Urban track systems

Engineers Ireland, 13th March 2017

Marcello Corsi Chartered Engineer – Head of Track Design TII
Track functions and key components
Track functions

1. Supporting (vertical forces)
2. Guiding (transversal forces)
3. Moving (longitudinal forces)

Providing a smooth surface with little friction
Reducing vertical and tangential forces
Drainage
Stress distribution

Ease of construction
Ease of maintenance
Reducing LCC
Durability
Track functions

Vertical force supports the vehicle

Tangential force transversal drives the vehicle

Low friction
Wheel Flange

Tangential force longitudinal moves the vehicle (traction or braking)

Low friction
several motorised wheels
Track key components

From top to bottom:
- Rails
- Fastenings (elastic - rigid)
- Sleepers or gauge bars
- Track support system (ballast - concrete slab - upper part of a structure - plinths, etc.)
- Subbase
- Capping (if needed)

25 - 30 cm ballast (crushed stone 30/60)
10 cm gravel

Subgrade
No matter how the infrastructure looks like, the top part is always the same, because the contact point between the vehicle and the infrastructure must be well defined.
TRACK TYPES
Urban track types

- Segregated
  - Ballast
  - Slab
  - Green
  - Plinth
  - Direct fixing

- Embedded
  - Shared
  - Segregated
Urban track types

S49 Rail Profile

SECTIONAL ELEVATION THRO' S49 RAIL

NOTE: S49 RAIL IS LAID AT 1/40. R159N IS LAID VERTICAL, BOTH THEREBY PROFFER THE SAME PROFILE TO THE WHEEL.

R159N Rail Profile

SECTIONAL ELEVATION THRO' R159N RAIL
Slab track – Luas 2004

Top down construction
Two separate blocks
Double resilience
Issues
Slab track – Luas 2010

Top down construction
Bi-block sleepers
Single resilience
Slab track – Luas 2017
Bridge deck to track regulation
Derailment containment
Direct fixation
Direct fixing

Slab track repair works
Plinth track
Minor sections
Time consuming
Single grout shutters for regulation
Grass track – Luas 2004
Grass track – Luas 2004
Grass track – Luas test 2010
Urban track types
Embedded
Embedded track – Luas 2004
Embedded track – Luas 2010
Embedded track - pros and cons

Pros:
- Visual-Urban realm-Architectural
- Shared running

Cons (issues to be resolved at design stage):
- Rail wear – maintenance – rail replacement
- Tighter construction tolerances
- Road-Track design: track-road joint interface
- Rail keeper back flange contact
- Vertical design to tie in with urban landscape
- Cost (up to 3 times ballast track, 50-70% more than slab)
Embedded track – Luas 2010
Few sections of road & rail in previous lines in Dublin

MOSTLY SEGREGATED

IT’S “ONLY” A RAILWAY
New challenges and old challenges

ROAD-RAIL INTERFACE ISSUES

60% of shoulders at junctions damaged
Shoulders, joints, road stability, rail wear, corrugation, rails replacement, constructability
MAINTENANCE ISSUES
4 nights to replace 18m single rail
Luas Cross City challenges

Confined construction sites
Alignment
Rail-road joint

Road and railway or railway and road? BOTH
Massive international benchmark, research and real scale tests into innovative embedded track systems. Results presented at several international congresses (Frankfurt 2015, Milan UIC world congress 2015, Birmingham, Dusseldorf 2014, Rome 2011-2013)
Embedded Track - Paris

Sleepers and rubber filler blocks.

Mostly segregated, no road traffic interface?

Stray currents?
Embedded Track - Paris

Treatment at road junctions!
Embedded Track - Berlin
Lines are mostly segregated from traffic.

Unreinforced slab, low profile

Vertical rail support only

Bottom rail continuous pad

Regum filler blocks

Rheda sleepers with proprietary fastenings

All asphalt

Joint sealant
Embedded Track - Freiburg
Embedded Track - Zurich

**Verkehrsbedrohle Zürich**

Unternehmensbereich: Infrastruktur

Lugwegstrasse 65, Postfach 8648 Zürich

Projektleitung Bauten
Telefon 044 434 41 11
Fax 044 434 45 34

**Gleiserneuerung mit Oberbeton (inkl. Strassenbau)**

Querprofil

---

**Belegannahme**

- Reinigen der Schienenkopfläne durch Sandstrahlen
- Beschichtung der Haftfläche an Schienen m. Epoxid-Hartguss
- Abriebzeugen mit Quarzsand
- Fugenflanken vorprimieren
- 2-elliger Hellasverguss

**Details**

- Decksole AC
- Binderhöhe AC B
- Tragschicht AC T
- Fundamentschicht

**Beton**

- C30/37, XC4, XP1, XD2, Draxel 32
- C25/30, XC2, Draxel 32

**Verankerung**

- Geokabel (z.B. Polyethylen) mit Trennfunktion
  - Zugfestigkeit: min. 8.5kN/m
  - Standsicherheit: längs min. 100%

**Werkleitungen**

- mit Magerbeton abdecken

---

**Beleuchtung**

- LED Flügel
- Flügel mit Zebra-Fluglinien und Schienenwegmarkierung

---

**Plan Nr.:** 11999080-027_H

**Datum:** 14.03.2005

**Gefunden:** 30.03.2011 mk

**Format:** A4
Embedded Track - Edinburgh

Initial design low slab, only vertical support
Bottom rail profile
C shaped filler blocks
Rheda sleepers
All asphalt
Joint sealant

Remedial works
Embedded Track - Croydon
Embedded Track – Bergen (NO)

Medium slab
Full filler blocks
No sleepers/fastenings
Low shoulders

CDM fillers booting
Embedded Track – Nottingham type 1
Embedded Track – Nottingham

Appitrack Alstom system:

Slipformed slab with automatic fastenings insertion
Nabla covered fasteners
Edilon filler blocks
Embedded Track - Rome

- Slip-formed slab
- Direct rail fixing
- Side filler blocks
- Bottom rail continuous pad
Embedded Track - Rome
Embedded Track - Florence

- Thin rail encapsulation
- Low slab (only vertical rail support)
- Sleepers
- Full asphalt height
Embedded Track - Florence

- ROTAIA CON PROFILO RI 60R13 (PROFILO NP4dS PER LA ROTAIA INTERNA DELLE CURVE CON R<200 m) CON ATTACCO NABLA
- TAPPETO DI USURA sp.3 cm
- STRATO DI COLLEGAMENTO BINDER sp.7 cm
- STRATO DI BASE IN CONGLOMERATO BITUMINO SO sp.medio 7 cm

Dimensions:
- 25, 60
- 143.5
- 34
Embedded Track - Karlsruhe
Embedded Track - Heilbronn
Embedded Track - Utrecht
Pre-cast track systems

A - Pre cast (Edilon-Sedra)
Rails are separate from the slab
Pre-cast track systems

A - Pre cast- CDM Paris Tram

RATP T1
An example of fast track installation in urban environment
Other Groups of Embedded Tracks

1  **GAUGE CONTROL**
- Active control
- No active control

2  **RAILS FIXATION AND PROTECTION**
- Thin encapsulation
- Resins poured on site
- Fillers and blocks

3  **CONCRETE SLAB**
- Only vertical support (low) or lateral support (high)
- Reinforced or not

4  **JOINT AND FINISH SYSTEM**
- Elastic polymeric and bituminous joints
- Bedding mortars for setts
- Asphalts (HRA or PMSMA)
Embedded track - Gauge Control

With mechanical gauge control:

- Rheda (RailOne)
- Sateba
- Rheinfeder
- Others....
Indirect gauge control - fastenings based

**Intermediate** systems (slab embedded fasteners – top down o bottom up)

- Vossloh
- Pandrol
- Alstom Appitrack
- Nabla Railtech
- Proprietary
No mechanical gauge control

Thin encapsulation
- Phoenix
- Vector ALH
- Others

Filler blocks
- Edilon)(Sedra
- CDM
- Regum
- Isolgomma
- Strail
- Getzner
No Mechanical Gauge Control

Filler blocks
- Edilon)(Sedra
- CDM
- Regum
- Isolgomma
- Strail
- Getzner
No mechanical gauge control

Poured resins
- Edilon)(Sedra - Corkelast
- CDM - Ptrack
- Resch and Vogt
Back in Dublin now

Stray currents and vibration control – continuous encapsulation

Shared running – no filler blocks for joint stability

Previous lines lesson learned on the shoulder and joints

Construction support for alignment and gauge control – sleepers

Track and Road – Reinforced track slab (DMRB)

Constructability in narrow sites in city centre
Back in Dublin now

Continuously reinforced jointless rigid pavement following DMRB standards.

- NRA DMRB HD25-26/10 Pavement and Foundation Design (design life 60 years)

- The slab is designed as CRCP continuously reinforced concrete pavement as this is the only arrangement possible for granite setts finish and the use of CRCP for asphalt does not preclude it from working as a CRCB.

- To increase rail and road stability at rail edge, it is proposed that concrete infill laying over the structural slab is brought up to minimum distance from the top of rail.
Initial real life trial 2009
LUAS A1 Citywest
Dublin: New embedded track
Asphalt finish – 40mm
Line A1
Real scale track test - 2013

Testing is underway on an innovative approach to track-work developed by RPA engineers. The new approach could be more sustainable and reduce the time needed for track laying and maintenance. Test results will support improvements here in Dublin and internationally.
Red Cow Track test – asphalt section
First LCC track

Rosie Hackett Bridge
Issues
Luas Cross City – special trackworks
Luas Cross City construction
Luas Cross City construction
Luas Cross City embedded track
Luas Cross City embedded track
Luas Cross City embedded track
Luas Cross City embedded track
Thank you

marcello.corsi@tii.ie