

13th UIC Sustainability Conference



life cycle concept and tools for sustainable
procurement of Korea Railway

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Background



UIC 345 recommends life cycle environmental performance



- ✓ Materials
- ✓ Energy Efficiency
- ✓ Emissions
- ✓ Noise
- ✓ Recycling/Waste

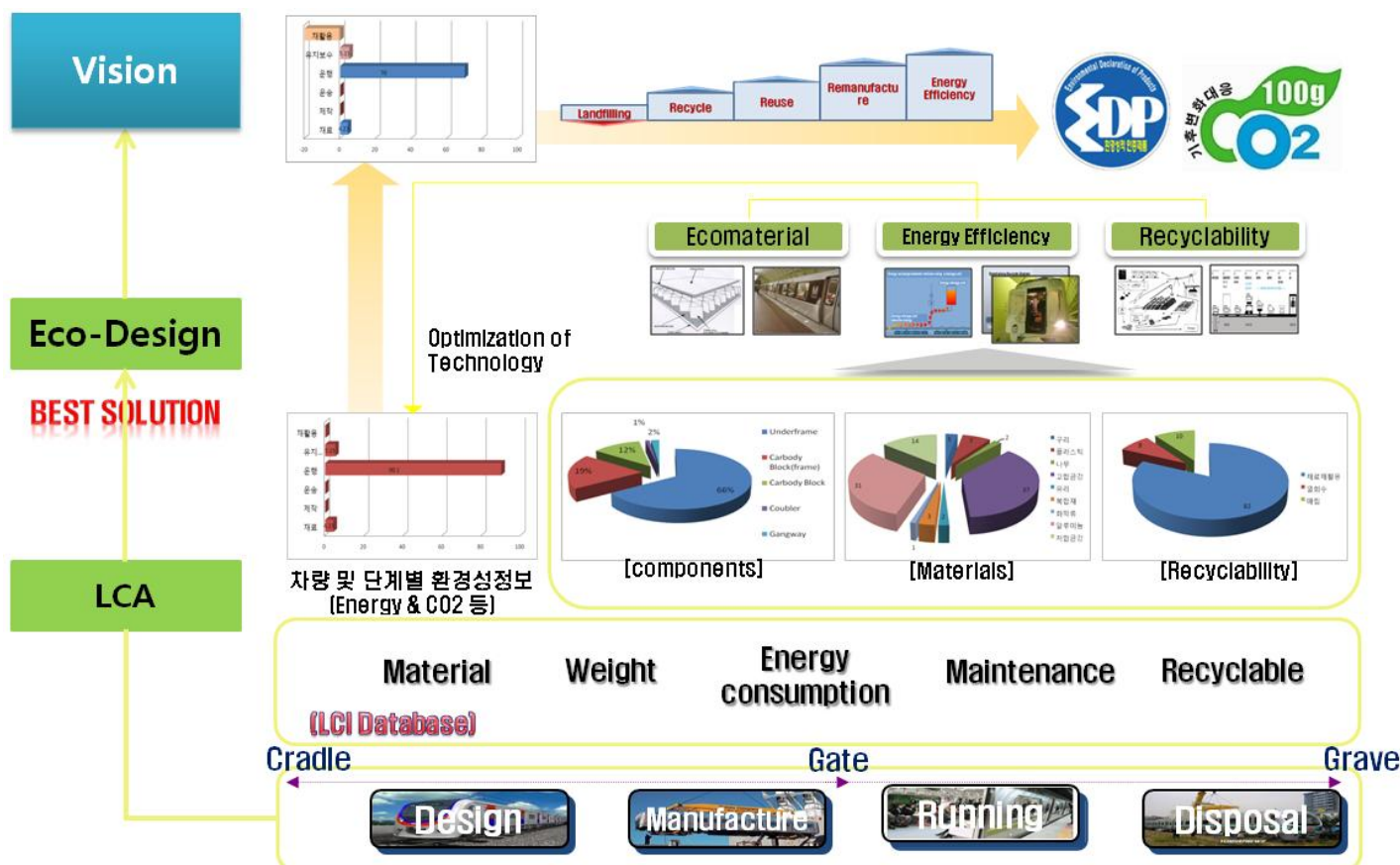
UIC 345
(Performance Index)

Noise	Energy Efficiency
Diesel Exhaust Emissions	Materials/ Recycling/Waste



Background

ECODESIGN based on LCA is a useful tool for the better performance

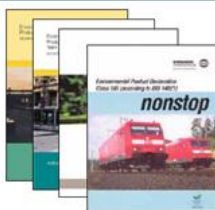


EPDs

EPD (eco-labelling, type3 of ISO 14025)
gives whole environmental specification of rolling stock



Bombardier



Stokholm
(Sweden)
(1999)



- Recyclability : 94%
- Energy Consumption : 0.09 kWh/passenge-km
- material & environmental impact

Regina
(Canada)
(2004)



- Recyclability : 93%
- Energy Consumption : 0.09 kWh/passenge-km
- material & environmental impact

Siemens

Oslo
(Norway)
(2004)



- Recyclability : 94.7%
- Energy Consumption : 0.09 kWh/ton-km
- material & environmental impact

ALSTOM

CORADIA LIREX
(Sweden)
(2006)



- Recyclability : 98%
- Energy Consumption : 0.06 kWh/passenge-km
- material & environmental impact

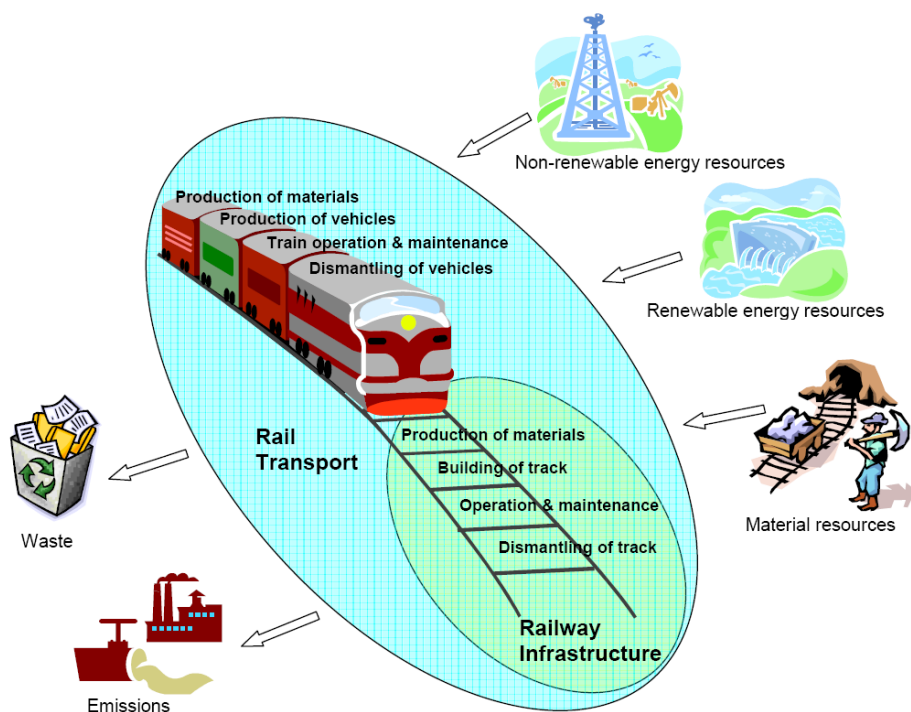


EPDs

Infrastructure also assessed for its life cycle CO2 emission

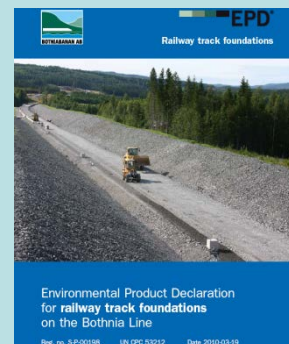


Environmental labels and declaration _ ISO 14025

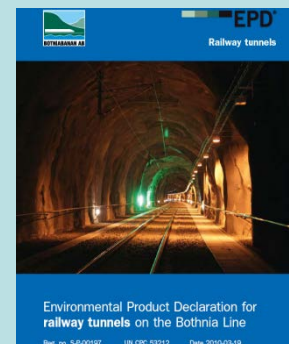


Product Category Rules for Railway Infrastructure

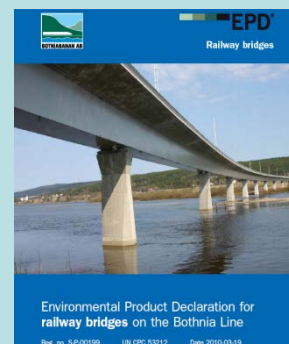
EPD cases of infra structure



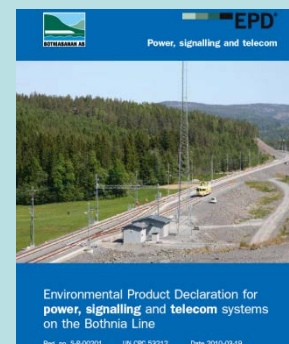
Track foundation



Tunnel



Bridge



Power & Signal

EPDs

One of Korea rolling stock investigated for its performance
(life cycle CO2 emission, hazardous material, recyclability)



KRI 한국철도기술연구원
Korea Railroad Research Institute



인증번호 : 2011-01
대상품목 : 틸팅열차(공공재)
제조기업 : 한국철도기술연구원
유효기간 : 2011. 11. 29 - 2014. 11. 28
인증기관 : 한국환경산업기술원



Eco-passenger (Korea case)

Korea eco-passenger developed for information of carbon emission of each mode (not opened yet in public)





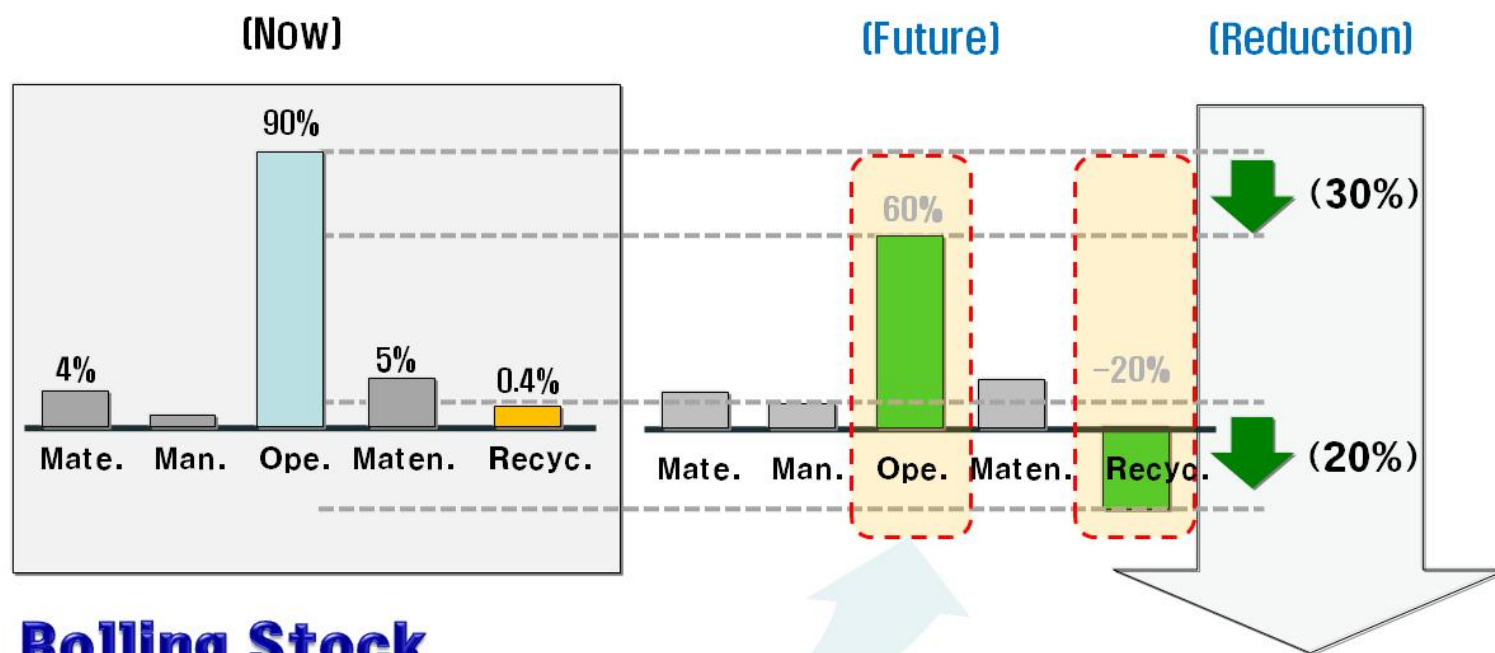
Rolling stock



Rolling stock

In case of rolling stock, energy consumption product,
Many opportunity of reducing carbon reduction

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Rolling Stock

- Energy consumption product
- Lots of materials used

Effect of Ecodesign
(**50% reduction expected**)



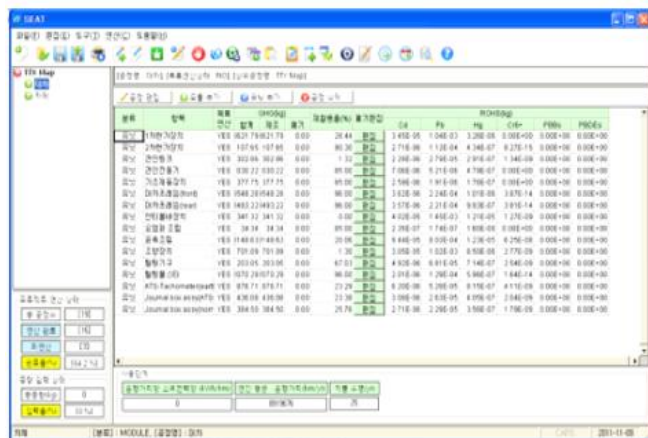
Eco design tool

For designer of rolling stock,
Ecodesign tool developed to simulate when designing



[Features]

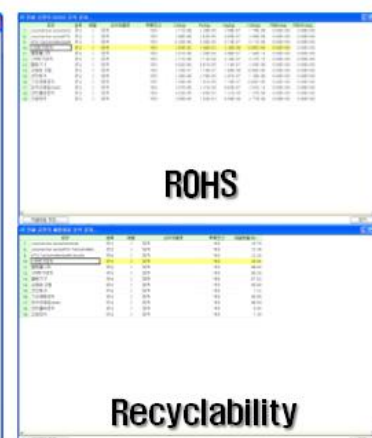
- User-Friendly
- Rolling stock components embeded
- Total weight calculation
- Life cycle CO2 emission simulation
- Hazadous material analysis



Main Screen



Life cycle CO2 emission



Eco design tool

The tool give information of life cycle performance
(alternative material, energy simulation, recyclability)



6car / 1unit
25 lifeyear

Composition & weight of 582 parts

(Materials)

composition	w/t(kg)
Resin	935
Plastics	2,902
Paint	3,240
Panel	2,765
Composites	11,763
Rubber	5,016
Glasses	5,607
Nonmetal	22,073
Metal	202,123
Wood	11,794
Electronic	6,444
Total	275,597

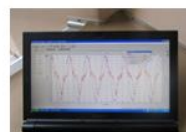
(Operation)



PQ Analyze - Fluke 1760



Cable connection



Fluke PQ Analyze



measuring

- Lifeyear : 25yr
- Elec. Consumption : 11.45kWh/km [278 seats]
- distance: 240,000km/yr
- Total consumption : 107백만kWh

(Disposal)

National Database of recycling
(2006, Korea)

-	landfill	Combustion	recycling
Wood	0.135	0.296	0.569
Rubber	0.112	0.688	0.2
Metal	0.0745	0.0755	0.85
Glass	0.319	0.143	.538
finer	0.301	0.296	0.569

(Manufacturing)

Site survey

- Electricity : 148,624.3 kWh / unit
- LNG : 21,032.8 m³ / unit

(Results)

Total CO2 emission :

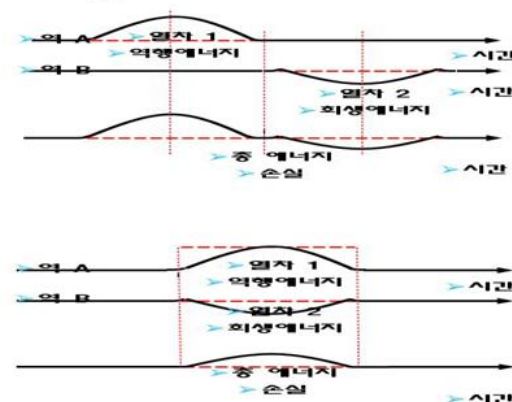
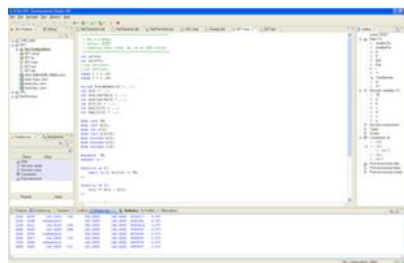
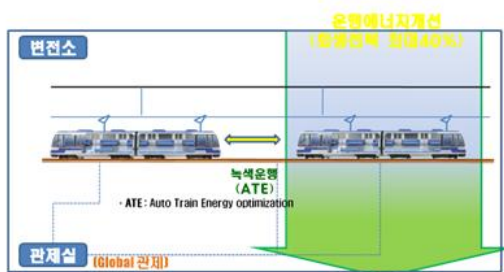
35,400 tCO₂



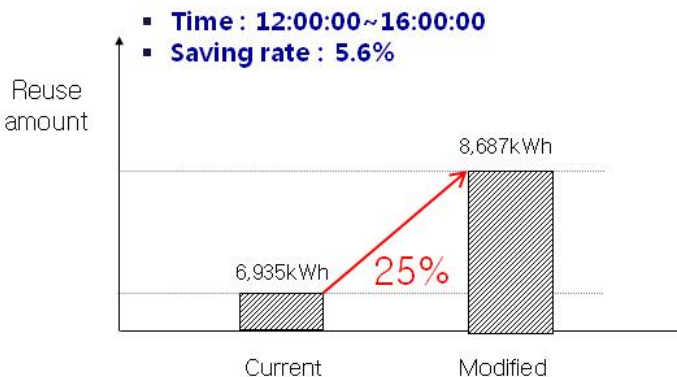
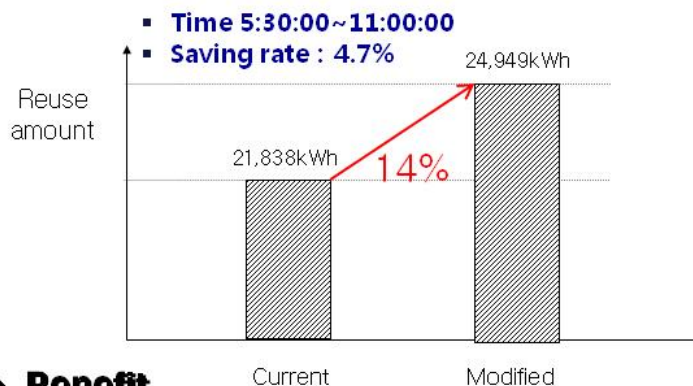
Eco operation

Energy optimization pattern can save up to 25%
(1.5 million Euro per year in case of line 4 of Seoul metro)

◆ Ecodriving pattern simulation considering regenerative energy



◆ Analysis results (Seoul Metro 4th line)



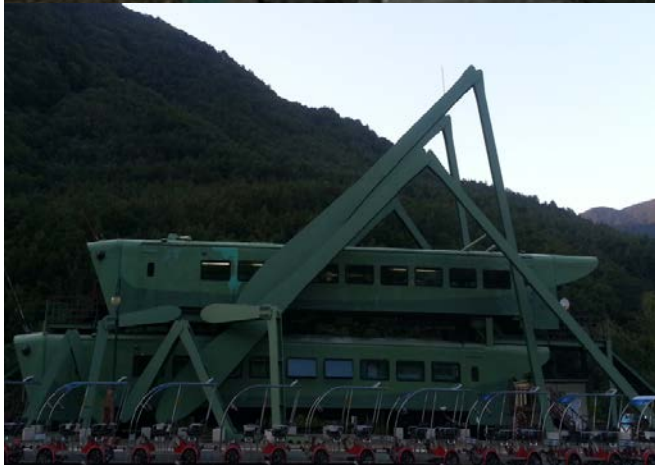
◆ Benefit

- If apply to Seoul Metro : 5% energy saving → 1.5 Mil. Euro saving/year



Eco disposal

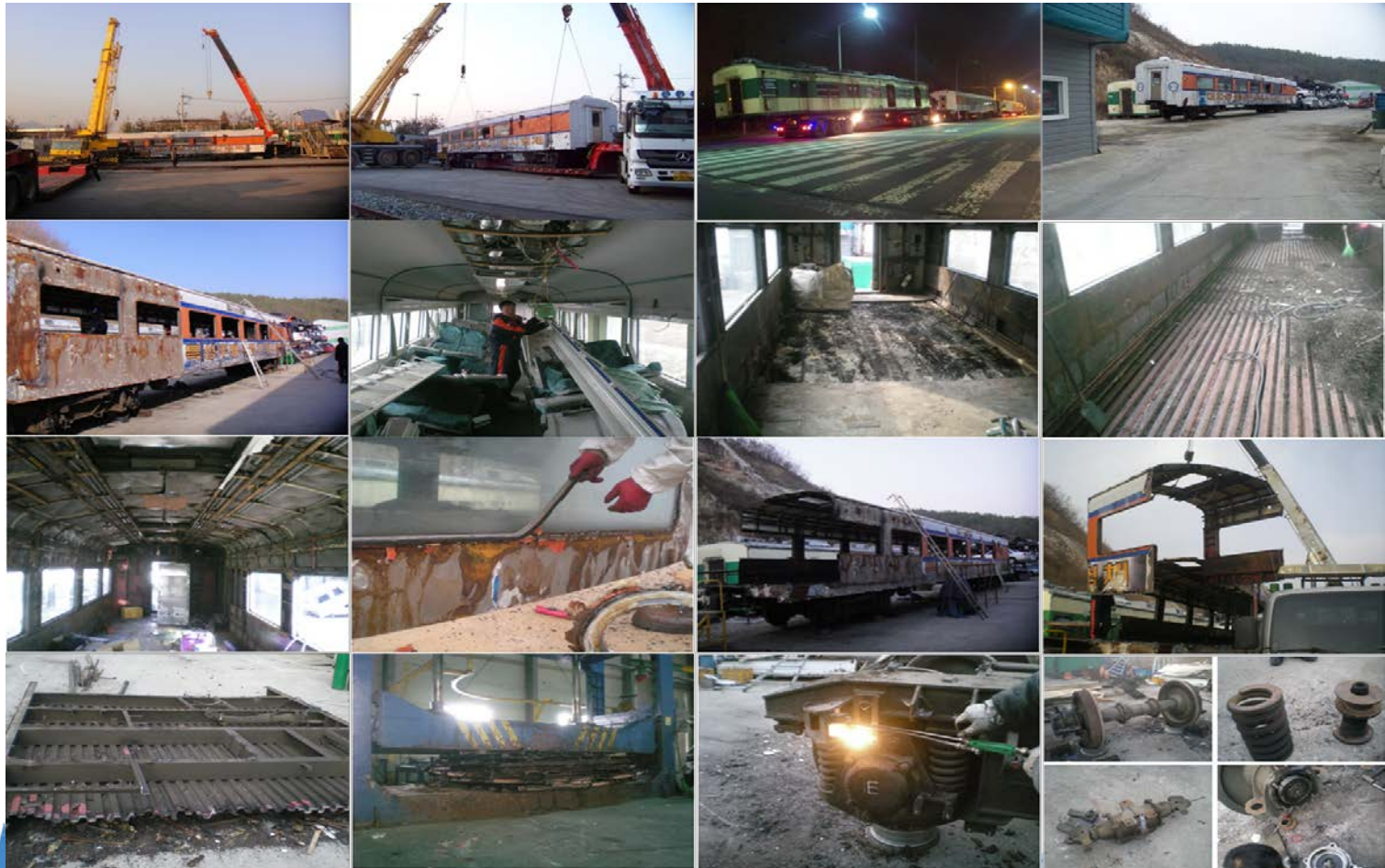
ELV directive want to increase up to 95% of recyclability
But, no specific method is suggested



Eco disposal

Test done to know current recyclability with traditional way

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Eco disposal

ISO Standardization being developed considering efficiency of each materials different with ISO 22628



> Recyclability rate

$$m_{i(\text{cyc})} = m_{i(\text{treat})} \times MRF_i$$

i : material type

m : mass

$m_{i(\text{treat})}$: mass of material type to be treated

$M_{i(\text{cyc})}$: result of recycling process

> Recoverability rate

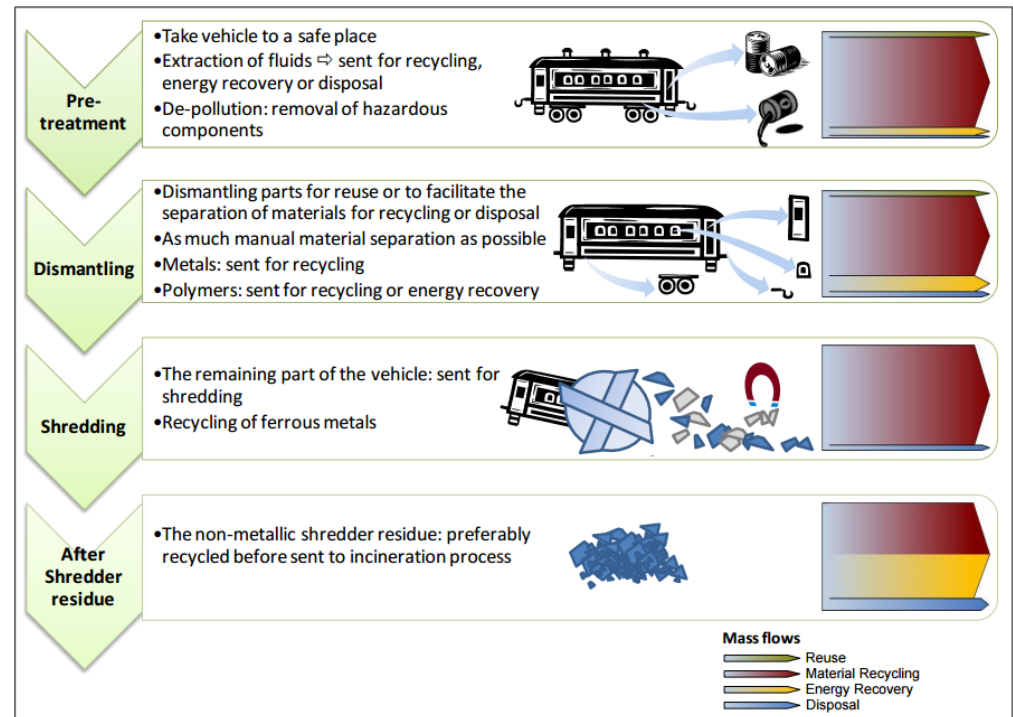
$$m_{i(\text{cov})} = m_{i(\text{treat})} \times ERF_i$$

i : material type

m : mass

$m_{i(\text{treat})}$: mass of material type to be treated

$M_{i(\text{cov})}$: result of energy recovery process



Source : UNIFE_Recyclability and Recoverability Calculation Method Railway Rolling Stock



Environmental treatment

'Recyclability and recoverability calculation method of Rolling stock 'under way for ISO document



2015. 4. 15 (1st meeting in Seoul)



ISO TC269/WG4

Secretariat: Ruediger Wendt

Recyclability and recoverability calculation method of rolling stock

(Draft Ver.4.0)

2016. 4. 19 (4th meeting in Vienna)



Warning for WDs and CDs

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.



To help you, this guide on writing standards was produced by the ISO/TMB and is available at <http://www.iso.org/iso/how-to-write-standards.pdf>





Infrastructure

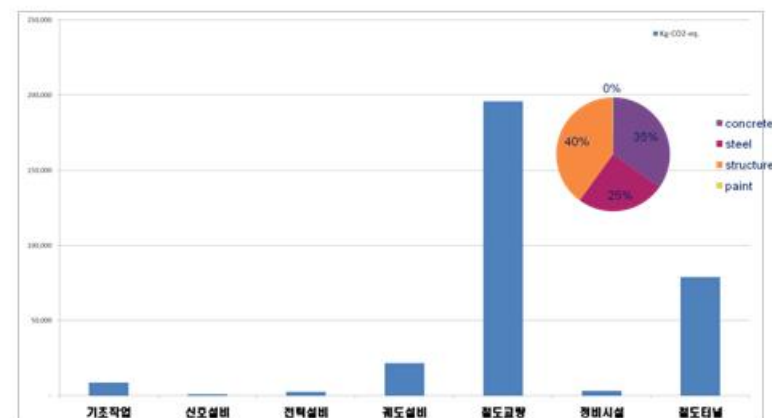
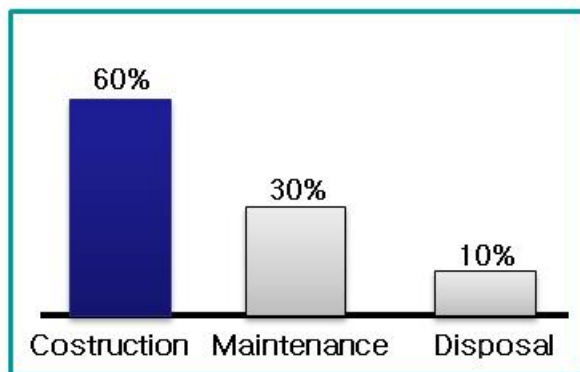
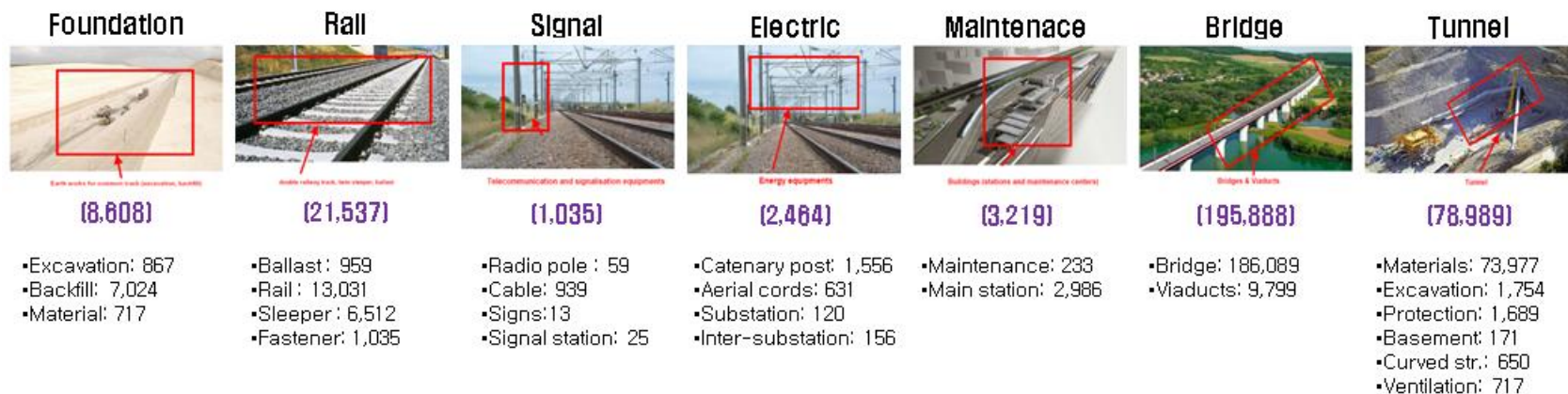


Infrastructure

Railway infrastructure is material using product
contrary to the rolling stock



단위 : kg-CO₂/km, yr

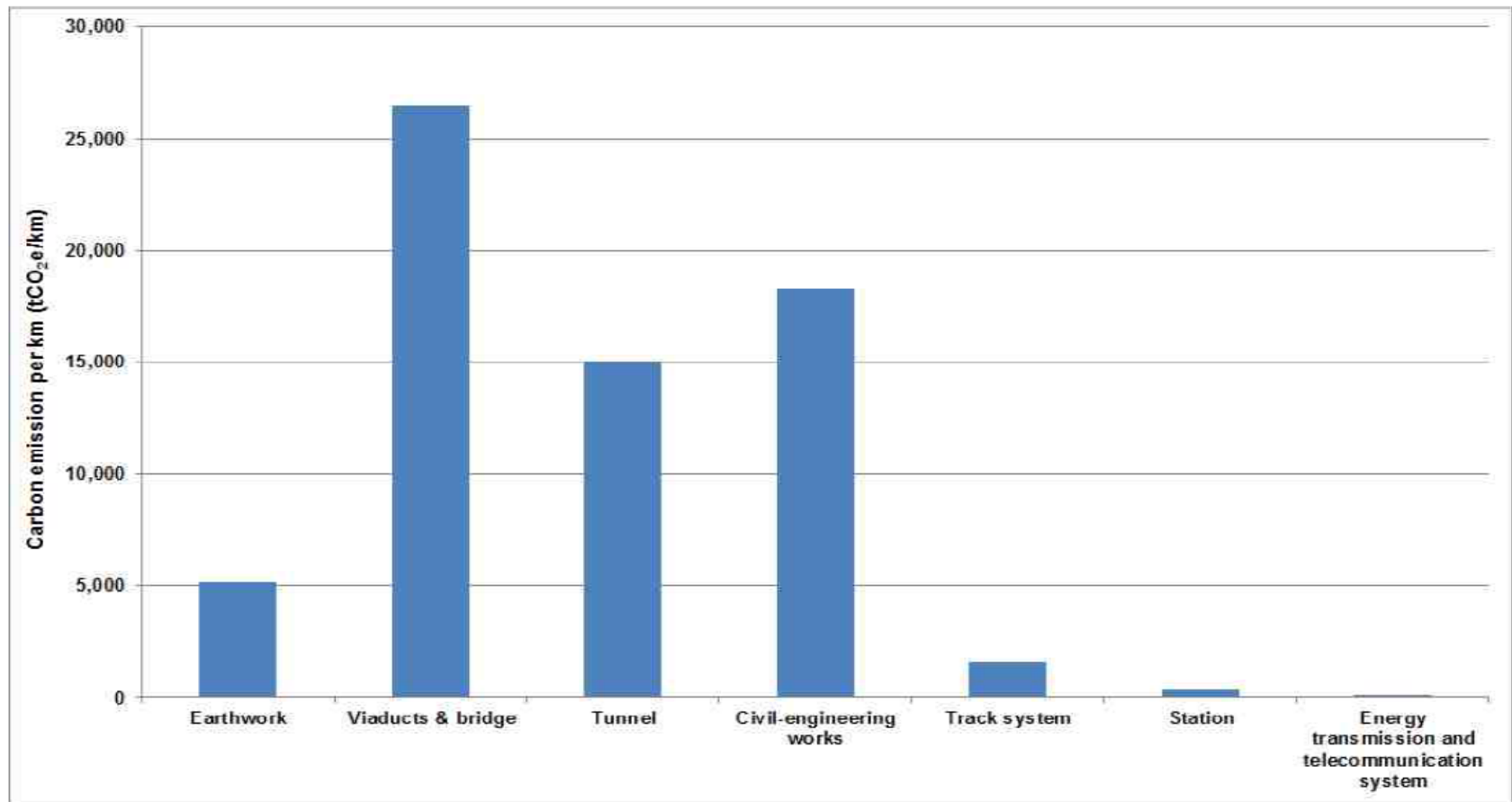


※ 출처 : UIC, 2009



Infrastructure

Railway bridge, tunnel and track foundation are the main contributor to carbon emission



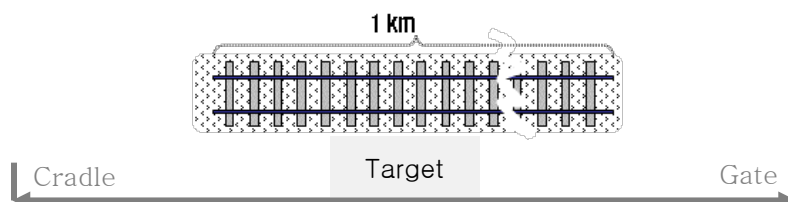
Infrastructure



Emission from the slab track is 2 times higher than ballast track



Ballast



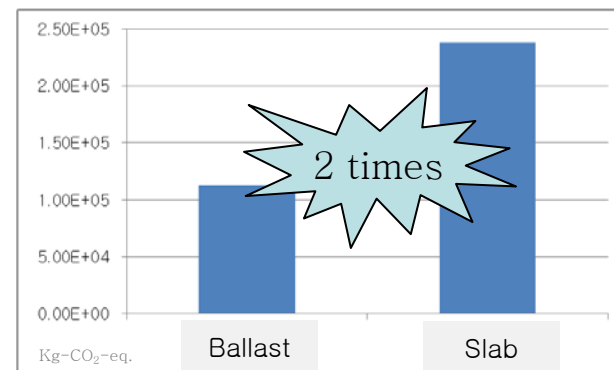
Slabe

■ 도상별 주요자재

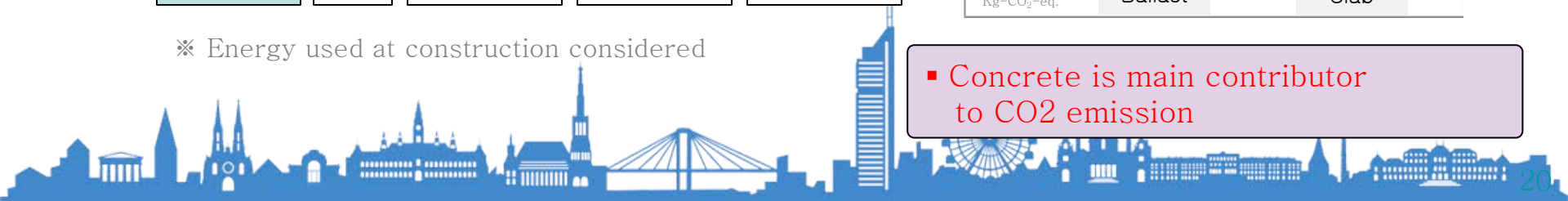
구분	Unit	Ballast	Slab	Remarks
Rail	ea	100	100	UIC60
Sleeper	ea	1,538	1,666	-
Fastener	ea	6,152	6,664	4ea/each
Ballast	m ³	1,470	-	0.35*4.2m
Concrete	m ³	-	1,470	0.35*4.2m

※ Energy used at construction considered

■ CO₂ 발생량 비교

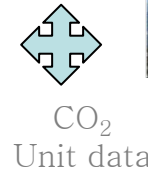
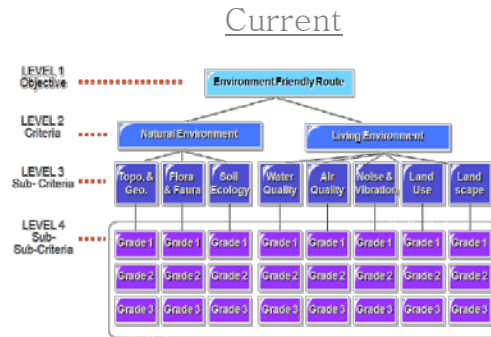
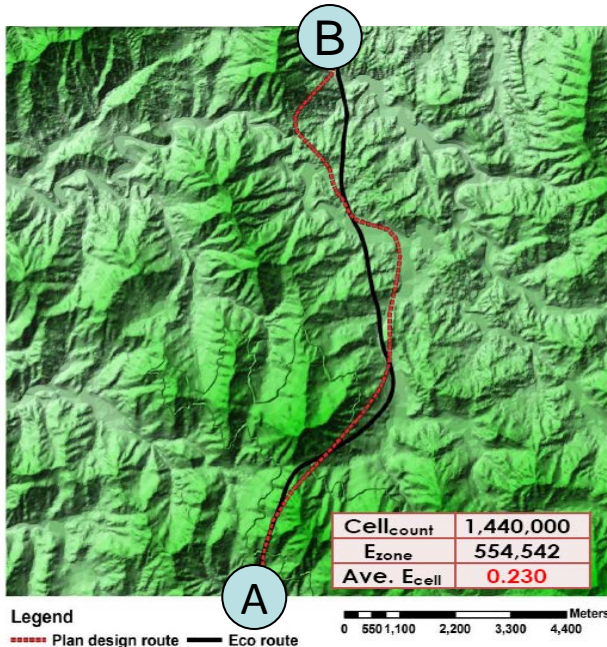


■ Concrete is main contributor to CO₂ emission



Eco design tool

To avoid the usage of cement, eco designing tool is suggested when considering new line



CO2 considered



(LCA & LCC integrated assessment)

<Current>			<Advanced>			(unit:km)	
구분	1 st line	%	%	Planning	Saving		
Track	53.8	12	12	47.8			
Bridge	117.5	39.3	38	139.3	17		
Tunnel	175.8	26.3	25	99.5			
Line	447.3	-	-	390.1			

1%

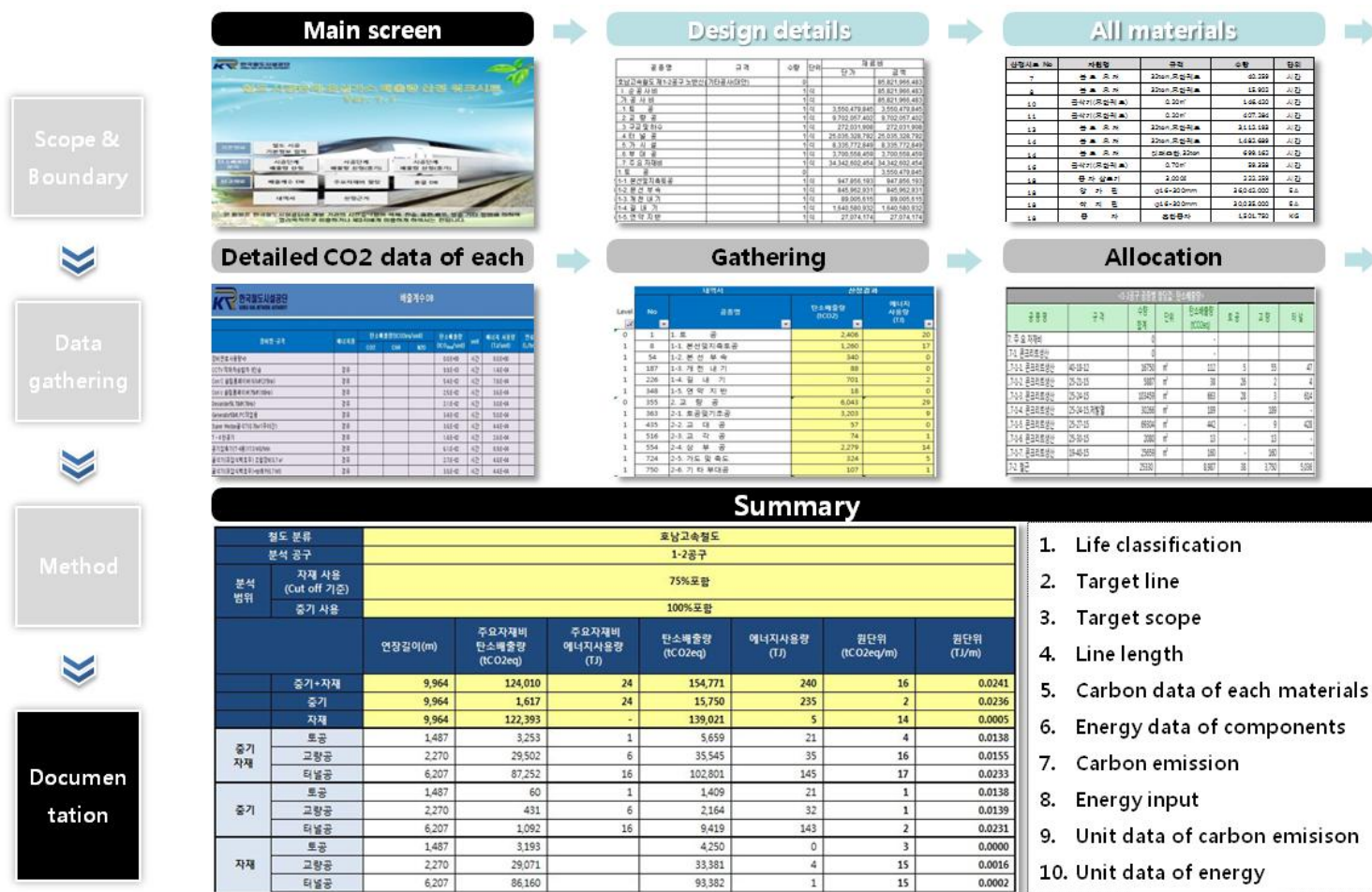
316 ton CO₂ saving

* data:infra statistics (2010), 2000 Mile of Korea Highspeed

Eco design tool

To reduce the emission from infrastructure management, CO2 management tool is developed

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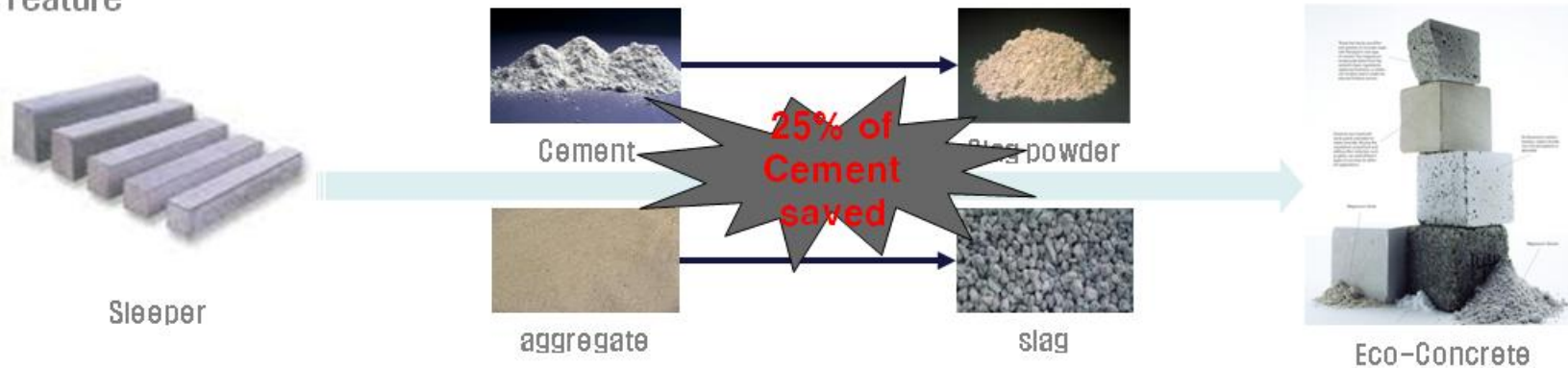


Construction

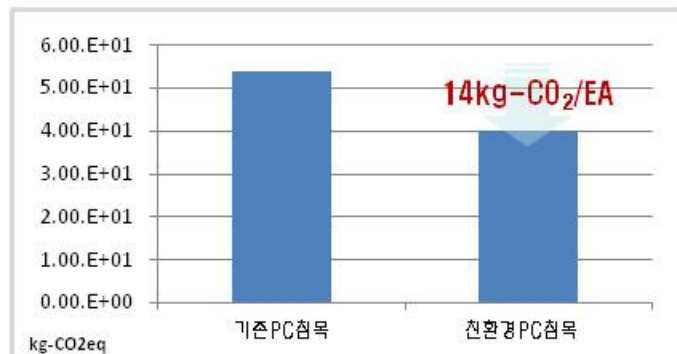
Low cement sleeper can be alternative for reducing carbon emission and construction cost



■ Feature



■ 친환경 콘크리트 적용효과 (PC 침목)



(unit: ton-CO₂-eq.)

구분	Line	unit	Effect	Remarks
Bridge	105	km	1,548,650	0.3kgCO ₂ /kg
Sleeper	70	1000/y	9,800	14kgCO ₂ /ea
Total	-	-	1,558,450	

☞ Cement used : 46,740 ton/km, bridge (UIC)

1,558
mton CO₂

※ data: Infra statistics (2010), 2nd Life of Korea highspeed



Maintenance

Anti aging agent for cement is a good solution for longer life of infrastructure



Rail bridge without protection

Concrete Protection Agent

- amount of usage : 1260ℓ/km

<Protecting agent>



- composition : Polyester

☞ 0.51 kg CO₂/ℓ, agent



Rail bridge with protection



example

Track

- 0.35 m(t) × 4.2 m(w) × 1000m (l)
- Lifespan : 50 year

- CO₂ total : 250 ton CO₂eq. /km
- annual CO₂ : 5 ton CO₂eq. /km, yr

Agent

- area : 4,200 m²/km
- amount : 1,260 ℓ/track, 1km

- CO₂ emission : 642.6 kg CO₂-eq.

4.4 tonCO₂/yr reduced



Conclusion

Railway is often to compare with automobile but
Automobile industry is changing with new generation
to get back its original position

Railway industry need to focus on life cycle environmental
performance not only for operation stage

