UIC HIGHSPEED
Morocco 2023

HIGH-SPEED RAIL : THE RIGHT SPEED FOR OUR PLANET

Under the High Patronage of his Majesty King Mohammed VI

Session 5.1, Room Fez 1
Infrastructure / Design

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Session 5.1
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Speaker Lists;

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					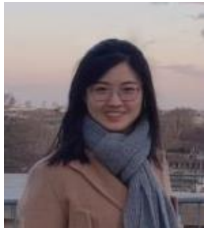
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Spain	Sweden	United Kingdom	China	China	China

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11TH WORLD CONGRESS OF HIGH-SPEED RAIL

Marrakech, 7-10 MARCH 2023

MIXED TRAFFIC IN HIGH SPEED LINES – DESIGN CONSIDERATIONS

Joaquin Botella
Chief Technical Engineer Railways, SENER ENGINEERING, Spain
Session1-5.1 Infrastructure /Design

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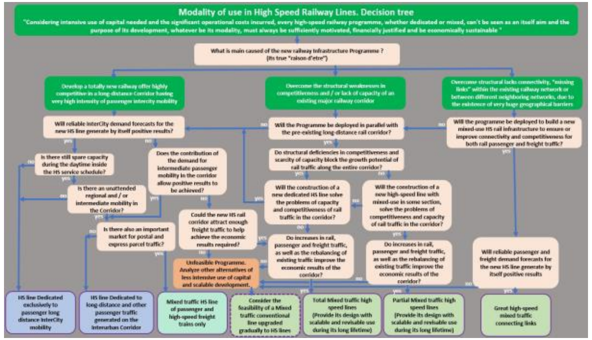
1. General aspects

- Mixed traffic implementation contribute to the **decongestion** of network sections, bottlenecks where there are saturation problems.
- Mixed traffic has a **significant influence** on the design, construction, operation and maintenance of the railway system.
- For economic reasons, mixed high-speed lines need to satisfy a balance on the competitiveness of passenger and freight service, in this aspect, the **performance of passenger trains is determinant** on the design and architecture of each subsystem that conforms the line.
- Therefore, the **higher part of the cost of a mixed high-speed line is basically attributable to passenger service**. Its mixed nature adds some **extra costs** whose impact will basically depend on the difficulties of the line layout, as well as the need to incorporate certain specific facilities.
- On the other hand, increasing needs for freight transport can lead to the saturation of the capacity of the line, constraining the **capacity of passenger trains**, main support of its justification and sustainability.

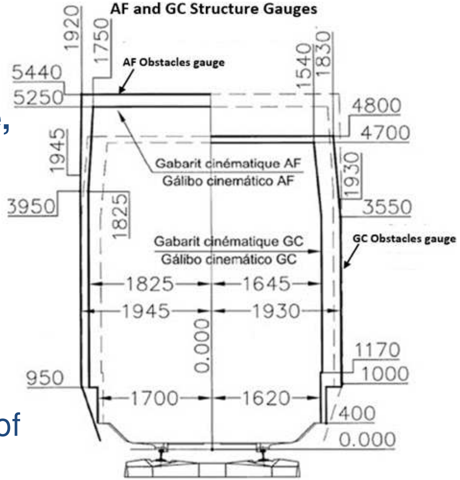
2. Planning and decision-making aspects

- The motivations to develop a mixed high-speed lines could be as follows:
  - Increase competitiveness of rail transport
  - Need to solve saturation problems in main sections of the railway
  - Convenience to solve structural deficiencies in connectivity, "lost links“
- Regardless its motivation, the development of a high-speed line should be carried out by applying proven and up to date railway technologies, in order to provide truly competitive transport solutions.
- Decision-making in each case should be based on **specific studies:**
  - Cost-Benefit analysis
  - Operation scenarios
  - Configuration of the infrastructure
  - Configuration of the rail service



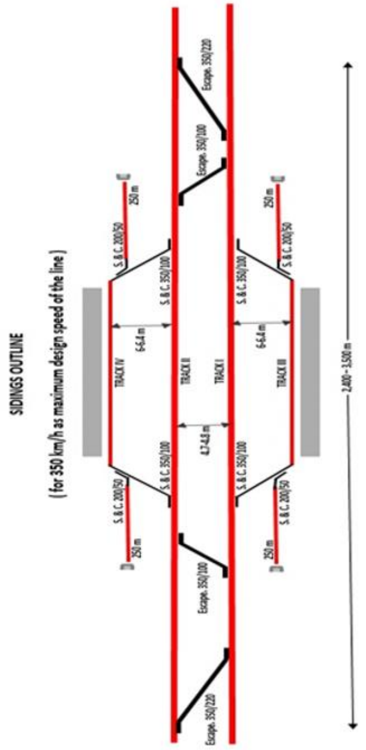
3. Infrastructure characterization parameters

- **Line performance recommendations (depending on national IM)**
  - Maximum speed: 250 ≤ Vmax ≤ 300 km / h, the closer to 250 the more feasible will be the mixed line.
  - Minimum speed of slower trains, freight, Vmin≥100 km/h, the higher the more feasible the operation of mixed traffic will be.
  - Maximum axle load - 25 tonnes (normally due to freight trains) (even more)
  - Maximum total train length. Passenger 400m; freight 850-1050m (including traction locomotives).
- **Requirements (only those affected by mixed use of the line)**
  - Structure Gauge. Convenience of establishing as freight gauge, the **piggyback gauge, according to market expectations** of this kind of trains on the corridor served.
  - Distance between track centers ≥ 4.7 m. (depending on IM)
  - Maximum gradients. Standard 12.5 mm/m, exceptional 18 mm/m
  - Minimum radius of horizontal curve, cant limit, deficiency and excess values.
  - Design cant. 110-120 mm, exceptional 140 mm.
  - Maximum Cant Deficiency: 100 mm (due to best passenger comfort. Just for safety reasons the limit could be raised up to 150mm).
  - Depending on the volume of freight traffic it is recommended a maximum cant excess of 80-90 mm to mitigate the damages caused of slow trains loads on the inside rail



4. Impact on Infrastructure and Facilities

- Less distance between siding loops and greater length of stabling tracks
    - Crossover implementation every 10 km approximately.
    - Spacing between siding loops 30 to 50 km.
    - Average length of sidings 2.0 to 2.5 km.
- Additional infrastructure connecting with the conventional freight network
- Mixed traffic requires additional specific safety and security equipment within the tunnels
    - Sizing of fire-resistance and fire-fighting elements
    - Sizing of a forced ventilation system (emergency situations)
    - Separate evacuation network for potential dangerous spills (fire-break siphons, etc.)
- Mixed traffic increases the needs and number of trackside equipment with a centralized control to guarantee safety and maintainability of the line, specifically:
    - Vertical track impact and unbalanced loads detectors: It is also recommended that the spacing between two consecutive detectors not to exceed 40/50 km (similar spacing as siding loops)
    - Dragged objects and derailed axle detectors. Every 40/50 km.
    - Pantograph lift detectors, not specific for freight, but essential. Also, every 40/50 km.
    - This spacing will depend on the level of availability to be provided to the line.



5. Rail Operations

- **Mixed traffic may reduce the capacity of high-speed lines:**
  - Limits and complicates the allocation of capacity by increasing the probability of conflicting paths.
  - The difficulties of path allocation to freight trains increase with the intensity of passenger traffic and the length of the line.
  - Given the greater commercial interest of passenger trains, their circulation will prevail in case of conflict on freight trains.
  - The segregated operating model, passenger trains during the day and freight at night, is the most appropriate when passenger demand is high and requires train intervals of less than 30 minutes. In that case full coordination with maintenance works scheduling is essential.
  - However, on high traffic intensity lines the shorter the mixed traffic route is, the more possibilities to be able to schedule freight trains into the daytime timetable, through a batch operation model of homogeneous trains with sequential circulation.
- **Access conditions to be required to freight trains (ERTMS, others,)**

6. Aerodynamic phenomena

- If possible, implement twin tube tunnels to avoid crossing that need speed restrictions
- Ideally, limit the maximum speed of high-speed trains to 200 km/h (max.) in double-track tunnels whenever there is a possibility of crossings with freight trains inside the tunnels.
- Integrity and fastening requirements of the load of the wagons admissible to circulate on mixed traffic high speed lines
- Key aerodynamics aspects on mixed traffic lines:
  - The aerodynamics of crossing at open air sections originates a set of pressure pulses, which translate mainly to lateral forces and bending moments.
  - The case of wagons with fabric covers should be considered as a potential problem.
  - During crossing at open air sections with cross wind, the pressure pulses are less important when wind speed increases.
  - During the crossing inside a tunnel, strong compression/tension loads may produce fatigue in the material, damage in load, risk of door opening, necessity of prevision for venting in some containers or goods, etc.

Objective is to maximize the crossing speed in order to maximize the capacity and to avoid damages with increasing speeds, to freight wagons and loads during operation.

7. Effects on the reliability and quality of rail service

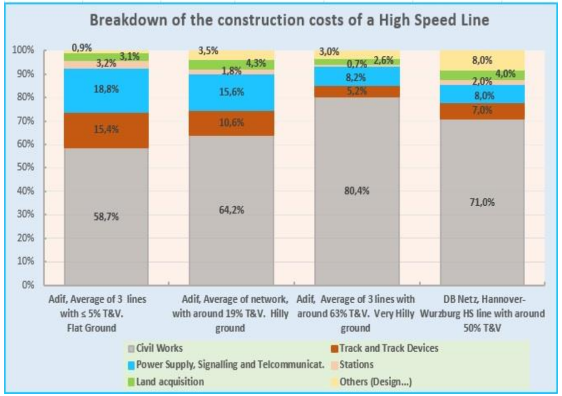
- **In mixed traffic lines the likelihood of traffic disruption is significantly higher than those existing in passenger-only lines**.
- This increased risk of disruptions on the service on mixed traffic lines might result in impacts on:
  - Reduction in the reliability of passenger service
  - Reduction of speeds and increase of travel time
  - Impact to customer experience
  - Effects on the operating costs of the service and the income of passenger service

Faster passenger High Speed trains, Vmax = 300km/h, running at every daily hours o'clock.
Faster passenger high speed trains, Vmax = 300 km/h, running at each half daily hours o'clock.
Regional Passenger high speed trains, Vmax = 250km/h, running at 15m pass and to every daily Hours o'clock.
Freight trains path allocation on a high speed line daytime schedule, depending on passenger trains traffic intensity.

8. Construction costs

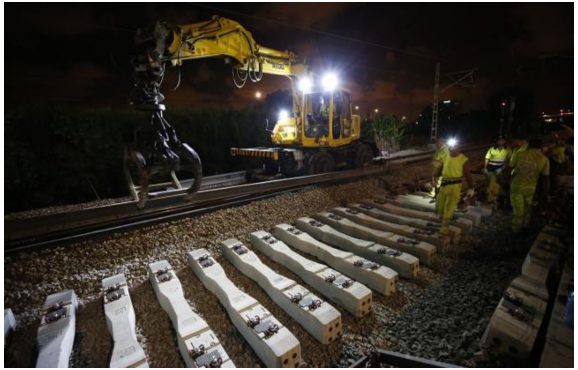
Possible **additional infrastructure costs** lines basically will come from the following aspects:

- Greater minimum radius in horizontal curves and limitations in the maximum gradients, which implies greater volumes of civil works, tunnels and viaducts, to overcome geographical barriers or urban crossings. The proportion of V and T and urban renewal works in a line due to geotechnical restrictions to support this gradient is on the side of freight.
  - Increase of track centers distance (>4,5 – 4,7m) due to crossings trains with different aerodynamic profiles.
  - Longer trains running on the line, > than 750 m vs 400m.
  - Specific structure requirements
  - Specific facilities (yards, links with other rail lines; bypasses for freight traffic, etc.)
  - Increased number of passing loops, crossovers, throughout the line
  - Additional and longer sidings
  - Possible need for reinforcement safety and security with trackside systems to monitor on real time the status of the rolling stock.



9. O&M Costs

- **Freight traffic does not substantially increase maintenance costs on high-speed lines, if the following requirements are met:**
  - Find and set the most suitable balance between the deficiency and excess cant for each specific route, avoiding untimely wear on small curves.
  - Limit and ensure the maximum axle load of freight trains in **22.5-25.0 tons**
  - Homogeneous distribution of the load throughout the train and its fastenings, avoiding unbalanced loads and load shifts.
  - Require and verify compliance with their own freight trains Maintenance Plan
  - Provision along the line of several kind of **detectors**, to control dynamic behavior of the train's rolling equipment and pantograph..
- According to the information available, mixed high-speed lines do not generate substantial additional maintenance costs (**only on operating costs** due to traffic control and safety), when **freight trains running at night-time**.



10. CONCLUSIONS

- The **selection and decision between a dedicated high-speed system and a shared-use high-speed line system** is the **fundamental question** ever since the preliminary phase in planning and designing of a new High-Speed program.
- The main expected advantages of a mixed HSL over an exclusive of passengers:
  - Enhance capacity for the entire rail network and eliminate bottlenecks.
  - Contribution to improve the profitability of high-speed lines due to use increase
  - Improving the competitiveness of rail freight transport and opening up to new higher value markets
- The decision process should consider and evaluate several key factors, characterization of the mobility market, pre-existing network, possibility to implement infrastructure requirements, **cost-benefit analysis**, etc..
- Mixed traffic may have impact on:
  - Infrastructure basic parameters
  - Operation restrictions
  - Reliability & quality on the passenger service
  - Construction cost
  - O&M cost (not that high)

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THANK YOU

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Session number and Name

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Environmental Friendly and Cost Effective HSL Design

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Obsticle on and under ground increas cost for HS railway

On ground

Buildings
Rivers
Forest
Vild animals
People
Roads
Nature
Agricultural
Birds
Monuments

Under ground

Arceological objects
Hard rock
Ground water
Instable soil
Soft clay
Polution
Perma frost

No obsticle over ground reduce cost for HS railway

Over ground

On ground

Buildings Rivers Forest Vild animals People

Roads Nature Agricultural Birds Monuments

Under ground

Arceological objects Hard rock Ground water Instable soil

Soft clay Polution Perma frost

High Speed Rail on embankment or landscape bridge?

Embankment 200 – 300 km/h

- Wide track corridore and service road 50 meter wide
- Track side obsticles 400 objects (1,6 /km)
- Re-route road network and service roads 200 roads 0,7 /km
- Ballast track – track alignment disturbence
- Barrier effect animals, persons, flowes etc.
- Expencive track maintanence
- Track buckling danger
- Transsioson zone dangers

Landscape bridge 300 – 500 km/h

- Narrow track corridore 15 meter wide incl. Service road
- Track side obsticles 40 objects (0,16 /km)
- Non influence on roads
- Slab track – No derailment and track buckling
- No barrier against animals, persons, flowes etc.
- Low track maintanence cost
- Low noice disturbance
- Excellent ride comfort

Masses for embankment HS railway

Embankment 192 806 ton/km

❖ Land use 30 m wide is 30 000 m2/km	484 ton/km
❖ Ground preparaton, soil clearance, piling	38 000 ton/km
❖ Back fill and stabilization and compactation	1 600 ton/km
❖ Embankment elevation 2,0 m	100 000 ton/km
❖ Permafrost isolation layer 0,5 m	20 700 ton/km
❖ Enforcement layer 0,5 m	18 630 ton/km
❖ Ballast layer 0,35 m	12 558 ton/km
❖ Rails, sleepers, fastings	657 ton/km
❖ Catinary fundamentation	160 ton/km
❖ Catinary pole and wireing	15 ton/km
❖ Signalling system	2 ton/km
❖ Mass weight 1 km embankment	192 806 ton/km
❖ Mass transport 5 843 lorries/km	964 030 tonkm

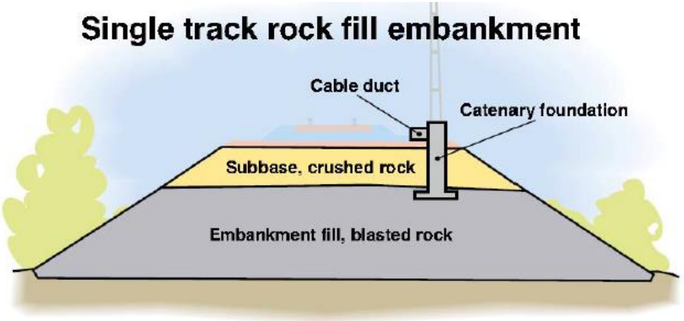
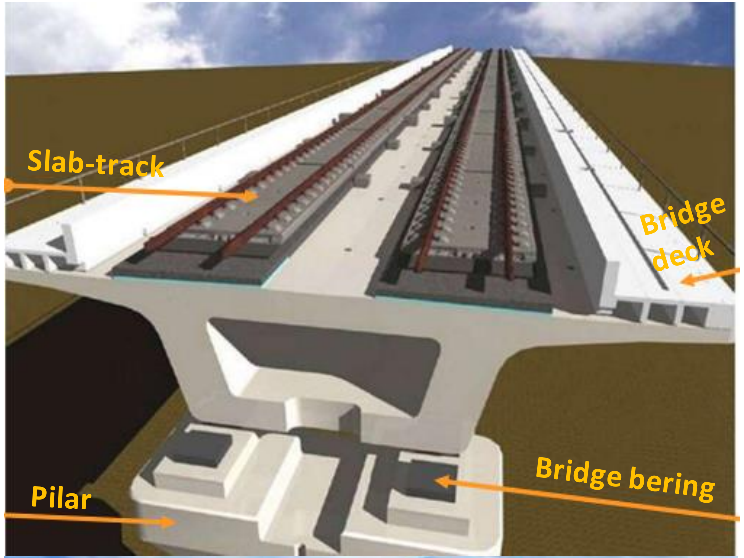


Figure 4 Schematic figure showing a railway foundation on flat land.

Masses for landscape bridge HS railway

Landscape bridge system 55 685 ton/km

❖ Land use 15 m wide is 15 000 m2/km	242 ton/km
❖ Fundation pit 25 units 1 750 m3	2 558 ton/km
❖ Ground enforcment pilar 12 x 25 units	8 478 ton/km
❖ Fundation block 25 units	10 260 ton/km
❖ Bridge pilar elevation 12 m	8 640 ton/km
❖ Bridge deck 40,6 m	23 153 ton/km
❖ Slab-track	2 397 ton/km
❖ Rails	240 ton/km
❖ Catinary fundamentation	0 ton/km
❖ Catinary pole and wireing	15 ton/km
❖ Signalling system	2 ton/km
❖ Mass weight 1 km landbridge	55 985 ton/km
❖ Mass transport 1 697 lorries/km	279 925 tonkm



CO2 emission for embankment HS railway

CO2 neutral after 340 000 passenger/year

❖ Land use 30 m wide is 30 000 m2/km	1,7 tonCO2/km/år
❖ Ground preparaton, soil clearance, piling	15,5 tonCO2/km/år
❖ Back fill and stabilization and compactation	0,7 tonCO2/km/år
❖ Embankment elevation 2,0 m	0,5 tonCO2/km/år
❖ Permafrost isolation layer 0,5 m	0,5 tonCO2/km/år
❖ Enforcement layer 0,5 m	0,5 tonCO2/km/år
❖ Ballast layer 0,35 m	1,0 tonCO2/km/år
❖ Rail, sliper, fastings	20,6 tonCO2/km/år
❖ Catinary fundamentation	1,0 tonCO2/km/år
❖ Catinary pole and wireing	2,3 tonCO2/km/år
❖ Signalling system	0,3 tonCO2/km/år
❖ Transports	6,1 tonCO2/km/år
❖ CO2 emission 1 km embankment	50,7 tonCO2/km/år

CO2 emission for landscape bridge HS railway

CO2 neutral after 857 000 passenger/year

Land use 15 m wide is 15 000 m2/km	0,9 tonCO2/km/år
Fundation pit 25 units 1 750 m3	0,3 tonCO2/km/år
Ground enforcment pilar 12 x 25 units	0,2 tonCO2/km/år
Fundation block 25 units	25,6 tonCO2/km/år
Bridge pilar elevation 12 m	21,6 tonCO2/km/år
Bridge deck 40,6 m	58,0 tonCO2/km/år
Slab-track	12,0 tonCO2/km/år
Rails	8,0 tonCO2/km/år
Catinary fundamentation	0,0 tonCO2/km/år
Catinary pole and wireing	0,5 tonCO2/km/år
Signalling system	0,1 tonCO2/km/år
Transports	1,4 tonCO2/km/år
CO2 in ton per 1 km landbridge	128,6 tonCO2/km/år

Concrete and steel use for surface, tunnel and bridge

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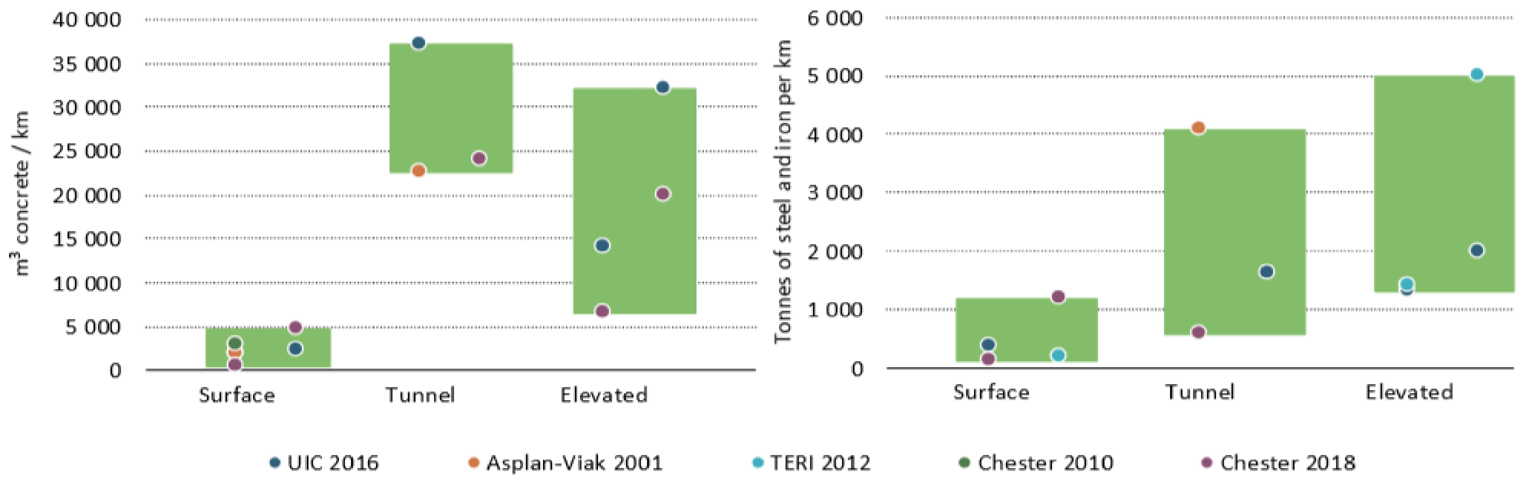
Figure 1.30 **Concrete, steel and iron use for one kilometre of conventional rail line (double track)**



Note: Boxes represent the range of material use in various projects and points represent values in the academic research mentioned in the cited sources. Elevated structures include bridges and viaducts. It should be noted that the use of tunnels and viaducts may have other important benefits, for example increased safety and less land use, and necessity for additional infrastructure for line crossings.

Sources: Chester and Horvath (2010); UIC (2016) and TERI (2012).

Performance example

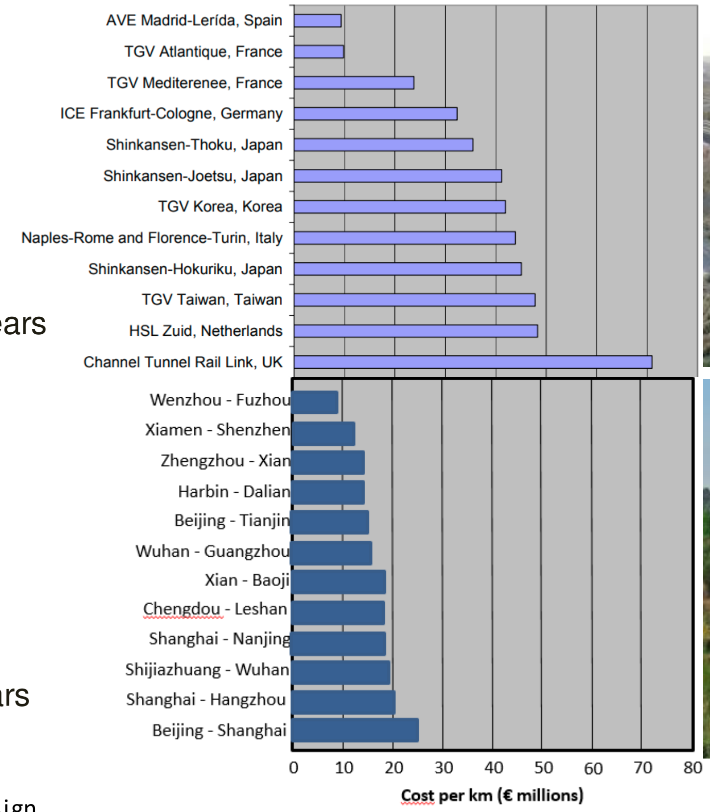
Embankment HS railway

- 170 km 7 years
- 50 000 000 €/km
- Total cost 8,5 bn€
- Pay-back 0,1 €/km
- 500 million passenger 25 years

Landscape bridge HS railway

- 480 km 3 years
- 20 000 000 €/km
- Total cost 9,6 bn€
- Pay-back 0,1 €/km
- 200 million passenger 10 years

FIGURE 4.1 HIGH SPEED LINE CONSTRUCTION COSTS PER KM



Cost Benefit Analysis embankment vs. Landscape bridges

Embankment 200 – 300 km/h

- Construktion time 10 – 15 years
- Standard cost 40 000 – 60 000 €/meter + 30% risk
- Intrest cost during construction 10 years 20 000 €/meter
- Loss of revenue 10 years 10 millinon pax/year 10 bn€
- **No private financer is posible – too high risk**
- Project pain and waiting
- Investment pay-back – too long

Landscape bridge 300 – 500 km/h

- Construction time 5 years
- Standard cost 30 000 €/meter fixed price
- Intrest 5 year shorter construction time 10 000 €/m
- Revenue profit 5 years 10 million pax/year 5 bn€
- **Private Public Partnership finance posible – low risk**
- Project sucess and less waiting
- Investment pay-back less then 20 years

Elevetade track the most common technology today

Great progress and fast building of landscape bridge track

- Today elevated track is most used technology for HSR
- Today 40 000 km elevetad track is equal to 1 round around the globe
- 2030 80 000 km HSR will be built equal to 2 rounds around the globe
- 2050 120 000 km HSR will be built equal to 3 rounds around the globe
- Climate change calls for rapid HSR development to reduce CO_2
- Elevated track have allways a sharp fixed price tag with low risk
- Elevated track reduce the demand for tunnels along the line
- Elevated track gives higher performance and higer revenues

Higher speed do not cost at all on elevated tracks,
but can be far more exepnsive on embankments

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RESILIENT RIVER LANDSCAPES AND HIGH SPEED RAIL

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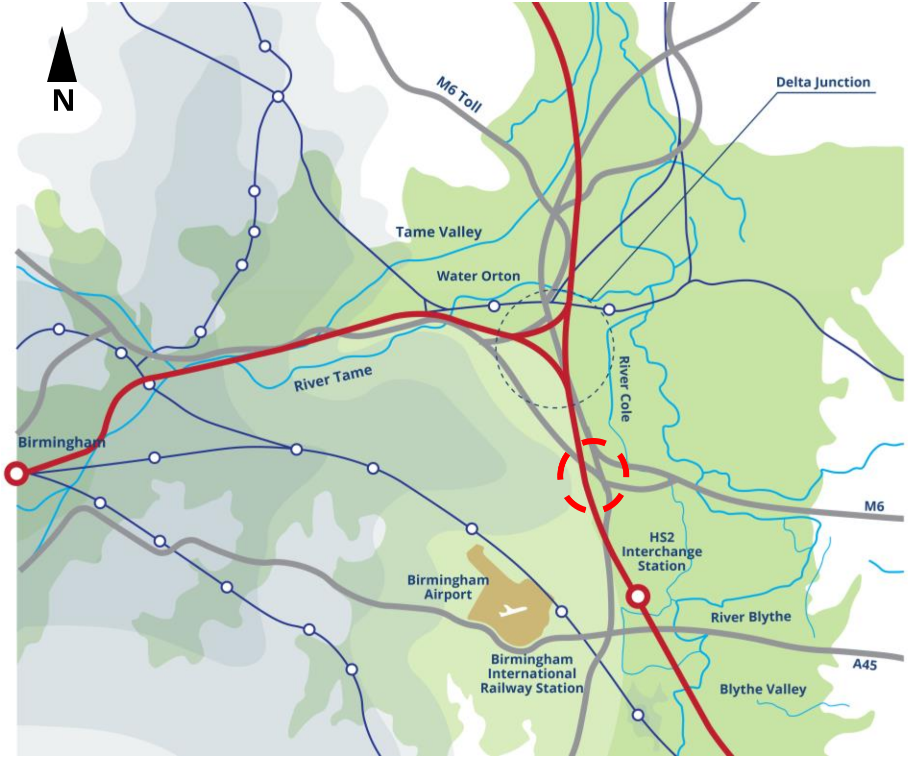
RIVER COLE AND HS2



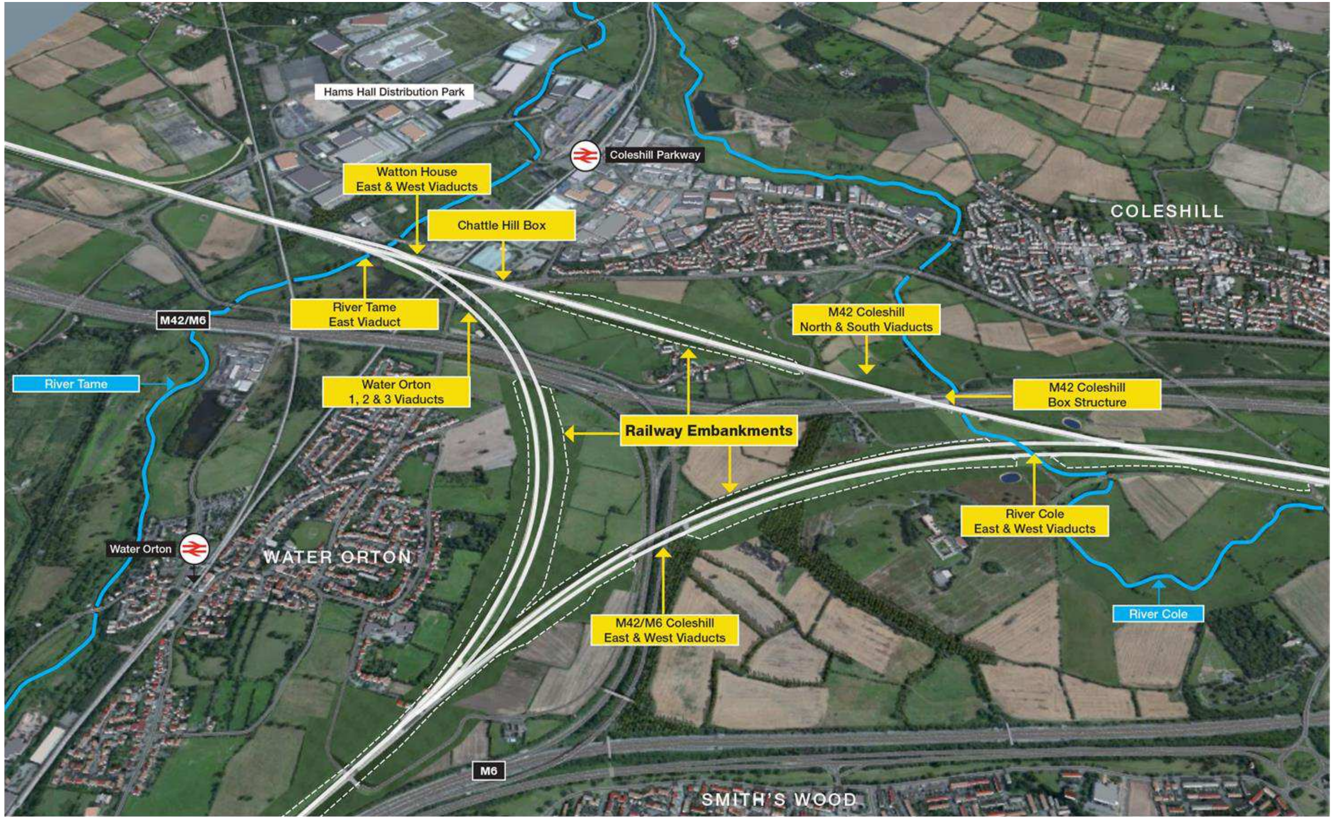
LEGEND

- HS2 Line
- HS2 Station
- National Rail Existing
- Existing Stations
- Main Highways Network
- River
- North Warwickshire Boundary
- River Cole Key Design Element (KDE)

Urban Density

Urban — Rural

RIVER COLE AND HS2



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LANDSCAPE CHARACTER

- Arden National Character Area (97)
- Located in the M42 and Cole Valley LCAs;
- Landscape character defined by M42 and M6;
- Flat landform with small to medium fields sizes;
- Strong hedgerows and motorway planting provide structure;
- Retains a rural character even with the motorways and pylons;
- Due to vehicle noise and lighting the tranquillity is low;
- But this is only half the story in this location.


Manor Drive


Coleshill Manor


View through the valley


River Cole


Formal Parkland Landscape


Coleshill Manor Parkland

HS2 DESIGN VISION

People
Design for everyone to benefit and enjoy

1 Design for the needs of our diverse audiences
2 Engage with communities over the life of the project
3 Inspire excellence through creative talent

Place
Design for a sense of place

4 Design places and spaces that support quality of life
5 Celebrate the local within a coherent national narrative
6 Demonstrate commitment to the natural world

Time
Design to stand the test of time

7 Design to adapt for future generations
8 Place a premium on the personal time of customers
9 Make the most of the time to design

Conserve

A sensitive high value landscape is likely to require a landscape design approach that creates significant screening and integration of HS2 but also develops measures that will conserve and enhance the overall landscape character.

Design measures will depend on local context but may include subtle earthworks designed to integrate HS2 and respect distinctive local topography. Planting design to replicate local patterns and reconfigure agricultural land to retain existing field sizes and patterns. Where practicable, local materials and styles will be selected to enhance landscape settings and recreate locally distinctive landscape features.

Restore

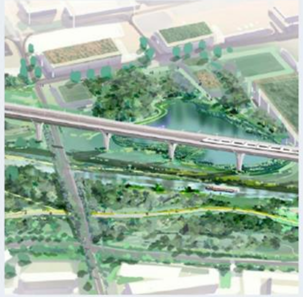
HS2 may traverse a landscape that has lost or is losing original features and qualities that provided its intrinsic landscape character. The opportunity is to restore and significantly improve existing landscape character.

The approach required may be gently graded earthworks that fit with distinctive local topography, whilst also providing visual screening. Extensive woodland and hedgerow planting to screen and integrate the railway whilst also rebuilding the local landscape pattern and restoring its character. Reconnected cycle and pedestrian routes will help to promote permeability.

Enhance

A landscape in which HS2 may be potentially highly visible is likely to require a bold landscape design approach to create effective screening and integration but also gives the opportunity for enhancement of local landscape character.

Measures may include large scale earthworks to integrate HS2 into the landscape, acting with large scale woodland planting to integrate the railway and screen noise barriers. Connected networks can be developed to enhance and link local water bodies, streams and waterways with woodland, field and hedgerow habitats to deliver overall landscape enhancement.



Transform

Some areas through which HS2 is planned may be in very poor landscape condition or are of a character that HS2 can bring bold transformation to that can also provide wide benefits and support local economies. The opportunity for HS2 bringing transformation and wide-reaching positive landscape change may occur both in rural and urban locations.

Public open space for local community and businesses may be created to include a range of leisure and recreational activities. Distinctive earthworks and artworks can be combined with water bodies and woodlands to create bold new spaces to link with the wider landscape and PRoW networks.

KEY PRICIPLES AND LANDSCAPE INTEGRATION

Heritage
Recognise the craft in surrounding heritage assets in the design.

Water
Use the aquatic environment as the base layer for the design focusing on the river diversion, ponds and flood storage areas.

Ecology
Provide habitat, foraging and connectivity for a diversity of wildlife

Landscape
Landscape design to promote the wider HS2 Green Corridor, mitigation requirements and to focus the river diversion area on accessibility and delivering a Nature Based Solutions approach.




Nature Based Solution
Deliver an integrated design approach that links the environmental and social system holistically:

- Flooding and ponds
- River diversion
- Biodiversity
- Heritage
- Recreation, health and wellbeing
- Resource efficiency
- Clean water
- Climate resilience
- Aesthetics
- Stewardship

HERITAGE

2nd century AD Romano-British building and enclosures

Late Iron Age/Early Romano-British: 3 roundhouses

Former boat house

Bronze Age burnt mound and Iron Age pit alignment

20 Iron Age pits aligned in a row

Two Iron Age roundhouses

Iron Age cremation burials, field systems and 30 aligned pits

Bronze age burnt mound

Medieval moated hall and gardens and Gatehouse with viewing mound

Excavations carried out at date

Mediaeval deer park - 13th Century historic map

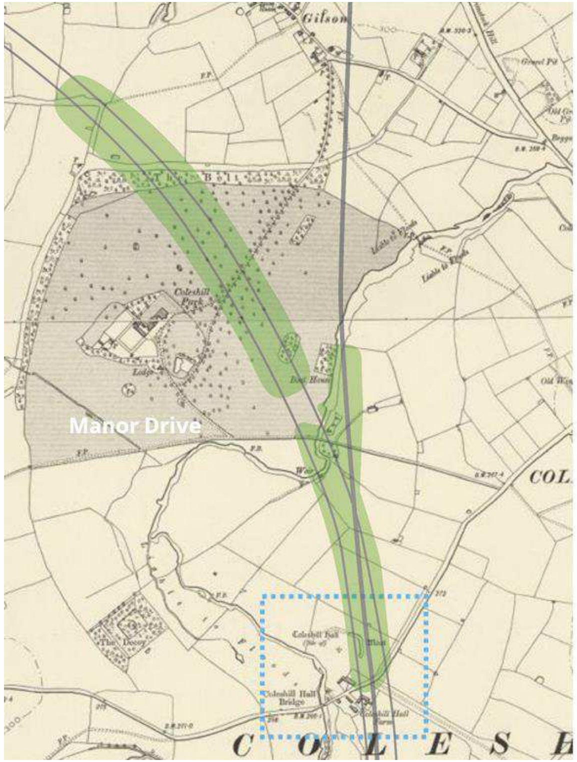
Historical layers with HS2 project and enhancement opportunities

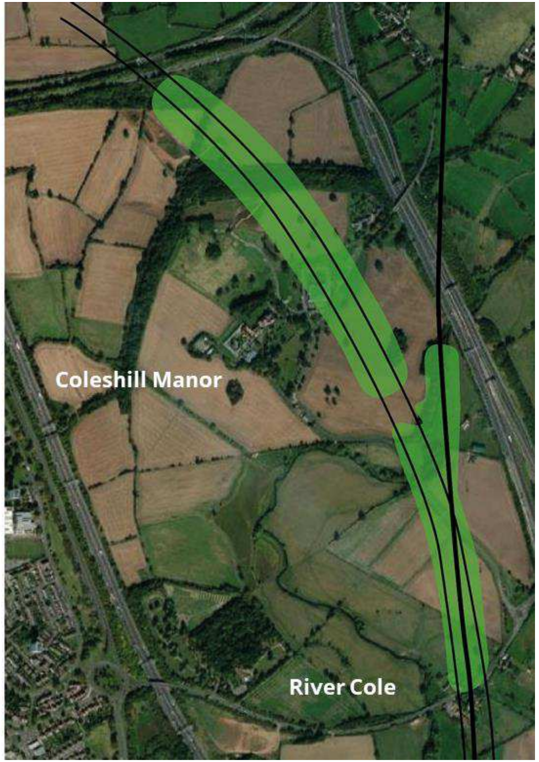
Raised viewpoint with views towards the Manor and Manor Drive planting and over the River Cole

Proposed tree planting on a grid form within the replacement flood storage area

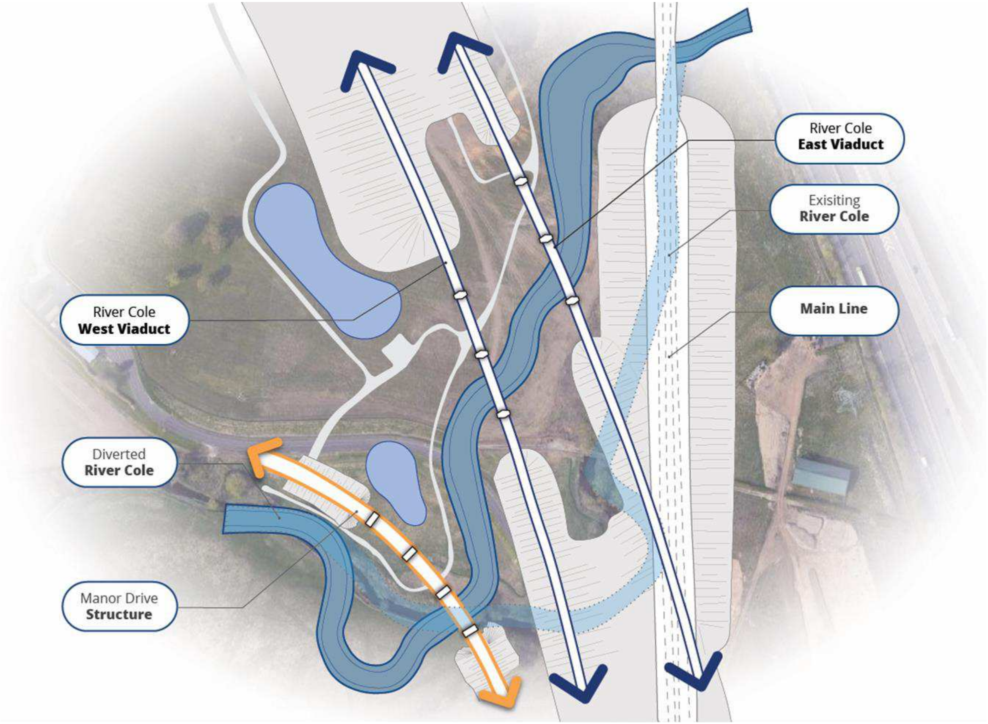
Historical PRoW retained and enhanced

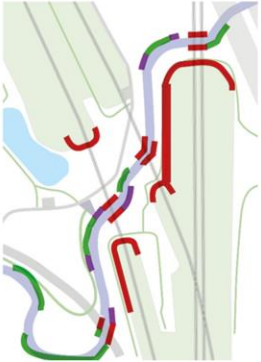
HERITAGE





WATER

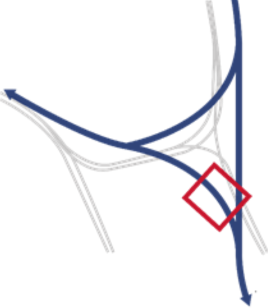




- Rip-rap
- Erosion control mat
- Pre planted Coir matting

- River Cole diversion
- Ecological ponds
- Manor Drive Structure
- HS2 Birmingham spur
- Mainline
- Embankment
- River Cole piers
- Manor Drove piers

Key plan



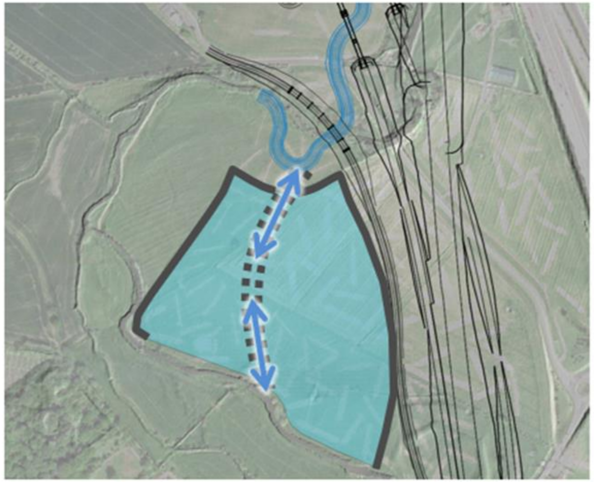
WATER

- Three options considered for upstream replacement floodplain storage (RFS)

Opening to the south

Opening to the north

Opening south and north with flood conveyance channel



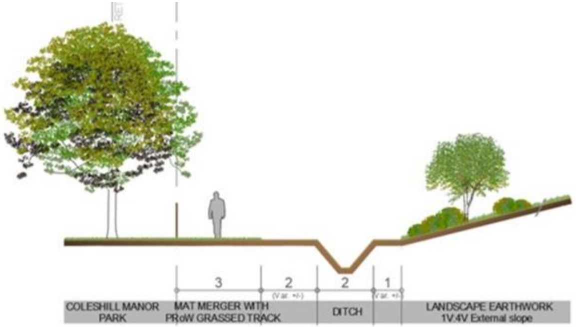
ECOLOGY



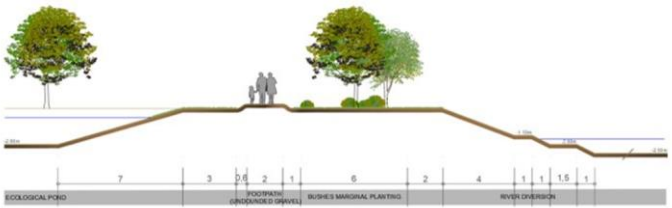


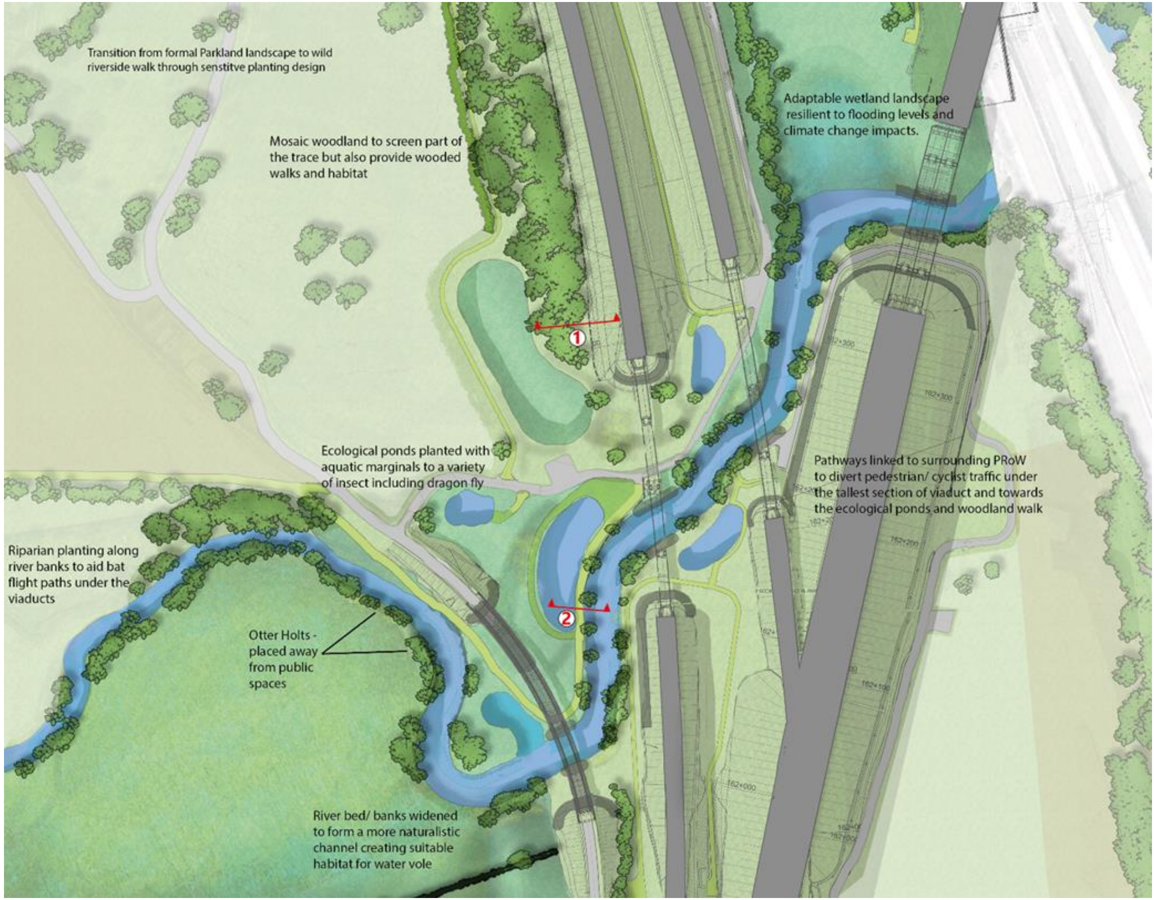

LANDSCAPE

Section 1



Section 2





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River Cole 2021 design – Aerial view – Year 10 post-construction in Summer

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11TH WORLD CONGRESS OF HIGH-SPEED RAIL

Marrakech, 7-10 MARCH 2023

Development of Rail Technology for High Speed Railway in China

Fengshou, Liu
Researcher, CARS, China
Session5.1 Infrastructure /Design

ONCF UIC

CONTENTS

1 Introduction

High Speed Railway (HSR)

- By the end of 2022, China has over 42,000 kilometers of HSRs in operation.
- HSR network composed of eight north-south and eight east-west corridors.
- High smoothness, good line conditions and stable infrastructure.






1 Introduction

Rail Technology for HSR

- **HSR Rail**: suitable for complex cold, hot climatic conditions, high humidity and high salt harsh environments.
- **HSR Rail**: the largest consumption, the most frequent maintenance among the high strength steel for HSR infrastructure.
- Over the past decade, based on independent innovation, rail technology for HSR has achieved breakthroughs in standards, quality, wheel-rail matching relationship, service performance, etc.

2 Standards and Products

Standards

- Including rail products, welding, selection, operation and maintenance.
- Independent innovation, scientific and advanced, highly operational.
- Leading and ensuring the improvement of rail manufacturing and quality.
- Complete rail technical standard system, keep in line with international standards.

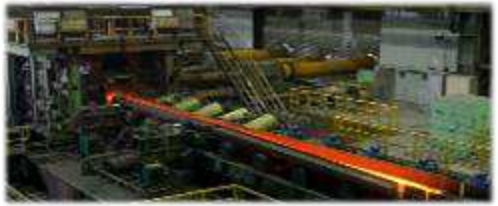
Steel Grade		Tensile Strength R_m MPa	Elongation A %	Head Crown Hardness HBW (HBW10/3000)
U71Mn	As-Rolled Rail	≥880	≥10	260-300
U75V		≥980	≥10	280-320
U71Mn	Heat-treated Rail	≥1080	≥10	320-380
U75V		≥1180	≥10	340-400

2 Standards and Products

Manufacturing technology

- International advanced equipment and technology
- **High internal quality**: Smelting, refining and continuous casting technology
- **High flatness and high straightness**： Hot pre-bending technology, horizontal and vertical composite straightening technology








2 Standards and Products

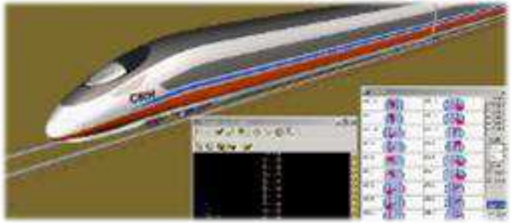
Rail Products

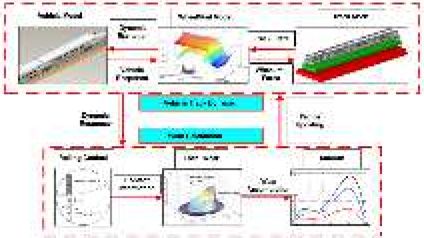
- Full independent intellectual property rights and all localization.
- **100m rail of HSR**: high purity, high dimensional accuracy, high flatness, high straightness and high surface quality.
- HSR rails are exported to Jakarta-Bandung High Speed Railway in Indonesia , which is active to serve high-quality development of Belt & Road Initiative.

3 Operation and Maintenance Technology

Theoretical and Technical Support

- The high-speed train-track coupling system dynamics, wheel-rail contact mechanics simulation platform and wheel-rail friction and wear test platform have been established systematically.

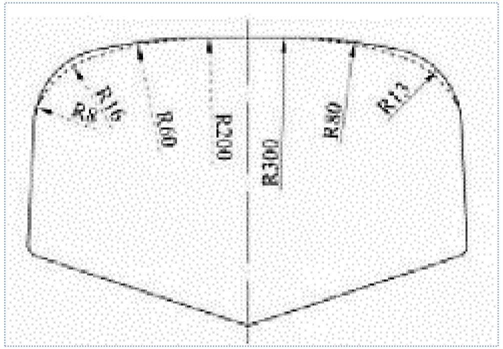




3 Operation and Maintenance Technology

60N Profile and Rail Grinding Technology

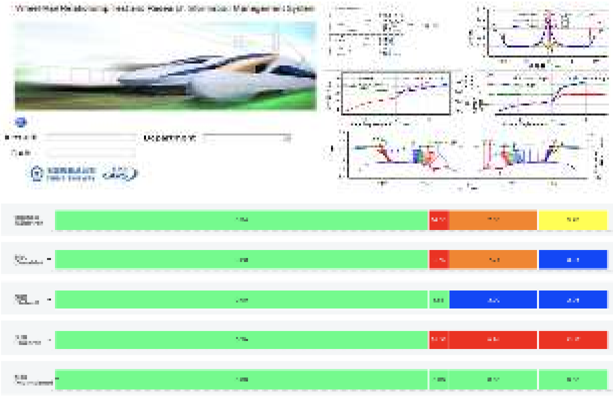
- **The 60N profile**(the dash line below): more suitable for the wheel-rail relationship of HSR, effectively guarantees the operation quality of high-speed trains.
- Rail grinding technology system: on-site inspection, status analysis, project design, operation implementation, quality acceptance. Improve the wheel-rail relationship, improve the running quality of the train, and extend the service life of the rail.



3 Operation and Maintenance Technology

Inspection and Evaluation of Rail Service Status

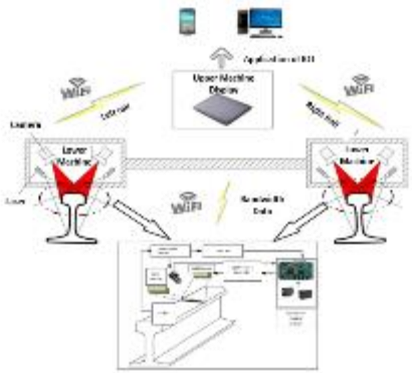
- **Inspection and evaluation technology** for wheel/rail profile, rail smoothness, rail surface state, mechanical properties, vibration characteristics, damage, etc.
- **Management platform** for rail service status and wheel-rail matching status.

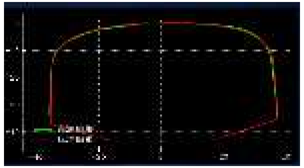


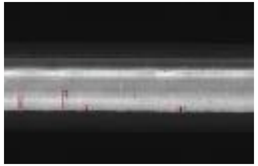
4 Prospect

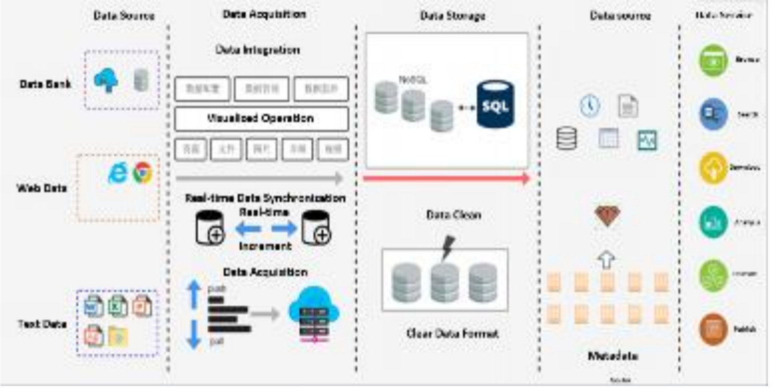
Intelligent Operation and Maintenance

- **More intelligent and higher speed**
- Accurate detection and evaluation and intelligent decision-making
- Rail life cycle health management
- **New generation HSR rail**: better performance, better wheel-rail matching relationship









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Marrakech, 7-10 MARCH 2023

Light-Visual Fusion Builds Railway Safety Base

Gu,Yunbo

President of Huawei's Enterprise Optical Business Domain

Session5.1 Infrastructure /Design

ONCF UIC HUAWEI

As railways continue to speed up, safety risks increase

People, animals break in

Frequent accidents and great safety hazards

Environmental impact

High maintenance costs and poor real-time inspection

Stealing incident/orbit damage

Traditional preventive maintenance measures have poor effect.

Long-distance coverage and accurate positioning

Fast reporting of valid alarms

Cost-effective and fast deployment

Multiple sensing technologies will be used to respond to external threats

Types of accidents as defined in UIC-SDB

Individual(58.3%) & Obstacle(24.8%): 83.1%

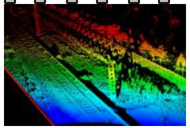
Types of accidents as defined in UIC-SDB		Additional information from UIC-SDB	
8.5%	Derailment of trains		
1.2%	Train collision with another train		
24.8%	Train collision with an obstacle	7.0%	Train collision with an obstacle not at LC
		17.8%	Train collision with an obstacle at LC
58.3%	Individual hit by a train	9.1%	Individual hit by a train at LC
		49.2%	Individual hit by a train not at LC
1.8%	Individual falling from a train		

Causes of accidents as defined in UIC-SDB

External Causes: 78.2%

2021	Causes at first level	Causes at second level	
EXTERNAL CAUSES 78.2%	THIRD PARTIES 75.4%	Trespassing	44.7%
		Vehicle (LC accident)	18.0%
		Pedestrian (LC accident)	9.2%
		Pedestrian on public railway area	2.2%
		Other or not specified	1.3%
	WEATHER & ENVIRONMENT 2.9%	Environment	2.4%
		Weather	0.5%

** From UIC Safety Report 2022*



Individual: Machine Vision + Fiber Optic Sensing or mmWave Radar

Obstacle: Machine Vision + Lidar

Sensing OptiX: all-weather, efficient perimeter protection solution

Current Situation and Challenges


People/Car break-in

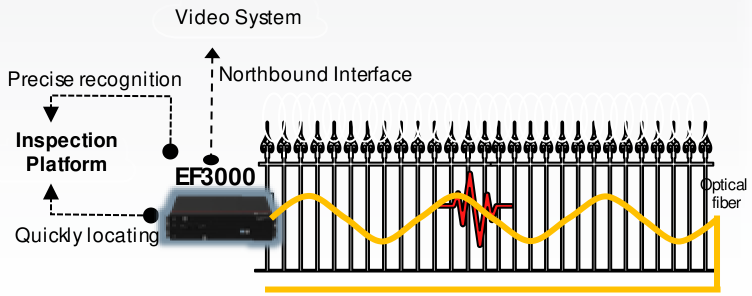

Environmental impact


Animal migration


Stealing

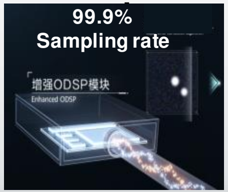
- Difficult to monitor in real-time
- Low efficiency of manual inspection
- Large property loss

Optical Sensing solutions for perimeter protection



Fiber	Fence	Perimeter
Fence-mounted + Buried	Railing Fence + Solid Fence	>5KM Distance

Lower missing alarms



Lower false alarms rate

Benefits

reduced missed alarms

80%

< 1%

5% → 1%

reduced falsed alarms

90%

< 1

10 → 1

false alarm/km/day

Light-Visual Fusion Builds Railway Safety Base

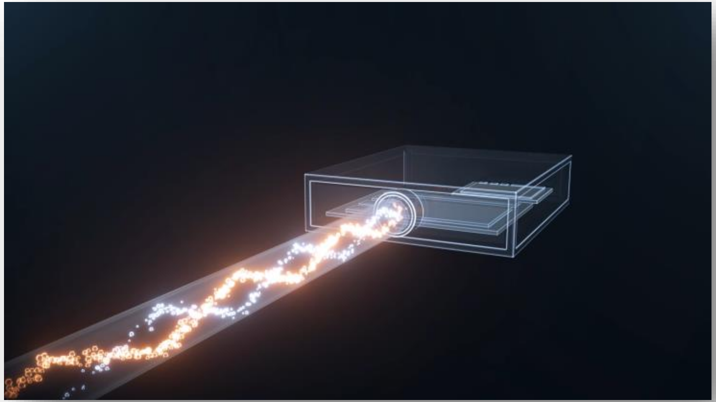
Sensing OptiX: Innovative Technologies

Enhanced oDSP:

Super error correction algorithm, improving the identification of weak signals.

(Industry average: 96% -> **Huawei: 99.9%**)

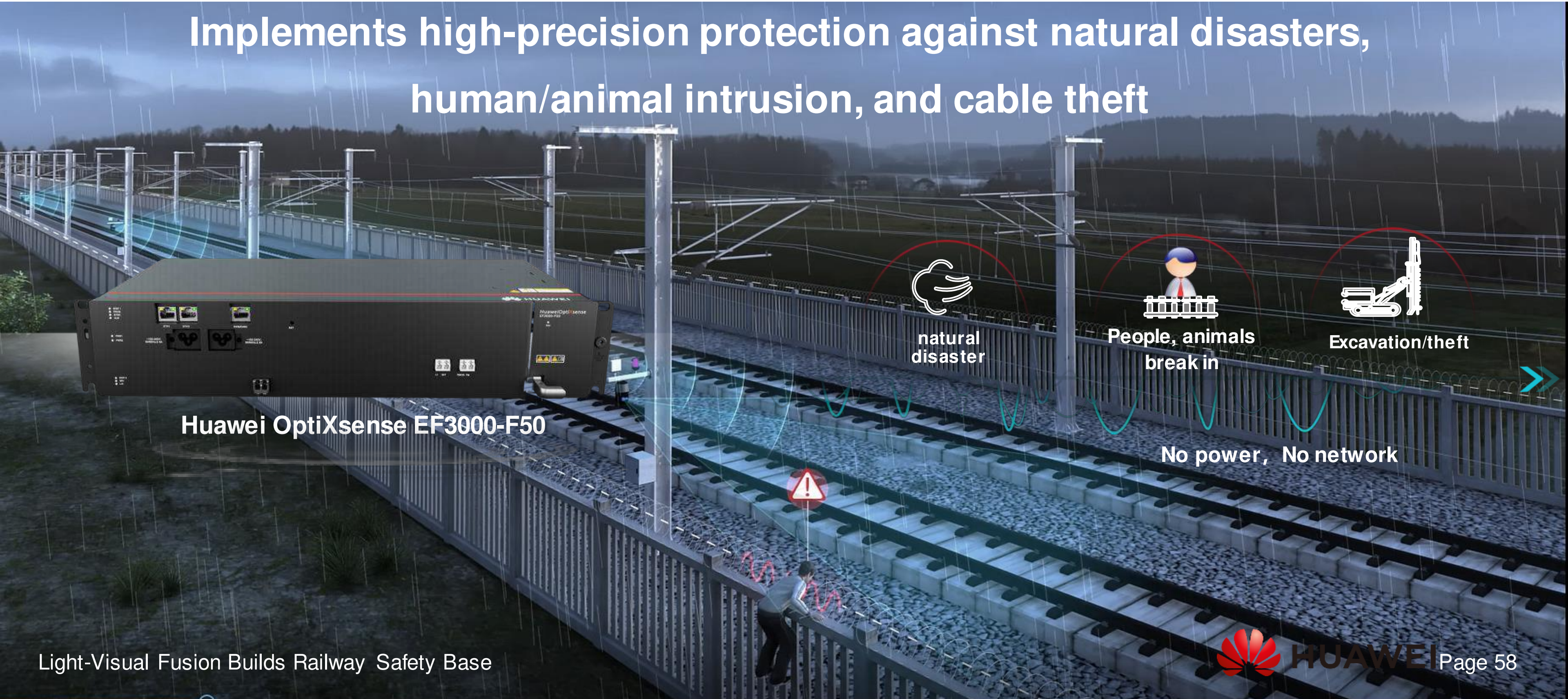
Sensing algorithm:



Multi-dimensional vibration analysis, including phase, frequency, timing, duration, and space, etc.

(Industry average: 83% -> **Huawei: 97%**)

Huawei OptiXsense EF3000-F50: the highest-precision light sensing technology

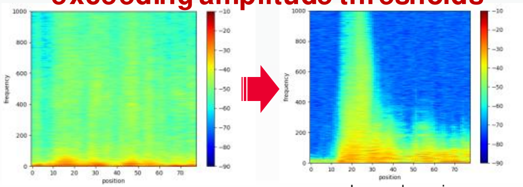


Highlights of Huawei Perimeter Inspection Solution

Comprehensive Detection , Zero False Negatives

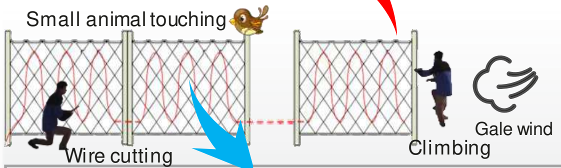
99.9% Sampling rate

Strong signal detection, without exceeding amplitude thresholds

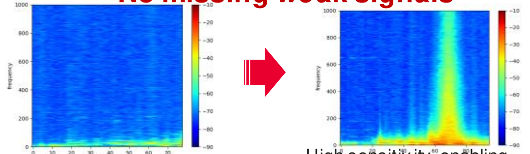


Small dynamic range: excessively large signal amplitude, incurring calculation failures

Large dynamic range: proper calculation of strong vibration signals



No missing weak signals

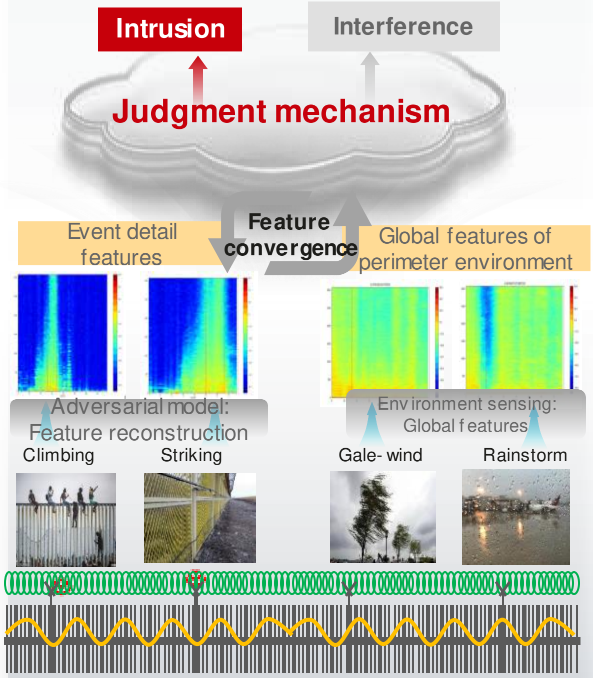


Low sensitivity, with weak disturbance events covered by system noises

High sensitivity, enabling capture of weak disturbance events

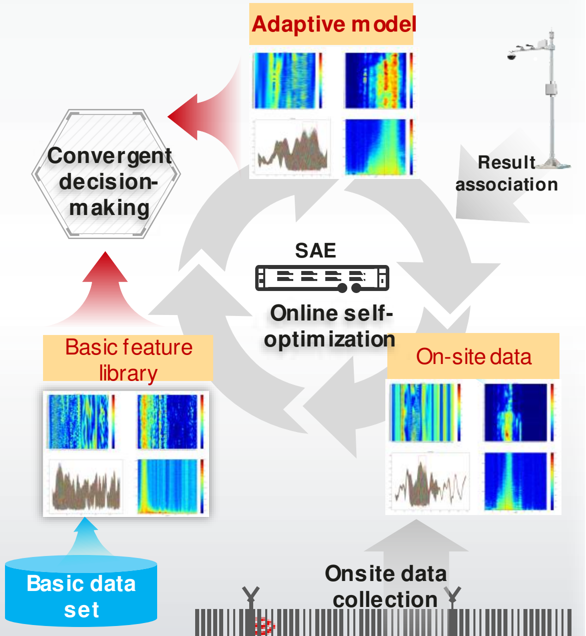
Anti-interference and Low False Positives

false alarms rate < 1 time/km/day



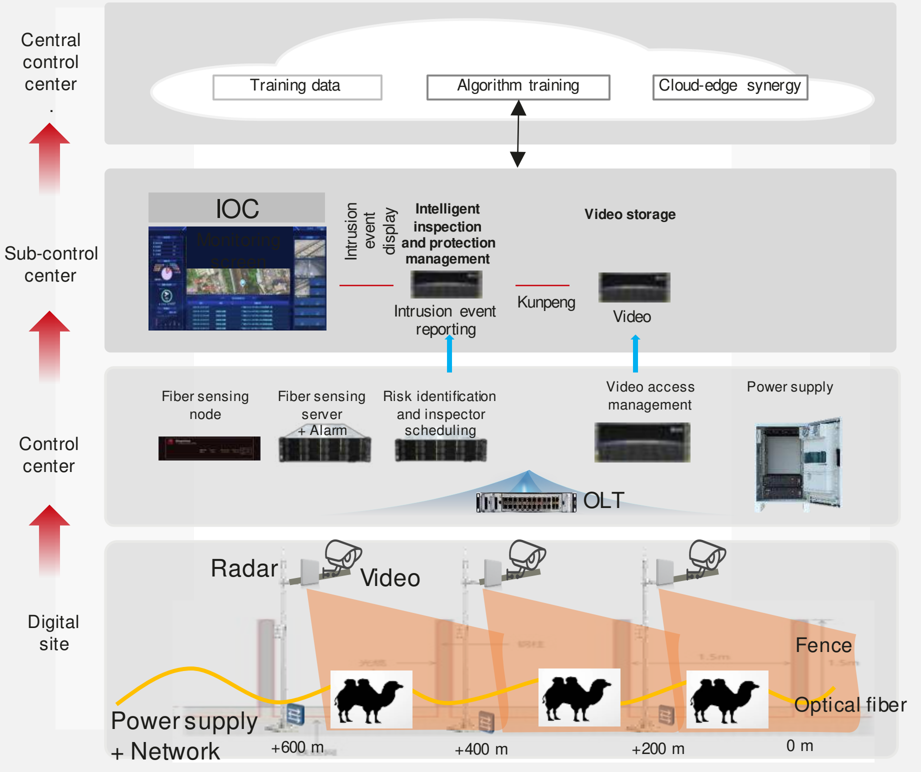
Fast Learning and Continuous Evolution

Model selection can be completed within 1 day



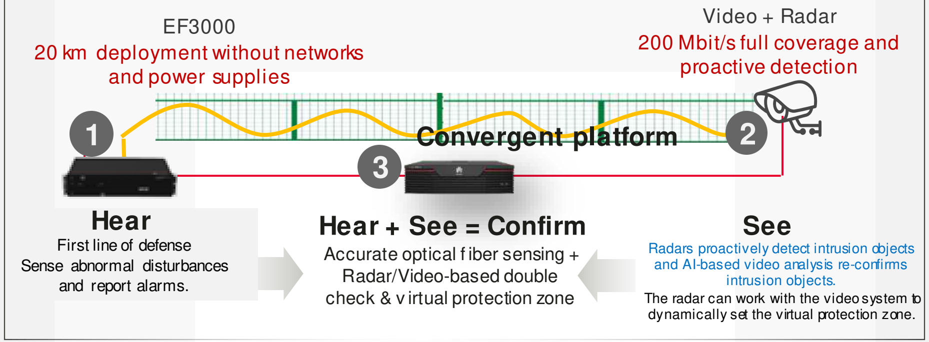
Perimeter Protection Project Deployment Cases

Chinese Railway Case



African Railway Case

Solution: Vibration optical cable + Radar- and video-based technology



Expected solution

Security assurance	Higher inspection efficiency	Ecosystem protection
Zero false negatives	Extremely low false positives, saving double check time	Protecting free migration of wild camels

Light-Visual Fusion Builds Railway Safety Base

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Under the High Patronage of his Majesty King Mohammed VI

11TH WORLD CONGRESS OF HIGH-SPEED RAIL

Marrakech, 7-10 MARCH 2023

Introduction to IRS 60680
Design of a high speed railway -- Infrastrucutre

Wenshan, FANG
Senior Engineer, China Railway Economic and Planning Research Institute, China
Session1-5.1 Infrastructure /Design

ONCF UIC

1. Background and Working Process of IRS60680

Design of a High Speed Railway series IRSs:

- IRS60680 *Infrastructure*
- IRS60681 *Communication and Signalling*
- IRS60682 *Energy*
- IRS60683 *Interface*

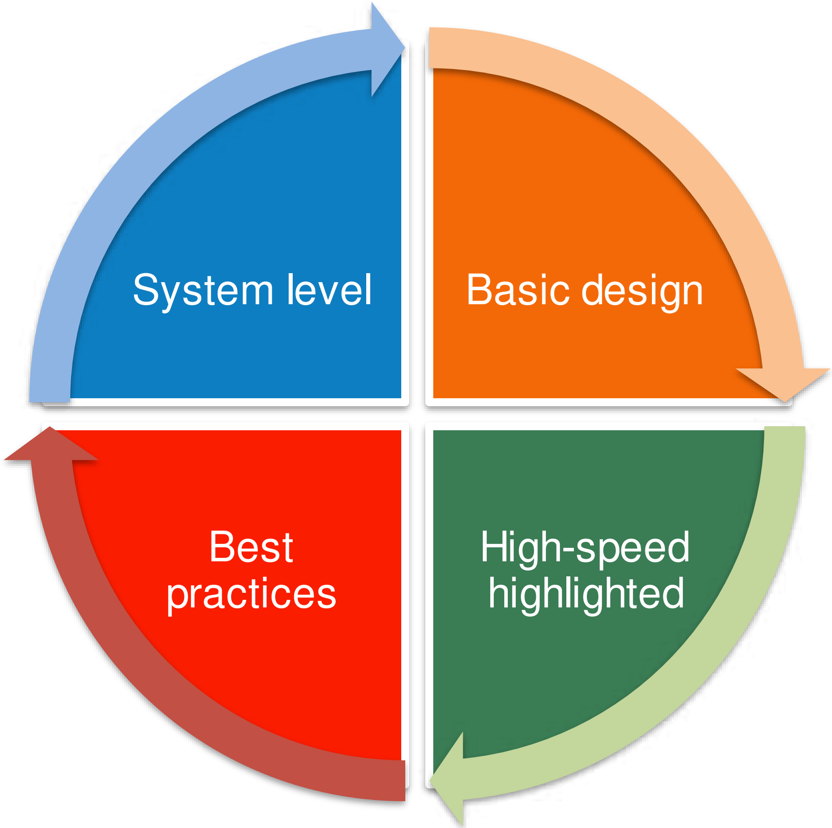
High-speed IRS programme of UIC Intercity and High-Speed Committee (ICHSC).

Item set-up	Initial draft	Draft versions and comments review	Final draft version	Committee final review and endorse	Approval by PGF	Published
2018.03	2018.04-2019.03	2019.06-2020.02	2020.03	2020.06	2020.09	2022.04






2. Topics of IRS60680



3. Main Content of IRS60680

- Foreword
- Summary
- Normative references
- Terms and definitions

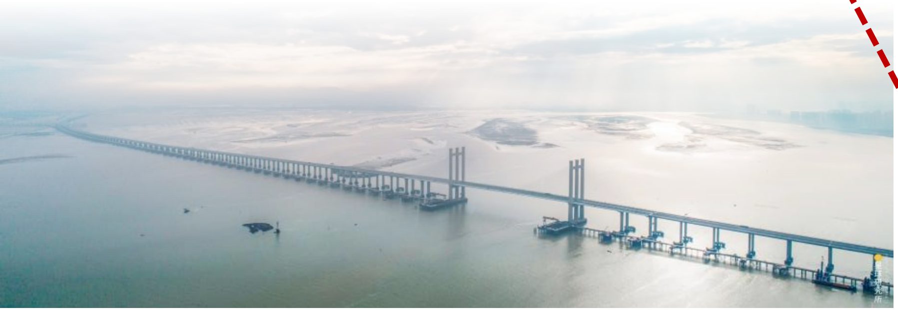
General Part

1- Overall design
2- Railway alignment
3- Earthworks
4- Bridge/Viaduct
5- Tunnel
6- Track
7- Station
8- Rolling stock maintenance facilities
9- Maintenance facilities for infrastructure, power supply, communication and signalling
10- Comprehensive protection
11- Environmental protection
12- GIS and BIM

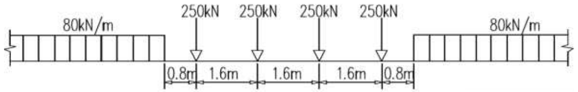
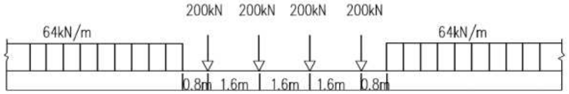
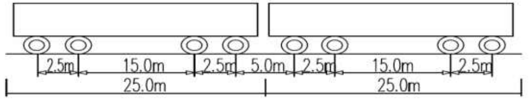
3. Main Content of IRS60680

Overall design

- 1.1- General requirements
- 1.2- Structure clearance
- 1.3- Load
- 1.4- Key parameters
- 1.5- Route selection and station location
- 1.6- Train operation and design capacity



- Typical loads adopted in different countries

Country	Type	Load Schematic
Europe	Load model 71	
China	ZK Load	
Japan	H Load	

- Key parameters for HSR design

Number of main lines

Traffic control system

Design speed

Minimum headway

Track gauge

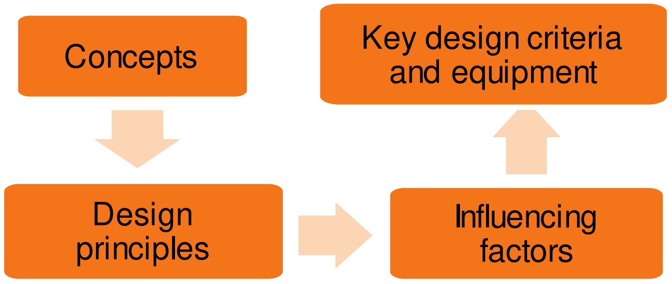
Life cycle

……

3. Main Content of IRS60680

Railway alignment

- 2.1- Basic requirements
- 2.2- Plan
- 2.3- Vertical profile
- 2.4- Station location



Best practices from worldwide HSR experience

- Minimum curve radius (R_{min})

  For instance, when the maximum design/operation speed is 300 km/h, 4000 m is adopted according to the practice of the Spain (Madrid-Sevilla railway) , China (ballastless track), and Japan (Sanyo Shinkansen) .

- Maximum gradient: 25‰-35‰ can be adopted according to the experience of Europe, China and Japan

3. Main Content of IRS60680

Earthworks

- 3.1- Basic requirements
- 3.2- Shape and width of subgrade surface
- 3.3- Earthworks stability criteria
- 3.4- Settlement control
- 3.5- Classification criteria of filling material
- 3.6- Geological investigation of earthworks
- 3.7- Subgrade
- 3.8- Embankment and cutting
- 3.9- Ground treatment
- 3.10- Waterprofing and drainage
- 3.11- Retaining structures
- 3.12- Slope protection
- 3.13- Culvert

Best practices from worldwide HSR experience

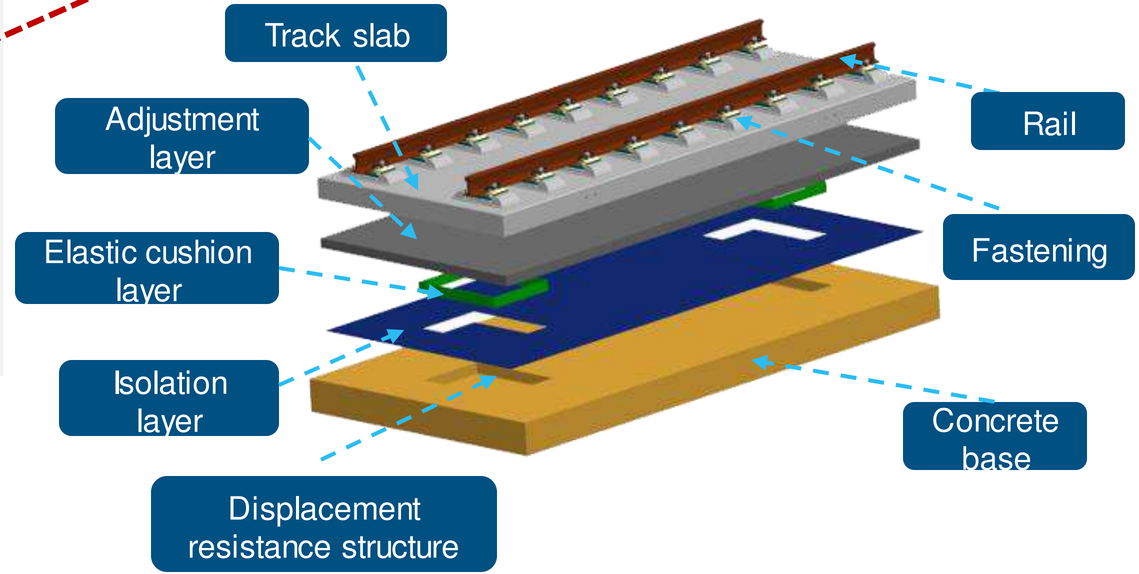
- Compaction criteria for subgrade
  - China: K, K_{30}, E_{vd}
  - Germany: D_{pr}, E_{v2}, E_{vd}
  - France: D_{pr}, E_{v2}, E_{v2}/E_{v1}
  - Japan: K, K_{30}

3. Main Content of IRS60680

Track

- ❖ 6.1- Basic requirements
- ❖ 6.2- Track structure
- ❖ 6.3- Ballasted track
- ❖ 6.4- Ballastless track
- ❖ 6.5- Transition
- ❖ 6.6- Turnout zone
- ❖ 6.7- CWR track
- ❖ 6.8- Geometry deviation of unloaded track

- Schematic of slab ballastless track in China as an example

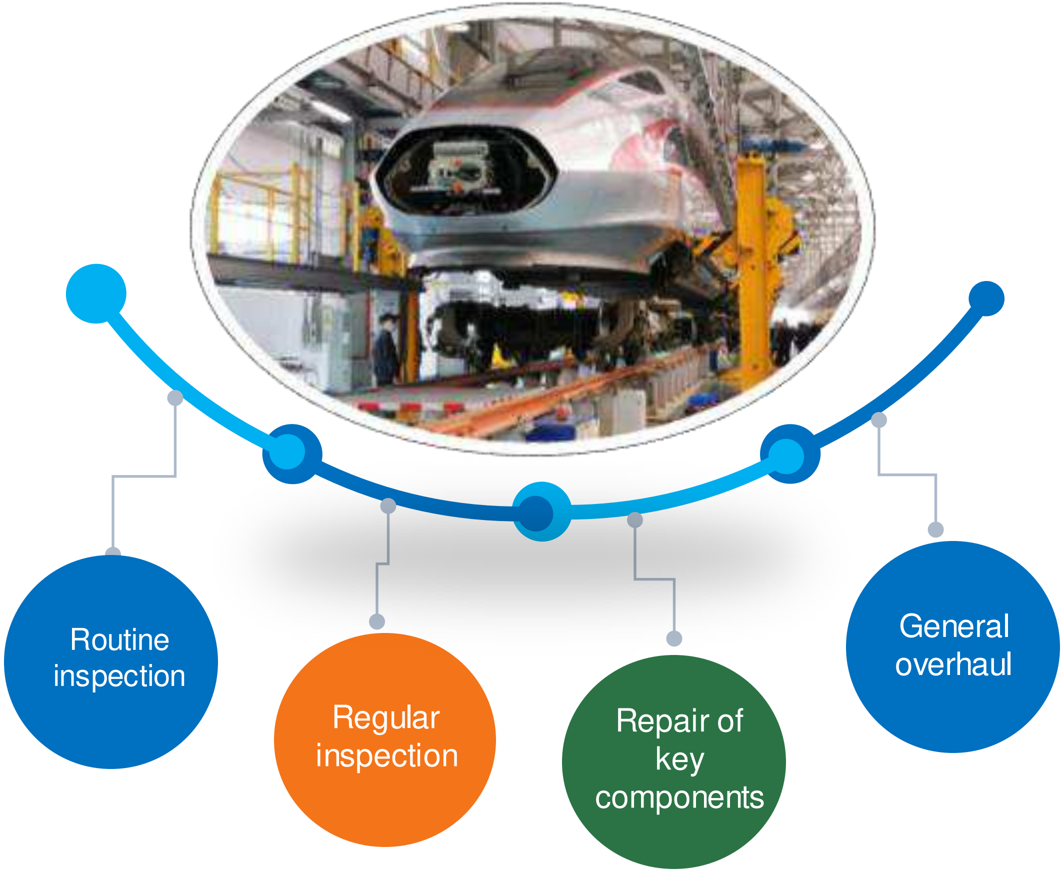


3. Main Content of IRS60680

Rolling stock maintenance facilities

- 9.1- Basic requirements
- 9.2- Classification of maintenance for rolling stock
- 9.3- Design of rolling stock maintenance facilities

- According to the experience of Europe, China and Japan, rolling stock maintenance can be generally classified into 4 categories.



3. Main Content of IRS60680

Environmental protection

- 11.1- Basic requirements
- 11.2- Ecological environment protection design
- 11.3- Protection against noise
- 11.4- Protection against vibration
- 11.5- Protection against water environment pollution
- 11.6- Protection against atmospheric pollution
- 11.7- Protection against solid waste pollution
- 11.8- Protection against electromagnetic pollution

4. Features of IRS60680

❖ Design of a high speed railway -- Infrastrucutre

Accessible	Sustainable
Inclusive	Serviceable

THANK YOU

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