BED EROSION ON THE RIVER GALET AND ITS IMPACT ON RAILWAY INFRASTRUCTURE

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ICSE6 : Bed Erosion on the River Galet and its Impact on Railway Infrastructure

- Introduction
- River Galet
  - Catchment characteristics
  - History of flooding
  - Geomorphology
- Hydromorphology study
  - Ground Investigation
  - Hydraulic Model
- Conclusions
Introduction

- The Galet viaduct is situated on the railway line between the towns of Givors and Grezan in the Languedoc-Roussillon region of France (Gard, 30).
Introduction

- An inspection of the viaduct railway in 2008 following flooding in the Galet catchment identified generalised bed lowering of the Galet exposing the foundations of the structure.
River Galet

Catchment Characteristics

- Physical characteristics
  - Surface area = 3.5km²
  - Watercourse length = 3.5km
  - Average slope 3%
  - Land cover predominantly agricultural (vineyards)

- Rainfall
  - Rainfall intensities of 200-400mm (upto 800mm) in a few days
  - Peak intensities of 125mm in 15 minutes have been recorded

- Flow estimation (ungauged catchment)
  - $Q_{100} = 70m^3/s$
  - $= 20m^3/s/km^2$
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- River Galet
  - History of flooding
    - 23 September 1924
      - Original structure comprised a single 3m span arch.
      - Structure destroyed by the flood of 23 September 1924
      - Breach of 60m formed in the railway embankment
      - River bed scoured by up to 6m downstream
    - 30 September 1958
    - 22 September 1993
    - 8 September 2002
    - 1 December 2003
    - 11 September 2008
    - ?? October 2011
River Galet
- History of flooding
  - Profile of the River Galet post flood of 23 September 1924
River Galet

- History of flooding
  - Rebuilding of the railway viaduct in 1926
    - 3 arches each of 6m span
    - Construction of 3 weirs at the confluence of the Galet and the Rhône
    - Artificial raising of the river bed between the weirs and the new viaduct (imported fill material)
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- River Galet
  - Geomorphology

![River Galet Map with Photographs](image-url)

Photograph A
Photograph B
Photograph C

Source: CartoExploreur
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- **River Galet**
  - Geomorphology

- Photograph A – Upstream of Garrigues Bridge


3m
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- River Galet
  - Geomorphology
  - Photograph B – Reach between Garrigues Bridge and the Galet Viaduct
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- River Galet
  - Geomorphology
    - Photograph C – Reach downstream of the Galet Viaduct
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- **River Galet**
  - Geomorphology
    - Observation of river bed changes

Viaduct pier base 2008

Viaduct pier base 2011

Traces of old bed level
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- River Galet
  - Geomorphology
    - Observation of river bed changes

Waterfall downstream of viaduct 2008

Concrete block

Waterfall downstream of viaduct 2011
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- River Galet
  - Geomorphology
    - Observation of river bed changes

Reach between Garrigues Bridge and the Galet Viaduct (bank protection placed in 2002/3)
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- River Galet
  - Geomorphology
    - Observation of river bed changes

Immediately downstream of Garrigues Bridge 2008
Following works in 2011
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- Hydromorphology study
  - Ground Investigation
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- **Hydromorphology study**
  - Hydraulic model
    - HEC RAS 1D
    - River length ≈ 1km
    - Run in steady state and sediment transport mode
Hydromorphology study

- Hydraulic model
  - HEC RAS 1D
  - River length ≈1km
  - Run in steady state and sediment transport mode
  - 3 year simulation:
    - Yr 1 – 1 flood 20m³/s
    - Yr 2 – 1 flood 40m³/s
    - Yr 3 – 1 flood 68m³/s
Hydromorphology study

- Hydraulic model
  - Results of sediment transport modelling (series of 3 floods of 20m³/s, 40m³/s and 68m³/s) reflect well observations made on the ground

After 20m³/s

After 40m³/s

After 68m³/s
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- **Hydromorphology study**
  - Hydraulic model
    - 4 Solutions for stabilising the river bed adjacent to the Galet Viaduct were integrated into the model:
      1. **Reconstruction of the weirs at the confluence of the Galet and the Rhône**
      2. **Construction of a single weir immediately downstream of the existing waterfall**
      3. **Construction of a series of low weirs between the existing waterfall and the confluence of the Galet and the Rhône**
      4. **Use of rock armour to protect the bed and banks of the Galet from further erosion between the existing waterfall and the confluence**
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**Conclusions**
- The River Galet is undergoing important and ongoing bed modification (lateral and vertical erosion)
- The Galet Viaduct is at risk of destabilisation without rapid intervention to control the erosion of the river bed
- Of the bed stabilisation options considered, the construction of single weir downstream of the existing waterfall is the optimal medium term option
- The proposed bed stabilising works adjacent to the Galet Viaduct will have a limited impact in terms of reducing bed erosion in the reach between the railway viaduct and Garrigues Bridge
- The reach upstream of Garrigues Bridge is at risk of erosion