





WHY RAILWAY MONITORING?

## NOW IS TOO LATE...

## <u>HOW MUCH</u> <u>MONEY THEY</u> <u>HAVE LOST?</u>





#### \_ A WELL DONE PROJECT: High speed railway milan-rome, italy



MONITORING SYSTEM: MAIN TASKS

- Monitoring of viaducts / bridges
- Monitoring of embankments
- Monitoring of critical sections

with RDS system





#### MONITORING OF VIADUCTS





#### MONITORING OF VIADUCTS









Aim: monitor the stress into concrete.

VW strain gauge should be installed in deck but also in the pile or foundation







#### 3-AXIAL JOINT METERS





3-AXIAL JOINT METERS

Aim: monitor the relative movement/displacement between pile and deck





#### \_\_\_ 3-AXIAL JOINT METERS





#### BIAXIAL TILTMETER





#### BIAXIAL TILTMETER

Aim: monitor the inclination in X and Y directions of viaduct pile.





#### BIAXIAL TILTMETER











Aims: Pore pressure monitoring





#### PIEZOMETERS FOR PORE PRESSURE







#### TELL-TALE EXTENSOMETER





#### TELL-TALE EXTENSOMETER



Aim: monitor ground settlement caused by viaduct construction and during railway life

#### TELL-TALE EXTENSOMETER













#### GEODETIC TARGETS

*Aims: monitor embankment body settlement / displacement* 











#### DEX SETTLEMENT COLUMN

*Aims: monitor embankment and foundations settlement* 







#### DEX SETTLEMENT COLUMN

DEX column allows:

- absolute settlement monitoring
- High accuracy
- Removable probes for re-installation at different

*locations and maintenance (if needed)* 

- Real-time monitoring in unattended location











Aims: Pore pressure monitoring





#### PIEZOMETERS FOR PORE PRESSURE







RDS - RAILWAY DEFORMATION SYSTEM





RDS - APPLICATIONS

For the measure of potential collapses or subsidences along a railway section, is important the use of a chain of <u>longitudinal sensors</u> in order to measure the railway longitudinal deformation



#### RDS - APPLICATIONS

In case of works nearby railway lines (injections, jet-grouting, drillings, pilings etc.) a

major importance is given to the evaluation of the *twist*, and so the application of

the transversal sensor.

Nearby excavation could cause differential settlement and so railway transverse deformation



#### PURE RDS SYSTEM: LONGITUDINAL AND TRANSVERSE GAUGES

Longitudinal RDS gauge

Transverse RDS gauge



HIGH SPEED RAILWAY MONITORING - JANUARY 2016

They are

and

digital MEMS

tilt meters with

high accuracy

low thermal

dependence

# OPTICAL-RDS INTEGRATED SYSTEM Microprism for 45.4.4 1.17.60 logitudinal geødetical monitoring SISGEO



Transverse RDS gauge \_ RDS LONGITUDINAL GAUGES

Aluminum beam with built-in sensor Special joint allowing termal linear expansion

> Optical targer for topographic surveying

Installation plate







RDS TRANSVERSE GAUGES

Signal cable

Cable out

Aluminum box with built-in

sensor

Installation plate

RAIL





gauge



INSTALLATION PROCEDURES

Installation usually takes place with railway cut-off power, so RDS gauges installation must take less time as possible  $\rightarrow$  RDS has been designed to be simple and quick to be installed.

Supports are positioned and fixed with mechanical bolts or with appropriate resins

Gauges are fixed to the supports and <u>fast connected</u> one to each other by connectors

3. Using the terminal JB, RDS gauge chain(s) is connected to OMNIAlog data acquisition system



2.

#### DATA ACQUISITION SYSTEM



OMNIAlog is the right solution for RDS automatic monitoring, data transmission and allerting:

- 1. OMNIAlog, through 3G router or other communication interface, sends the data packages at a preset intervals to a dedicated server
- 2. Data are subjected to a first automatic validation in order to delete peaks and abnormal readings
- 3. OMNIAlog can be set to send alarms (i.e. through SMS/email) or activation of sirens / flashings at the pre-set thresholds overcoming.



#### DATA MANAGEMENT AND INTERPRETATION



WMS Web Monitoring System is a SW platform for data management for geotechnical and structural monitoring systems, with the possibility to import data from both automatic data acquisition systems or manual readings. With WMS platform, data are sorted, converted into engineering units, validated, corrected by temperature variations, processed and plotted on special navigable and interactive charts.



#### EXAMPLE OF APPLICATIONS

• PURE RDS SYSTEM

Milan-Bologna

high speed railway

• OPTICAL-RDS INTEGRATED

SYSTEM: Milan M5 metro line, Domodossola Station







### MILAN-BOLOGNA HIGH SPEED RAILWAY Installation of support plates







Longitudinal RDS gauge mounting (3







Transverse RDS gauge (1m length)





Junction box for analogue gauges



"JB" NOT needed

anymore.

New digital RDS gauges are installed in chain (ModBUS)

















\_ MILAN-BOLOGNA HIGH SPEED RAILWAY RDS Longitudinal gauges - Raw data WEBMONITORINGSYSTEM



Longitudinal RDS Data elaborated with WEBMONITORINGSYSTEM FieldStat - zero reading @ 19.11.2008

PFIELD 📕



- 20/11/2008 - 12/12/2008 - 13/13/2008 - 14/12/2008 - 15/12/2008 - 16/12/2008







#### "DOMODOSSOLA" TRAIN STATION MONITORING, MILAN





#### "DOMODOSSOLA" TRAIN STATION MONITORING PFIELD RDS system scheme WEBMONITORINGSYSTEM Garbi Domodossola :: Galemys 3.5 🧭 Impostazioni Generale 0 Procedura di Chart Importazione Manager Sito Field Aggioma Global Report Help About 🕒 6375eb52-f082-4cea-92ca-1118c14576bf.jpg - Visu... 💻 💷 💻 🍋 Mappe Cad\* Mappe Mappe Grafici Tabelle Dispositivi Documenti Report Immagini -Google \* Dati Azioni Documenti Strument Links (?) File 🔻 Stampa 🔻 Posta elettronica Masterizza 🔻 Galemys 📝 Monitoraggio Stazione Domodossola 📓 Chart Manager :: Test Merali; proprietario supervisor 📊 Profilo Longitudinale - Binario 1 📊 Profilo Longitudinale - Binario 1 🕴 📝 Monitoraggio Stazione Domodossola ESISTENTE Azioni Aggioma Situazione POZZETTO ESISTENTE RDS28 RDS27 RDS26 RDS25 **BINARIO 2** RDS19 RDS20 RDS21 RDS22 RDS23 RDS24 SD1 Scatola di derivazion 40x40 interrata RDS14 BINARIO 1 🕈 RDS13 RDS8 RDS9 RDS5 RDS10 RDS12 RDS7 RDS11 RDS6 -0-12764.284, 36321.786





"DOMODOSSOLA" TRAIN STATION MONITORING

#### RDS transverse gauge data and graphs



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#### "DOMODOSSOLA" TRAIN STATION MONITORING

#### RDS transverse gauge data and graphs



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WEBMONITORINGSYSTEM

"DOMODOSSOLA" TRAIN STATION MONITORING

#### Railway longitudinal profile

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- RDS System can be effectively used to guarantee the safety of the railways and the safety of the passengers.
- RDS can be easily installed and, if needed, could be dismounted and installed on other railway line.
- If correctly designed, installed and managed, RDS can offer to the Customers an amazing cost reduction by erasing the need of on-site technicians





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