**: Monitoring, Asset management tools
- **Sixense**:
Freyssinet’s history in brief

Eugene Freyssinet (1879 – 1962) Civil Engineer

1903 – Invented Prestressing
1928 – Patented PT system
1943 – Established STUP company
1957 – Introduced Hydraulic Jacking
1976 – STUP changed into FREYSSINET
Freyssinet Group

- 2016 Revenue: 751 M€
- Locations: 70 countries
- Employees: over 7500
- 1,700 Engineers
2 Business Lines - Unique Integrated Approach

**Construction**
- Post tensioning
- Construction methods
- Cable structures
- Structural accessories

**Repair**
- Protect
- Repair
- Strengthen
- Maintain

3rd Bosphorus Bridge (Turkey)

Hammersmith bridge repair (UK)
Segmental construction
More than 100km over the last 10 years
Freyssinet’s expertise in bridge/road new build

Bridge structural accessories /equipment
Freyssinet’s expertise in bridge/road new build

Isosism devices

- **3 types of isolators**
  - Main function: isolation
  - Damping from 10 to 35%

- **2 types of dampers**
  - Main function: damping at high velocity
  - Free to move or fixed point in service

- **1 type of connector**
  - Main function: transmitting dynamic loads (like a seat belt)
Freyssinet’s expertise in bridge/road new build

Bridge technology:
Cable design, supply and install:
- Stay cables bridge
- Extradossed bridges
- Suspended bridges

Post-tensioning, bearing and joints, formtraveller, heavy lifting

Largest cable stayed bridge in the world with 1 408 m Span.
Stay cable supply and installation / Segment lifting
> 300 other references worldwide
Freyssinet’s expertise in bridge/road new build

Future developments:

- Increasing bridge span length
- Development of cable technology and cable design

Volume versus span for various bridge forms, including:
(a) suspension bridge;
(b) cable-stayed bridge;
(c) suspension bridge with optimal pylon height;
(d) cable-stayed bridge with fan cable arrangement and optimal pylon height;
(e) cable-stayed bridge with optimal pylon height;
(f) optimised double split-pylon design;
(g) optimised triple split-pylon design;
(h) reference bridge design.
(Source: Theoretically optimal forms for very long-span bridges under gravity loading)
2 Business Lines - Unique Integrated Approach

**Construction**
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- Cable structures
- Structural accessories

**Repair**
- Protect
- Repair
- Strengthen
- Maintain

INTEGRATED SPECIALIST CONTRACTOR
- DESIGN
- SUPPLY
- INSTALL / EXECUTE

3rd Bosphorus Bridge (Turkey)

Hammersmith bridge repair (UK)
Structure Repair – Life Extension & Re-purposing
**Bridges**

**Ageing Structures Maintenance**

**Increase of Capacity, & Widening**

**Corrosion, Aggressive Environment**

**Seismic Retrofitting**

**Design and Construction Defects**

**Change of Use, Regulation**

**Foundations Deficiency**

**Accidental Damages**

- Ayala bridge, Philippines
- Maameltein bridge, Lebanon
- Hammersmith, London
- Penang bridge, Malaysia
- Bridges widening Vietnam
- Recouvrance, France

Bearings replacement
Buildings & Facilities

- Ageing Structures
- Maintenance
- Materials Pathologies
- Change of Use, Loads, & Regulations
- Seismic Retrofitting
- Excess of Deflections
- Design and Construction Defects
- Fatigue
- Ground Slides
- Water Infiltrations

MLC Tower
Sydney

Historical buildings
Europe

Katong Mall,
Singapour

MAMO
Algeria

CMC
Amman
Jordan

Halle
Freyssinet
Paris
Industrial Structures and Plants

**Ageing Structures Maintenance**

**Restauration of Capacity**

**Materials Pathologies, Aggressive Environment**

**Seismic Retrofitting**

**Design and Construction Defects**

**Process / Fatigue (Filling – Emptying / Temperature)**

**Change of Use, Regulation**

**Ground Slides**

*Quevilly refinery Tank, France*

*Power station Chimeys, Aus.*

*Iligan Preheater, Philippines*

*Socma Silo, France*

*N’kossa barge, Congo*

*Geraldton Grain silos, Australia during and after*

*Tarong Cooling Towers, Australia*
Dams & Hydraulic structures

- Ageing structures maintenance
- Materials pathologies (AAR, Masonry...)
- Watertightness (cracks, infiltration)
- Waterproofing membrane and coatings
- Environment (corrosion, temperature)
- Foundation improvement, ground anchors
- Change of regulation

Pannecière Dam, France

Wolfcreek Dam, USA

Reservoirs and canals France
Port, Jetties, and Marine Structures

**Ageing Structures**

- Maintenance, Life span extension

**Increase of Capacity, Crane Loadings**

- Corrosion, Aggressive environment

**Design and Construction Defects**

- Change of use, Regulation

**Accidental Damages**

- Port of Tolu, Colombia
- East webb dock, Melbourne
- Kurnell Wharf, Australia
- South Hook Jetty, UK
- Puente de la unidad, Mexico
Tunnels & Galleries

- Ageing Structures
- Maintenance
- Aggressive Environment
- Structural Failures
- Design and Construction Defects
- Change of Use, Regulation, Electrification
- Foundations Deficiency
- Accidental Damages
- Fires...
- Water Infiltrations

Glasgow Tunnel, UK

Enlargement for tunnel electrification

Safety Upgrade France

Hai Van Tunnels, Vietnam

Channel Tunnel, UK-France

Grigny water collector France
Root causes of bridge structure deterioration

1. Human error
2. Extreme events
3. Accidental events

Italy 2016
4. Reinforcing rebar corrosion

5. PT tendons corrosion

6. Concrete pathologies and deterioration

7. Foundations issues
Root causes of bridge structure deterioration

7. Structural modifications
8. Change of use
9. Increase in loads
10. Bearing replacement
11. Expansion joints replacement
12. Cable maintenance or replacement
Repair solution development process

1. Initial Visual Inspection
2. Analysis of existing information (as-buils, reports)
3. Investigation and Diagnosis
4. Definition of investigation strategy
5. Repair solutions and strategy
6. Conceptual Design
From the results of the structural assessment report

- Determine the actual capacity-curve of the structure
From the new Client objectives

- Set the new Performance Criteria
Repair solution development process

From the various possible repair strategies

- Select the “right repair Solution”
Repair solution development process

1. Initial Visual Inspection
2. Analysis of existing information (as-builds, reports)
3. Investigation and Diagnosis
4. Definition of investigation strategy
5. Repair solutions and strategy
   - Conceptual Design
6. Estimate Quantities and budget
7. Detail Design
8. Repair Works
Bridge structure condition assessment

**INTEGRATED SPECIALIST**
- **DESIGN**
- **CONSTRUCTION METHODS**
- **MANUFACTURING**
- **SITE WORKS**

**IN-SITU TESTING SERVICES**
- Pachometer
- Radar
- MIRA - Tomography 3D
- S’MASH - Acoustic admittance
- Impact Echo
- Infrared thermography
- Snostress®
- Loading test

**ADVANCED MODELLING**
- Seismic and hurricane assessment of existing buildings
- Blast resistance evaluation
- Impact resistance evaluation
- Fire resistance of structures

Provides support to infrastructure owners, designers, builders, and operators to understand, analyse, anticipate and optimize investments and maintenance.

**EVALUATION OF MATERIALS**
- **IN-SITU TESTING SERVICES**
  - Measurement of corrosion
  - Characterisation of concrete and masonry
  - Inspections on steel and steel assemblies

- **LABORATORY ANALYSIS AND TESTING**
  - Concrete
    - Mechanical tests
    - Physical measurements
    - Chemical analysis
    - Microscopic observations
    - Ageing tests
  - Metallic materials
  - Prestressing tendons
  - Masonry
  - Polymer coatings
Repair solution design – Concept to execution

FIC Corporate Technical Department with 50+ staff
Local Technical Department in each Subsidiary
- Conceptual Design
- Assistance for Execution/Detail Design
FPC ensures fabrication, quality control and certification of the proprietary Freyssinet products.

**Freyssinet undertakes more than 3000 Repair Projects each year**
Repair techniques

- Hydrodemolition
- Shotcreting, Concrete reprofilling, injections
- Carbon Fiber Strengthening
- External Post-tensionning
Repair techniques

- UHPC developments
- Underpinning
- Ground anchors
- Steel works
- Cable maintenance
  - post-tensioning
  - stay cables
  - suspension cables
- Jacking, load transfer
  - Base isolation
  - Dampers installation
Repair techniques

Reinforced Concrete Treatments, Cathodic and galvanic protection

Protection Coatings, Hydrophobic, Polyurea, Fire protection
Bridge re-purposing and life extension

Our aim is to deliver **Tailored Solutions** for bridge re-purposing and life extension

- Fulfill new performance criteria
- Minimize Execution constraints
- Meet Owners objectives
- Address Structural disorders

Working with Owners & Engineers seek for the most effective solution

cost & schedule advantage with quality and safety
Bridge repair, strengthening, life extension and re-puposing

Some case studies
Hammersmith Flyover – London, UK

• Segmental Flyover, 622 m long, completed in 1961
• Emergency repair in 2012 before London Olympics
• Full PT replacement under traffic Started January 2014
Hammersmith Flyover – London, UK

New capping tendon anchor blisters

Main new post-tensioning comprising 6 N° 37 strand tendons inside box

New capping post-tensioning 3 N°, 13 strand tendons (1 N° inside box and 2 external)

New mid-span tendon anchor blisters

New mid-span post-tensioning external to box 3 N°, 22 strand tendons (one anchored beyond this section)

New access door cut through pier

New main tendon pier-head deviator

New main tendon mid-span deviators
Ayala Bridge – Manila, Philippines

• Built in 1949
• Inspection, Diagnosis, Design and Build Contract
• Lift bridge by 70 cm to increase clearance
• Rehabilitation: steel structure repair, sandblasting, coating
• Re-purposiong, strengthening and 50 year life extension
• Seismic retrofitting to AASHTO 2012:
  • Strengthening of the steel structure
  • Additional Post-Tensioning in the chord beams
  • Change Static configuration of the bridge (ground beams and bored ples)
  • Add dampers and damping bearings
La Recouvrance Bridge - France

- Built in 1950
- Re-purposing, strengthening and 40 year life extension
- Design and Repair / Retrofit of the full structure
- Strengthening to allow operation of tramway:
  - Carbon Fiber
  - Shotcrete
  - Additional Post-Tensioning
  - Replacement and Upgrading of Bearings
- Full replacement of the central span
- Addition of corbel sidewalks for pedestrians
Peats Ferry Bridge - Australia

- Concrete Repair:
  - Hydrodemolition
  - Dry Shotcrete
  - Form & Pour

- Impressed Current Cathodic Protection on piers and pile caps
- Silane and anti-carbonation coatings

- Minimise future maintenance
- Life Extension – 50 years
Ewijk, Netherlands

Locked coil cables replacement by Freyssinet stay cables
Life extension and future maintenance minimisation
Panama – Las Americas bridge

replacement of hangers by modern stay cable systems (design & build)
Binh Trieu Bridge - Vietnam

- Built in the 1960s, 560 m long
- Bridge widening 1.4m
- Diagnosis, Design and Works Contract
- Strengthening according to new construction codes (traffic & seismic); Widening to include 2 wheels lane
- Re-purposing and life extension
• Strengthen the concrete approaches with shotcrete & additional PT

• Strengthen the central steel span; create continuity with moment resistant connection; damping devices and new bearings for seismic behaviour
Future developments for bridges – Instrumentation and monitoring

UScan

Ultrasonic Reflectometry
Inspection of T15 strands
Detection of broken wires in anchorage area
Future developments for bridges – Instrumentation and monitoring

SlotStress

Stress Measurement in Concrete
Improved ASTM D4729 Strain Relief Method
Accurate Measurement of Absolute Stress

17/03/2017 SIXENSE Systems
Void Detection

Electric measurement
Detects voids and white paste in external cables / plastic ducts
Future developments for bridges – Instrumentation and monitoring

UPUS

Ultrasonic propagation method
Accurate measurement of tension in short bars

17/03/2017 SIXENSE Systems
Future developments for bridges – Instrumentation and monitoring

Vibration testing & analysis

Periodic measurement of tension, damping or logarithmic decrement in cables
Vibration testing & analysis

Identification of dynamic characteristics of structures
Periodic measurement of natural frequencies, damping ratios & mode shapes
Vibration testing & analysis

Natural frequencies and damping are excellent condition indicators. Using ambient or forced vibrations, Vibration analysis method can detect gradual changes in structures and hidden defects such as scouring, micro cracking or loose assembly.
Our approach and added value

Assist / Advise in:
• Structural assessment
• Corrosion survey
• Diagnosis
• Conceptual design
• Feasibility checks

Use Worldwide experience:
• Proven efficiency and durability
• Returns of experience from the field

Involves us at an early stage

We aim to deliver site-proven solutions

Technology provider

Execution know how

Engineering expertise
THANK YOU