4th International Conference on
Structural Health Monitoring on Intelligent Infrastructure (SHMII-4) 2009
22-24 July 2009, Zurich, Switzerland

Abstract of Paper No: XXX

The new travel of Ramses II

Romuald BUDIN
TELEMAC S.A., France

Ayman HAMED
EOAM, Egypt

Philippe BERNARD
TELEMAC S.A., France

The huge statue of Ramses II was discovered in the Mit Rahina area in Egypt, fragmented in 6 parts. These parts were joined and moved in 1954 near the Cairo train station.

After more than 50 years, the red granite statue measuring 11 meters high and weighing more than 100 tons was damaged by the pollution and vibrations by local traffic and subways. For this reason it was decided to relocate the statue to Giza in a safer place.

Telemac S.A, manufacturer of sensors for structural and civil works since 1947, had already instrumented several historical monuments in Egypt. After monitoring the Serapeum tomb in Saqqarah and the Hibis Temple in Khargha oasis, the company was called to follow the transportation of Ramses II Statue from Cairo to Giza.

The project required the monitoring of the crack movements and the inclination during the 30km transportation through Cairo. Ten crack-meters, model FIC, and one biaxial tiltmeter, model Geocline, were installed and monitored with a data acquisition system and daily reporting to the local authorities on the statue condition.

On the 25th of August 2006, Ramses II was transported on a truck. A car, carrying Telemac engineers, shadowed the truck in order to provide, in real-time through a Bluetooth link, continuous monitoring and ensure the statue's safe arrival.

The trip was successful. The sensors did not detect any relevant variations of the cracks and the Ramses II Statue can now breathe pure air in the Giza area.

Corresponding author's email: romuald.budin@telemac.fr

The new travel of Ramses II

Romuald Budin[1], Ayman Hamed[2], Philippe Bernard[3]

[1] TELEMAC S.A., Gretz-Armainvilliers, France
[2] EOAM, Cairo, Egypt
[3] TELEMAC S.A., Gretz-Armainvilliers, France

ABSTRACT: The huge statue of Ramses II was discovered in the Mit Rahina area in Egypt, fragmented in 6 parts. These parts were joined and moved in 1954 near the Cairo train station.

After more than 50 years, the red granite statue measuring 11 meters high and weighing more than 100 tons was damaged by the pollution and vibrations by local traffic and subways. For this reason it was decided to relocate the statue to Giza in a safer place.

Telemac S.A, manufacturer of sensors for structural and civil works since 1947, had already instrumented several historical monuments in Egypt. After monitoring the Serapeum tomb in Saqqarah and the Hibis Temple in Khargha oasis, the company was called to to follow the transportation of Ramses II Statue from Cairo to Giza.

The project called for the monitoring of the crack movements and the inclination during the 30km transportation through Cairo. Ten crack-meters, model FIC, and one biaxial tiltmeter, model Geocline, were installed and monitored with a data acquisition system and daily reporting to the local authorities on the statue condition.

On the 25th of August 2006, Ramses II was transported on a truck. A car, carrying Telemac engineers, shadowed the truck in order to provide, in real-time through a Bluetooth link, continuous monitoring and ensure the statue's safe arrival.

The trip was successful. The sensors did not detect any relevant variations of the cracks and the Ramses II Statue can now breathe pure air in the Giza area.

1 INTRODUCTION

Discovered in 1882 in a palm jungle at Mit Rahina village in Saqqara, the red granite of Ramses II broken in six pieces was transported and placed near to the Babul Habid train station in downtown Cairo where it stood for more than fifty years and was restored. The reassembly was done inserting iron bars inside the body of the statue.

Then, the statue became one of the most famous landmarks of the Cairo city, giving its name to the square where it was located.

Unfortunately, the increase in the pollution rate and the vibrations caused by train and cars traffic affected the statue.

To protect the monument, the Minister of Culture decided, with the approval of the Supreme Council of Antiquities' Permanent Committee, to relocate the statue in the area of the Grand Egyptian Museum overlooking the Giza plateau.

The works were attributed to the construction company Arab Contractors.

Figure 1: Square Ramses II - Cairo

1.1 Who was Ramses II

Ramses II, also known as Ramesses The Great or Ozymandias, was born around 1303 BC and ruled Egypt from 1279 BC to 1213 BC. He was the third Egyptian pharaoh of the 19th Dynasty, the son of the successful Seti I (himself the son of Ramesses I) and Queen Tuy. He was a great builder and a famed warrior who is credited with bringing Egypt unprecedented power and splendor during his 67-year reign.

Indeed Ramses II had an extraordinarily long reign, longer than the average lifespan during the period of Ancient Egypt; he constructed many temples (not only at Karnak, Luxor, Gourna, Nubia or Abydos) and erected many colossal statues and obelisks.

During his long reign, Ramses II had eight principle wives, but Nefertari was Chief Queen, his first and most likely favorite one. He sired more than 100 children.

He probably died in his 90th or 91st year.

Ramses II was buried in the Valley of the Kings at Luxor, but was discovered last century and his mummified remains are now displayed in a Cairo museum. Ramses II's mummy is thought to be one of the best-preserved mummies ever found.

1.2 Instrumentation Project

After the completion of the architectural and geophysical studies as well as other studies proposing different means of transportation, it was decided to remove the 11 meter high and 100 tons statue in one piece and to dislocate it standing inside an iron cage covered by rubber foam and hanging on a steel bridge to allow free axial movement like a pendulum while the vehicle was moving.

The 10 installed crack-meters had to verify that the interfaces resulting from the reassembly did not move, and the inclinometer had to show the real axial inclination of the statue during the transportation.

2 MEASUREMENT EQUIPMENT

2.1 Equipment

Table 1 summarizes the installed instrumentation on Ramses II as well as purpose and pictures of the equipment.

Table 1: Sensor types, purpose and picture

Sensor Type	Specs	Measurement/Purpose	Picture
Crack-meter FIC	Range +/- 2.5mm Resolution 0.3micron Diameter 20mm Length 150mm Cable 30m	Cracks Cracks opening (interfaces between the six statue's pieces)	
Biaxial Tiltmeter GEOCLINE-WE	Range +/- 5° Resolution 0.0002° Diameter 45mm Height 65mm Cable 30m	Tilt Real axial inclination of the statue (on movement's axis)	
Data Acquisition System SensLog with multiplexer	CR1000 Campbell Scientific 2MB Memory	Collection and visualization of the measurements data Measurement every minute	
PC and real time data monitor software RTMC	Portable PC with Bluetooth module and RTMC web server	Real time monitoring on screen during transportation	

2.2 Installation scheme

The Figure 2 provides an overview of the installed instrumentation on Ramses II.

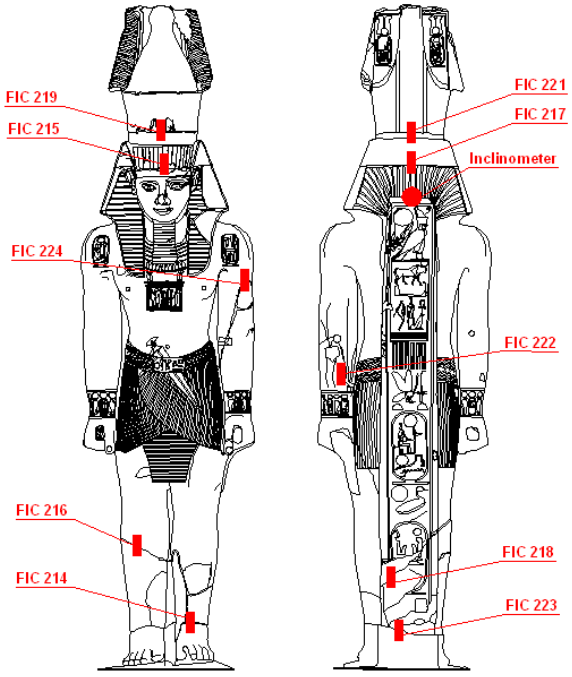

Figure 2: Installation drawing

Figure 3: Sensors on Ramses II (FIC 215 on the left and Inclinometer on the right)

3 TRANSPORTION PHASES

3.1 Preparation works

Ramses II was equipped with the sensors and protected with rubber foam. An iron cage was built around it and connected to steel beams. Afterwards the statue was cut from the bottom and raised.

Figure 4: Ramses II's protection and support for transportation

Figure 5: Ramses II ready to be moved

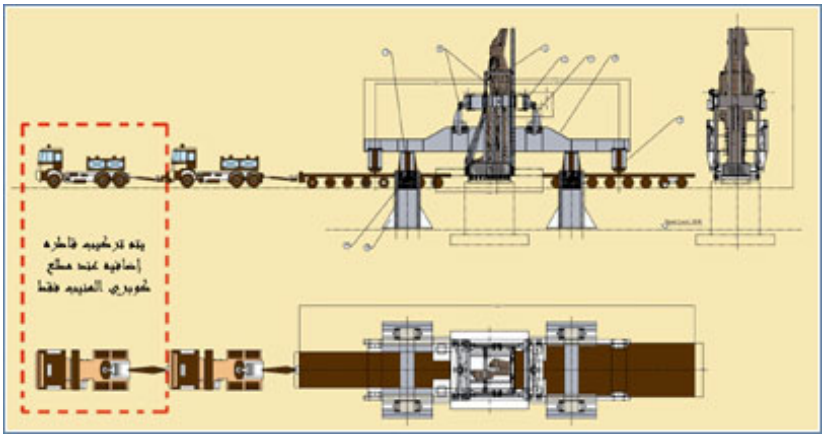

Figure 6: Means of transportation (Courtesy of Arab Contractors)

3.2 Travel

On 24th August 2006, late in the evening, the statue began its new journey, under the eyes of the people of Cairo. The convoy moved at the speed of 5 km per hour, moving along the Nile River, crossing the Al-Monib Bridge, and after almost ten hours, in the morning of August 25th, the statue arrived at its new location, near the pyramids district.

Because of the weight and dimensions of the truck and its low speed, Ramses II had to be driven to the final destination overnight to avoid traffic. The 30km long road shown in the following picture was the only possible way to go through Cairo with Ramses The Great.

Figure 7: The travel (Google image)

4 MEASUREMENTS RESULTS

4.1 Measurements

Measurements started on 24th August 2006 during the preparation works and sensors detected every movement. E.g. FIC 218 placed on the lowest part behind the statue detected the opening of the cracks in the range of -3mm / +2mm. This displacement was due to the preparing, cutting and raising works of the statue from the soil.

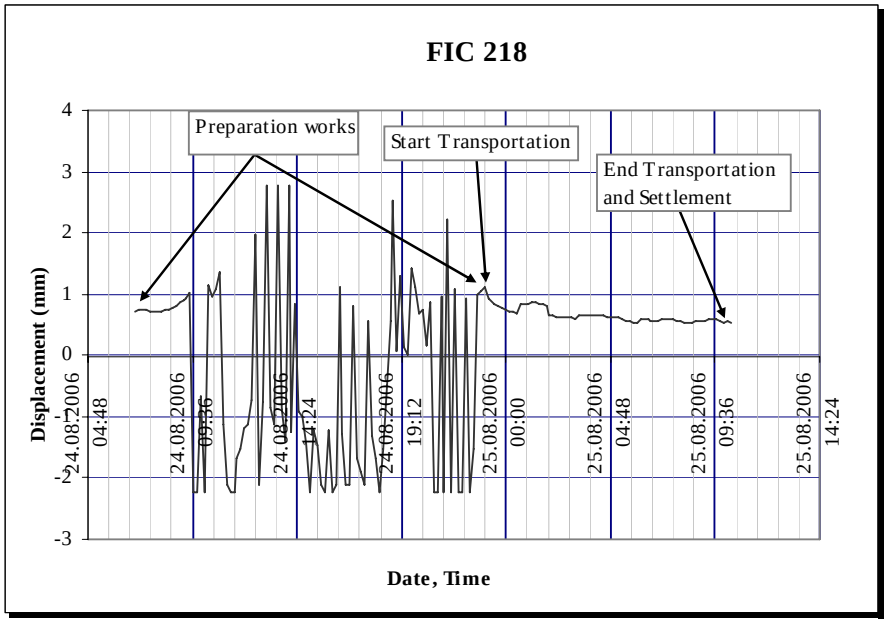

Figure 8: Measurements on the Crack-meter FIC 218

The measurements continued during the whole transportation and settlement of the statue.

A car, carrying Telemac engineers, shadowed the vehicle in order that a continuous and real time monitoring through a Bluetooth link could ensure the statue's safe arrival.

Neither the inclinometer nor the crack-meters detected any alarming variation.

The inclinometer detected tilts in the range of -0.7° / +0.7°.

The crack-meter FIC 219 positioned on the front of the Ramses II head detected the biggest displacement in the range of +/-0.1 mm during the transportation.

The other crack-meters (e.g. FIC 214) measured even smaller displacements, due mostly to the temperature changes rather than to the movement conditions.

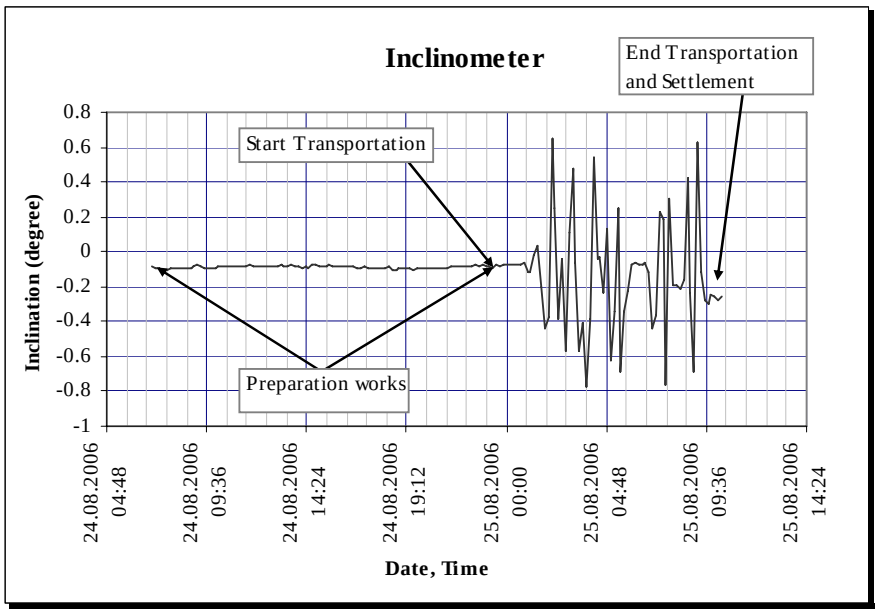

Figure 9: Measurements on the Inclinometer

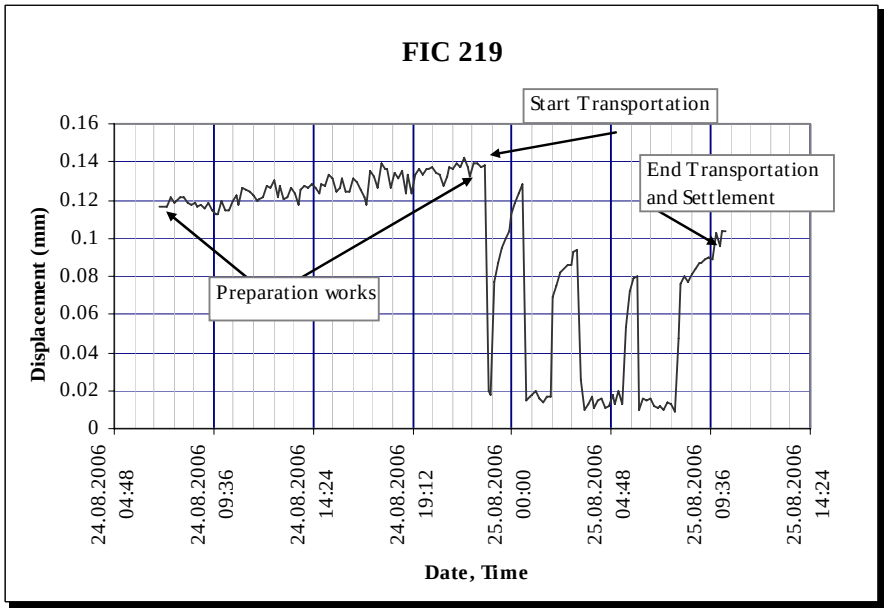

Figure 10: Measurements on the Crack-meter FIC 219

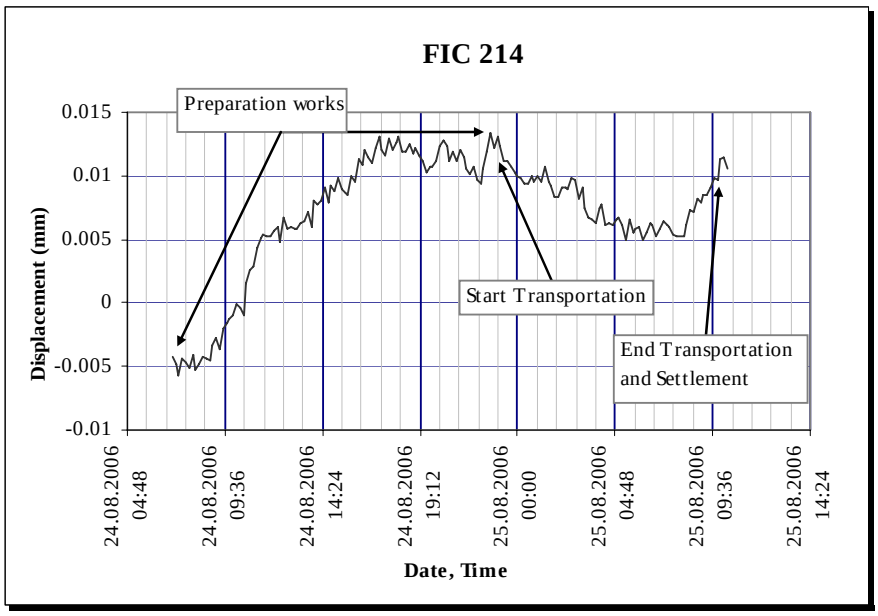

Figure 11: Measurements on the Crack-meter FIC 214

5 CONCLUSIONS

This project was very fascinating and involved a lot of professionals as well as common people being fond of historical monuments and interested in preserving this important landmark of Cairo and symbol of the ancient Egyptian civilization. For the first time in the world such a heavy and valuable statue was moved. This was also a unique example of monitoring of an historical monument in motion.

The transportation was successful. The sensors did not detect any remarkable cracks and after this further journey the magnificent Ramses II Statue can now breathe pure air in the Giza area.

6 REFERENCES

Glisic, B., Inaudi, D., Posenato, D., Figini, A. and Casanova, N., *Monitoring of Heritage Structures and Historical Monuments Using Long-Gage Fiber Optic Interferometric Sensors - An Overview*, The 3rd International Conference on Structural Health Monitoring of Intelligent Infrastructure - SHMII-3, November 13-16, (2007), on conference CD

Internet references: www.foxnews.com, www.travelvideo.tv, www.wikipedia.com, www.gardians.net