Durability and sustainability: new challenges for Road Traffic Noise Barriers

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Introduction

- Regulations and technical standards on product perfomance assessment
- CE marking according to CPR305 2011
- Environmental Noise Directive
- About noise reduction planning activities

ENBF partecipation to:

- CEN standardization committees
- Expert Group @ EU Commission

- Noise legislation: noise limits and budget allocation
- Legislation and technical standards for:
- Structural design and material specifications
- Procurements rules and procedure
- Installation and maintenance procedures
- End of life management

Role of national associations of manfacturers gathering in ENBF

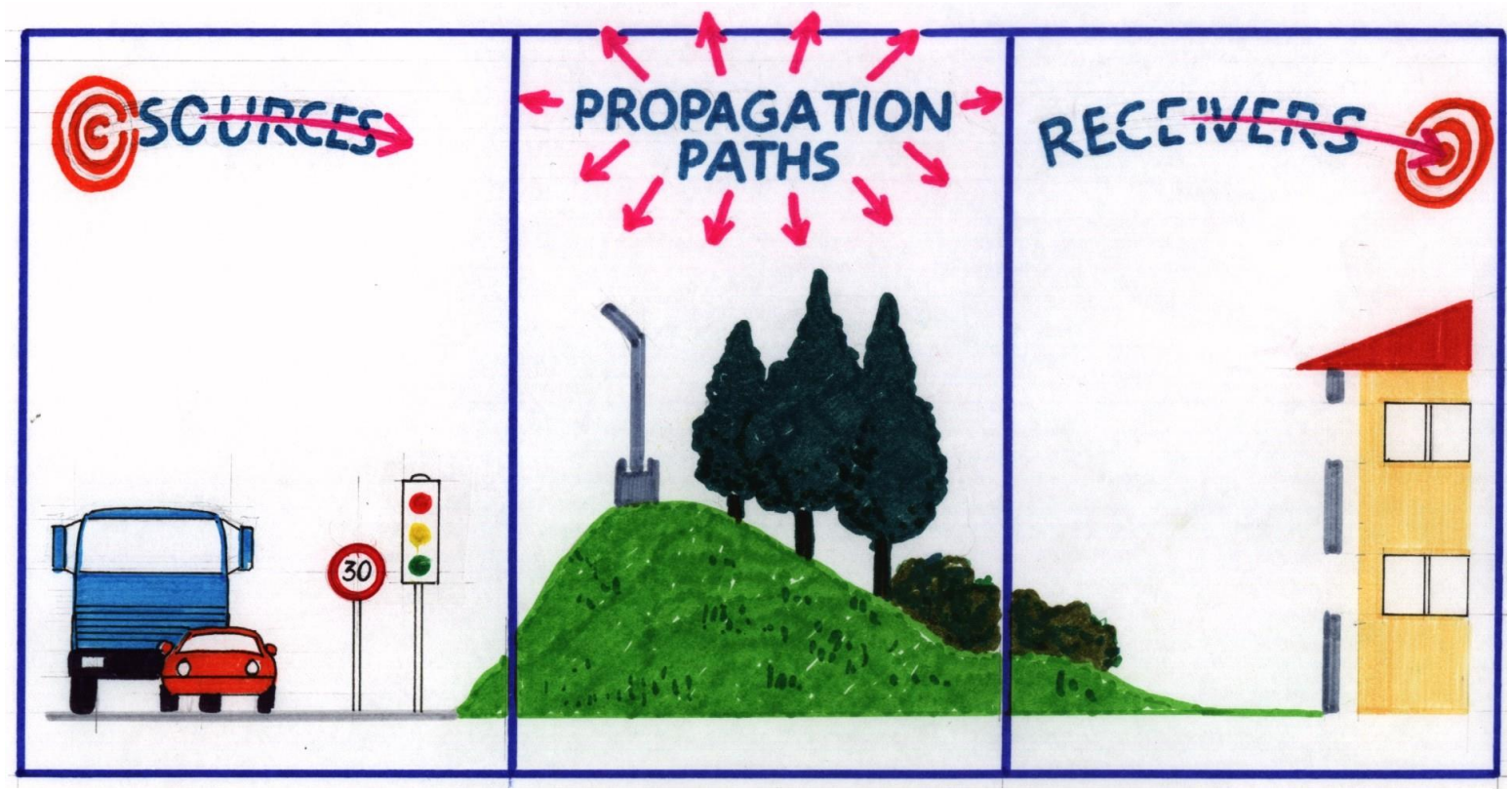
UNICMI technical library about road and rail equipments:

- Roads safety barriers,
- Noise barriers,
- Wind and rockfall barriers,
- bearing and joints for bridges

http://www.unicmi.it/strumenti/strumenti-online/corso-brero.html

Summary

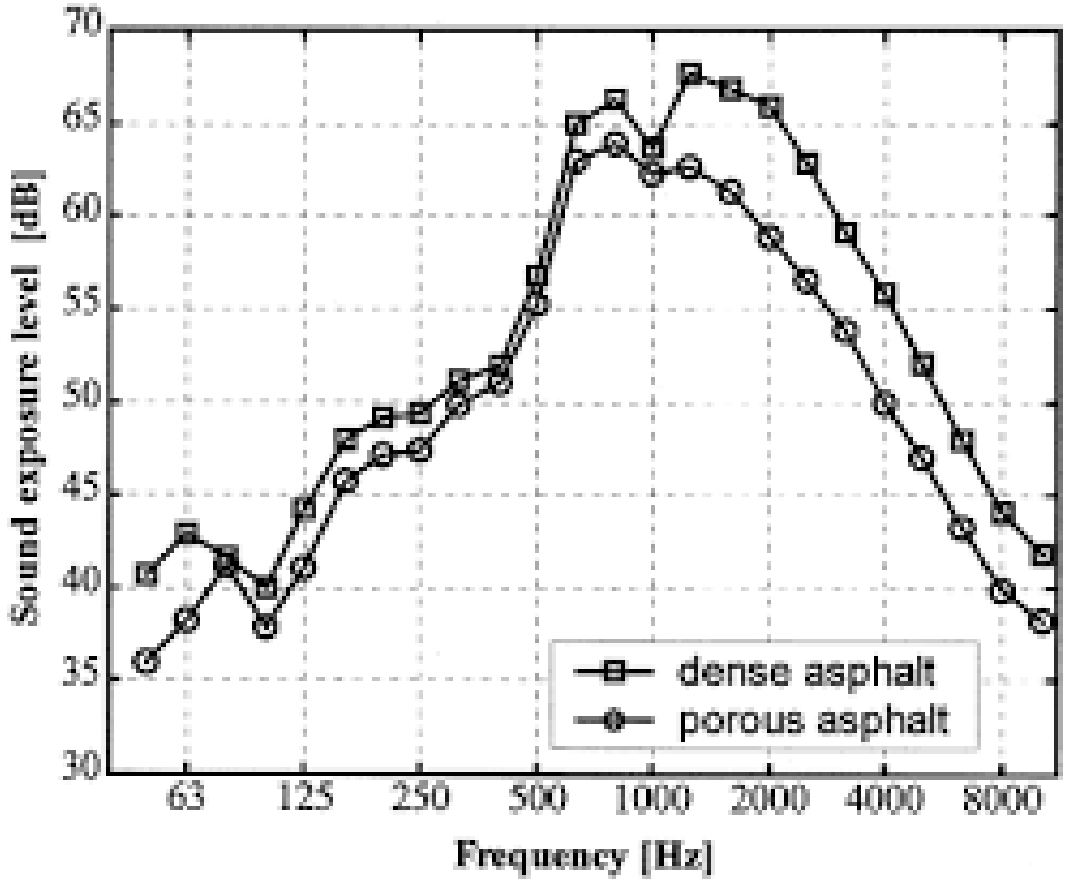
- Road Traffic Noise Reduction Policy
- Noise Barrier Design
- Installation and Maintenance
- Sustainability



EXPECTED INSERTION LOSS VS POPULATION INVOLVED

- 4 dB(A)	-10 up to -20 dB(A)	> 20 dB(A)
FOR ALL RECEVERS	FOR MANY REVEICERS	FOR A FEW RECEIVERS

Combination of porous asphalt and noise barrier : any chance?



- Conventional porous asphalt effect is evident over 500 Hz third octave band
- Effect of noise barrier due to diffraction is expected in the same frequency range
- This is not a favourable condition as total results is not the mere summation of the effects; i.e.

- IL (measured behind a noise barrier) = 15 dB
- IL (measured with a porous asphalt) = 4 dB
- IL (measured with both) = 16 dB

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In the rail sector:

- Absorbing track surface
- Low height noise barrier

or

- Close proximity barrier
- Rail dumpers

Electric mobility will not provide a solution in extra urban areas

Action on road surface can ensure a moderate noise reduction for many receivers

Action on the building can ensure an high noise reduction for a few receivers

Noise barriers (or covering) remains the unique approach in case a significative noise reduction is required for many receivers

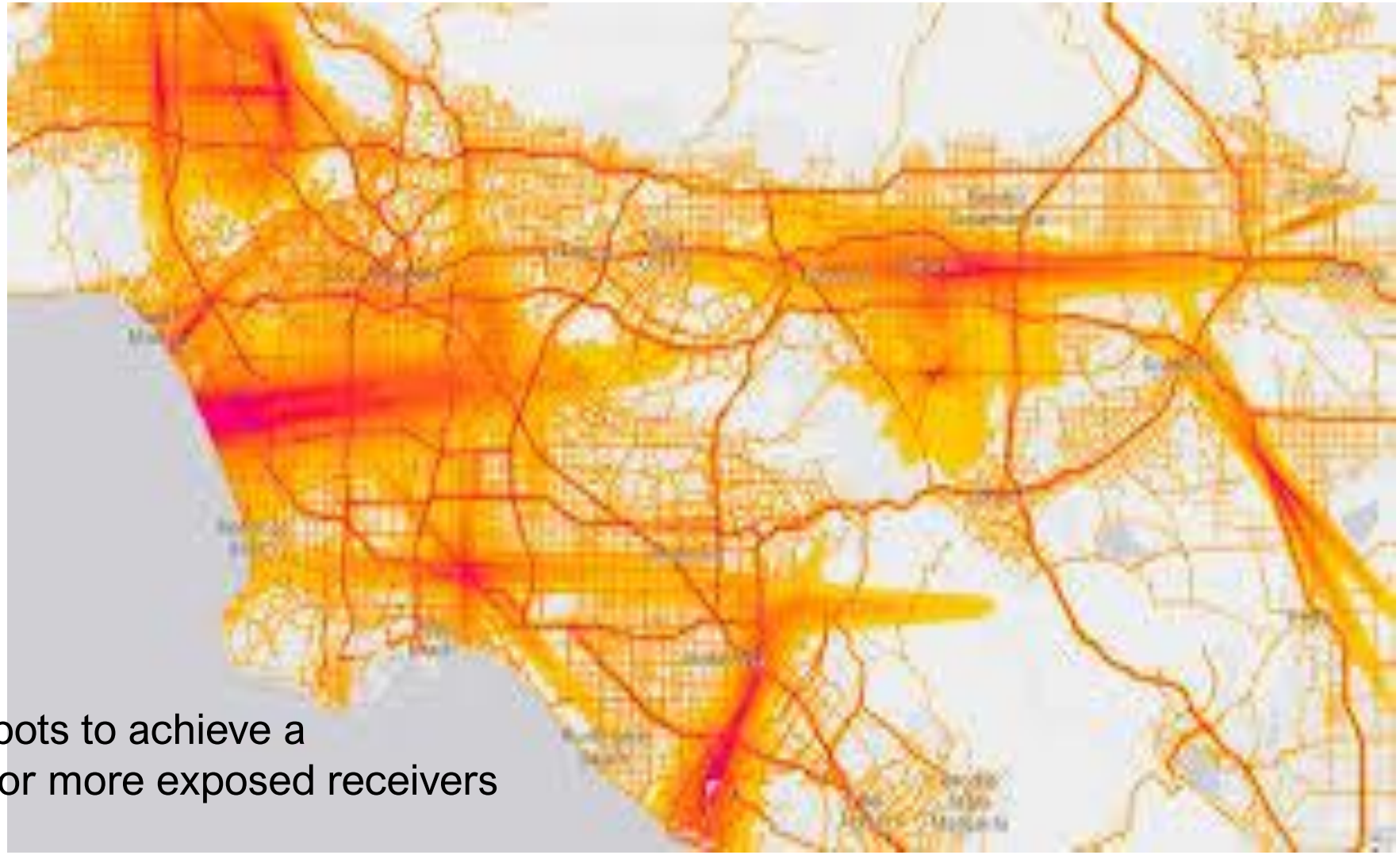
How to address public resources for traffic noise reduction ?

Option a)

Use available fundings for a few decibel reduction on the whole network ?

Option b)

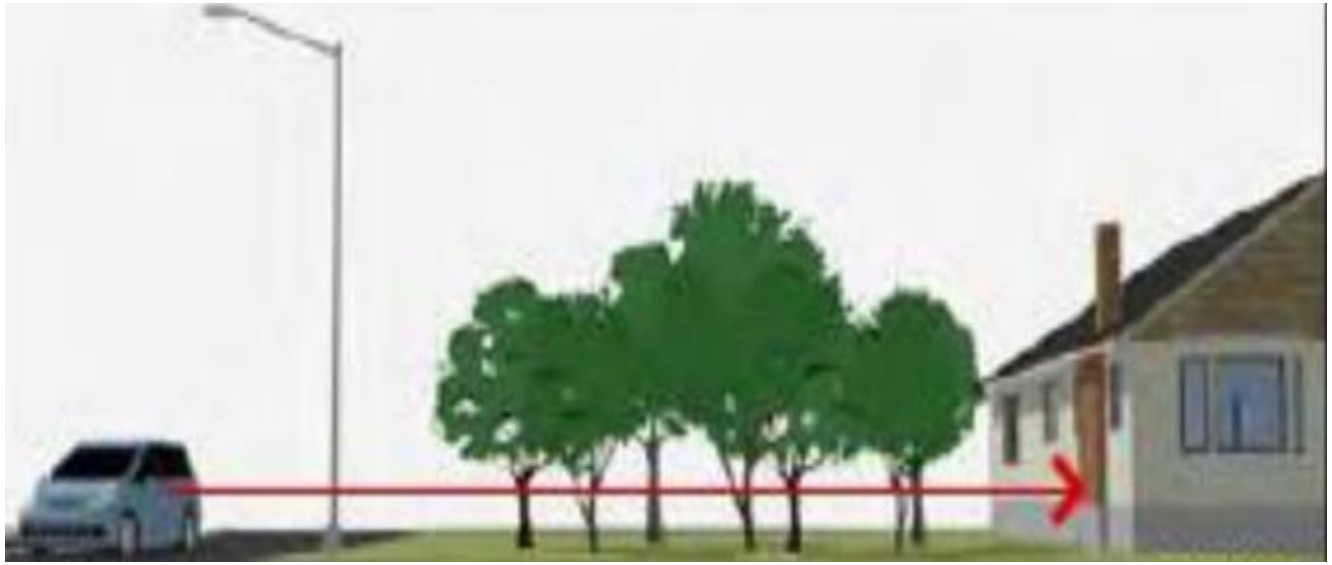
Start focusing on the black spots to achieve a significative noise reduction for more exposed receivers ?

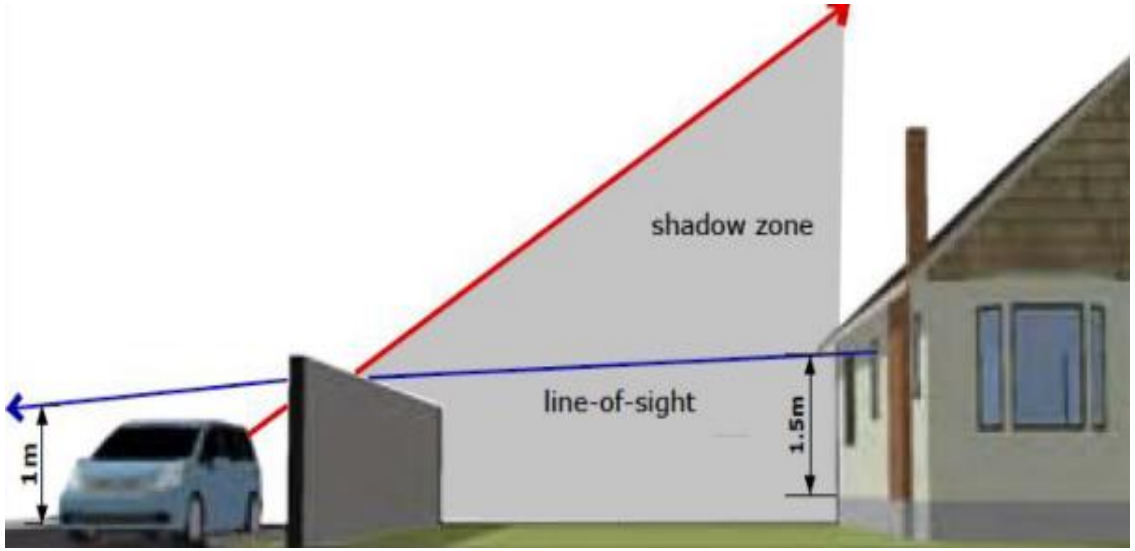


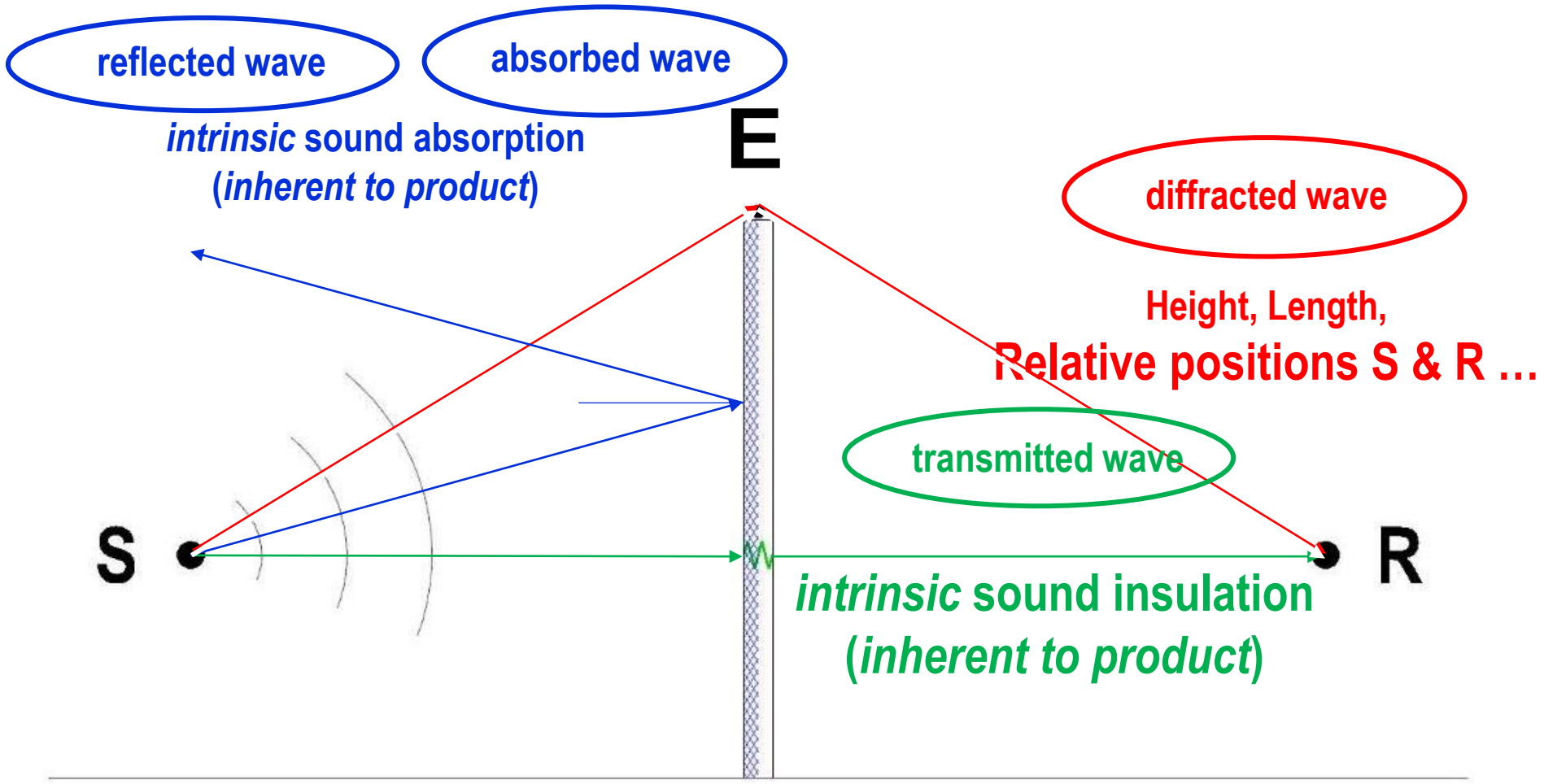
Target of the acoustic design of the noise barrier:

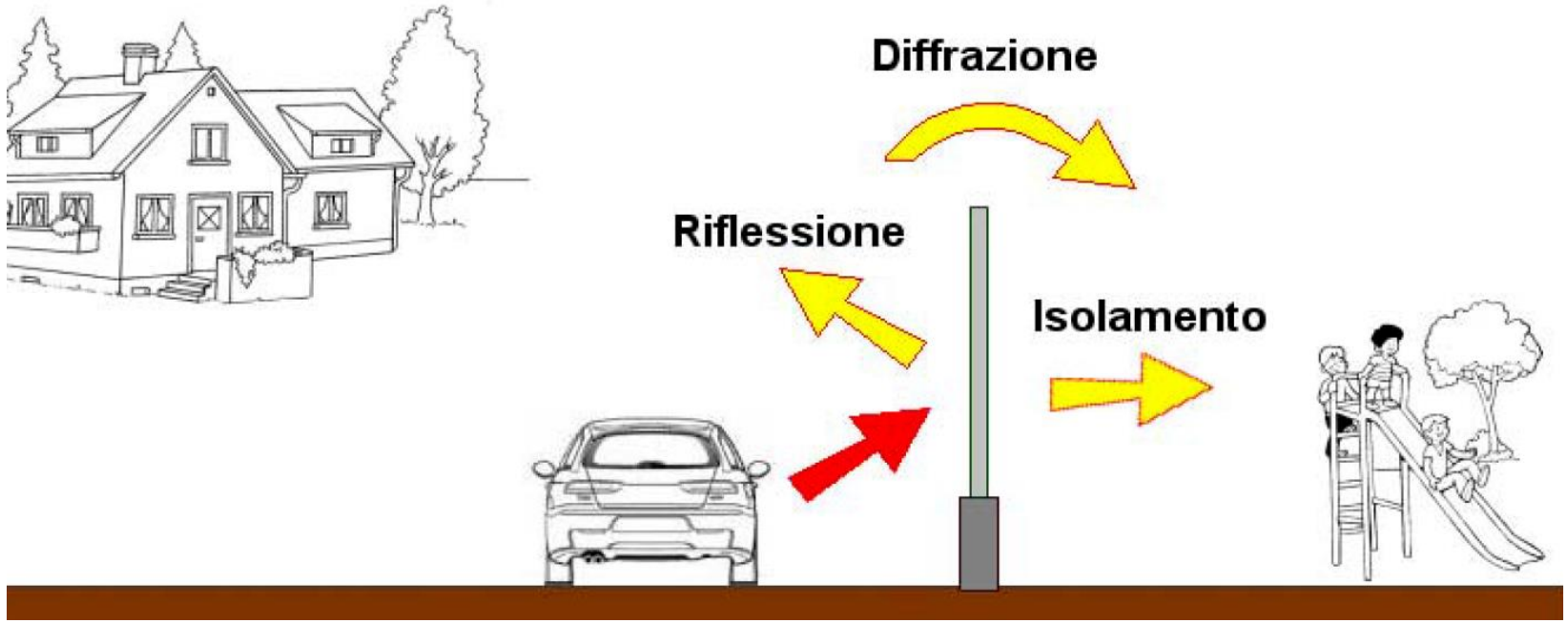
To improve its extrinsic performance

Characterized by the Insertion Loss IL: difference of noise levels without and with the noise barrier






reflected wave
absorbed wave
intrinsic sound absorption
(*inherent to product*)
E
diffracted wave
Height, Length,
Relative positions S & R …
transmitted wave
S
R
intrinsic sound insulation
(*inherent to product*)



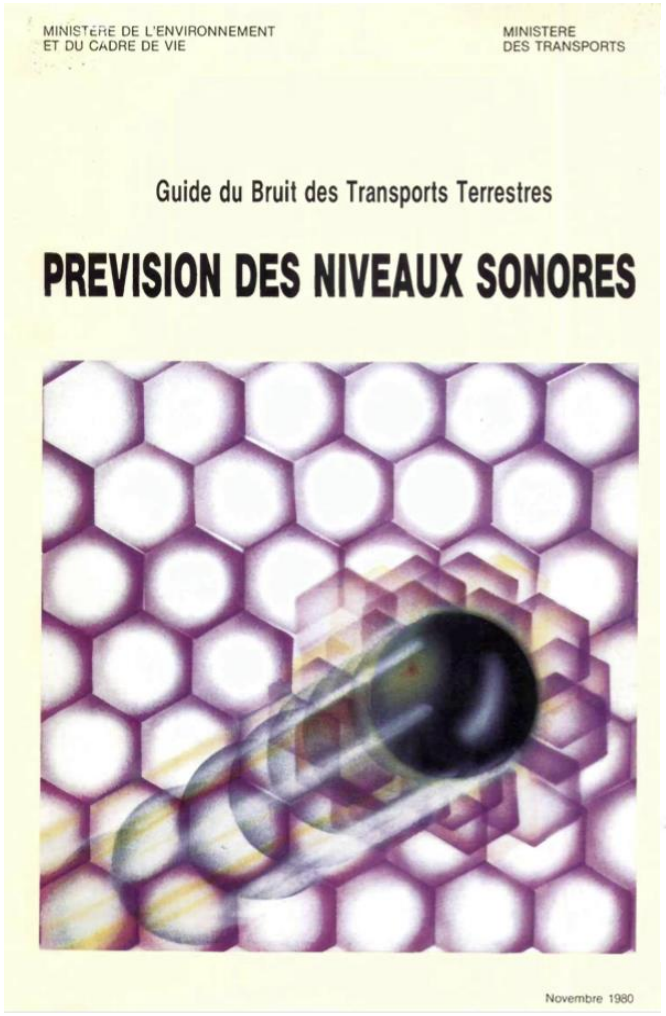
Acoustic design steps:

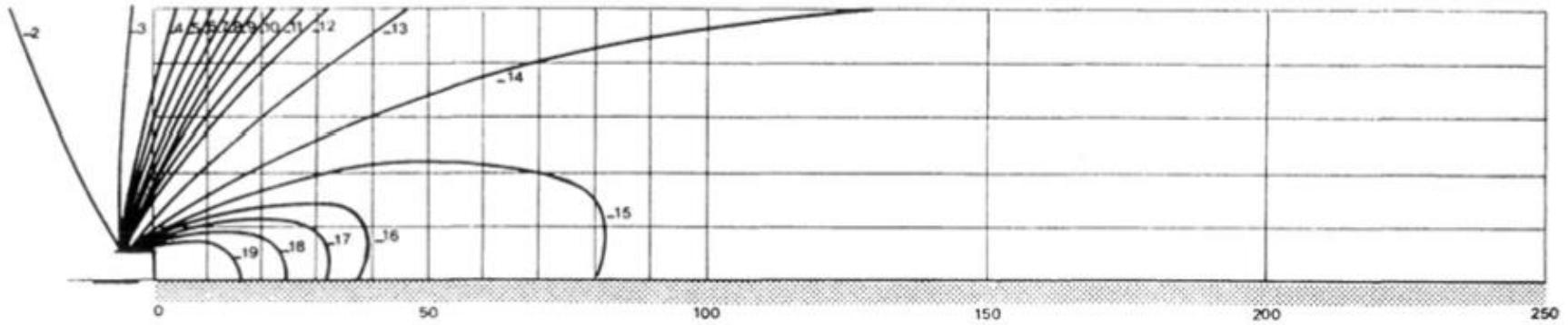
1 - calculation based on **diffraction**: the height and the length of the noise barrier is defined to achieve ti noise reduction required at receiver point

2 - choice of the noise barrier type to achieve maximum **acoustic insulation** requested

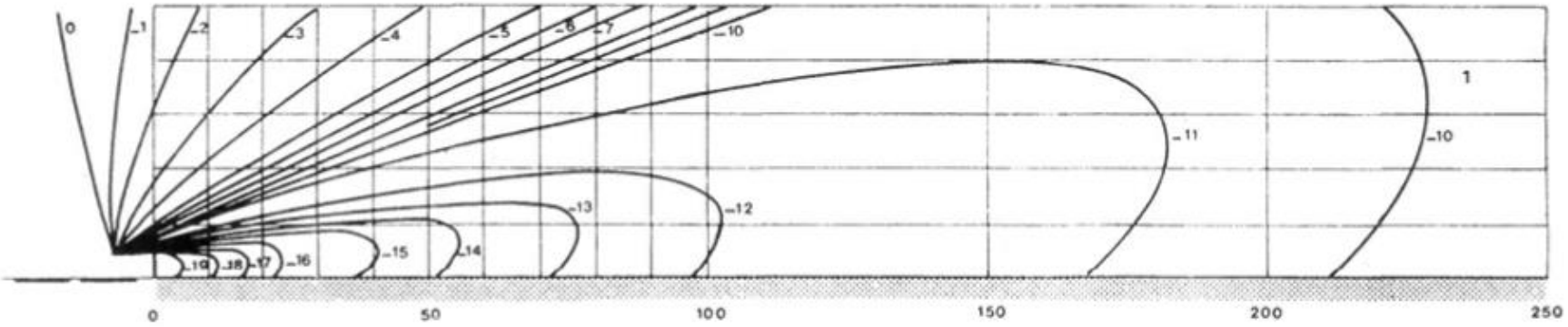
3 - choice of the noise barrier type to achieve maximum **acoustic absorption (minimum reflection)** requested

Acoustic modelling tools based on scale models or numerical techniques



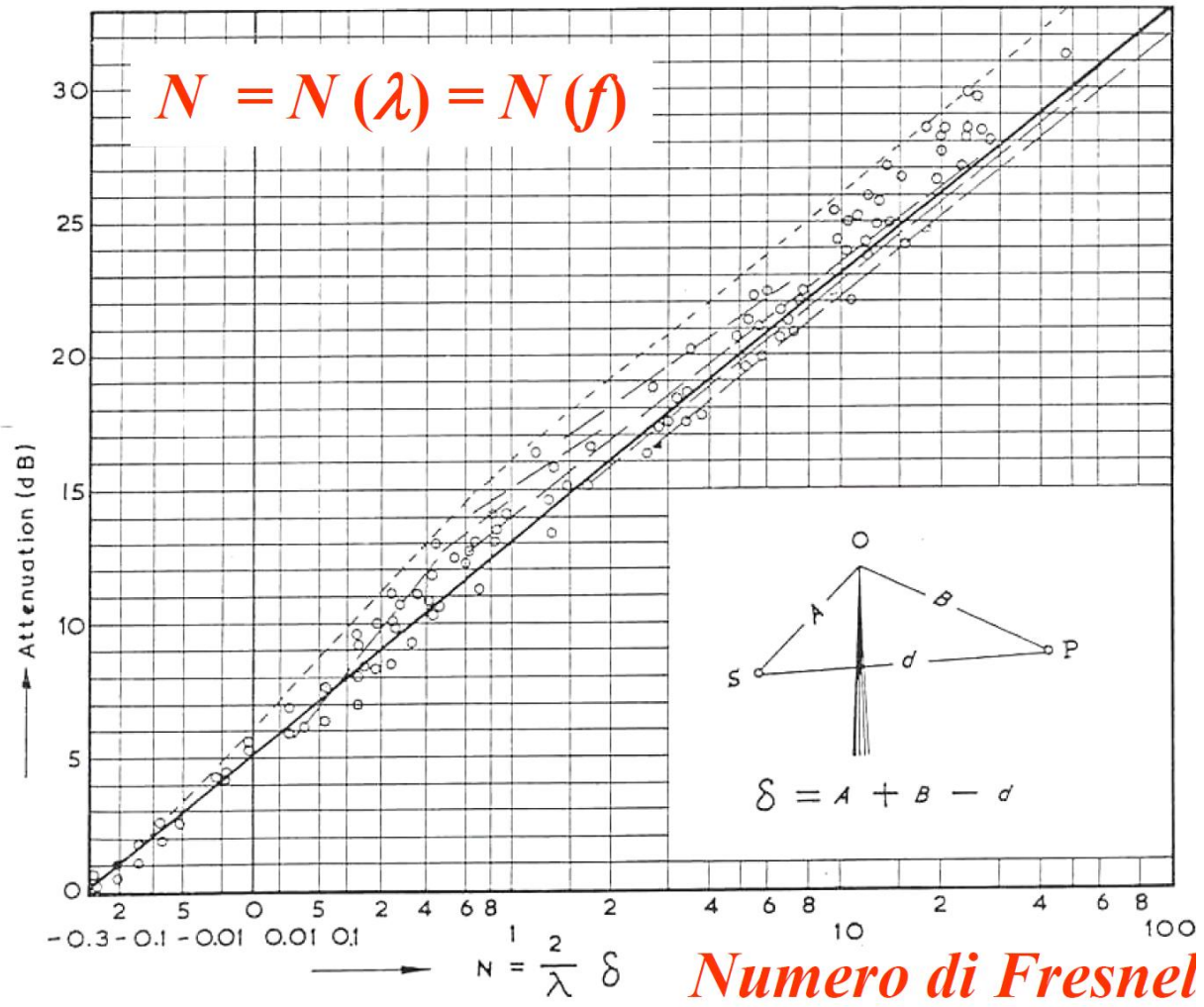


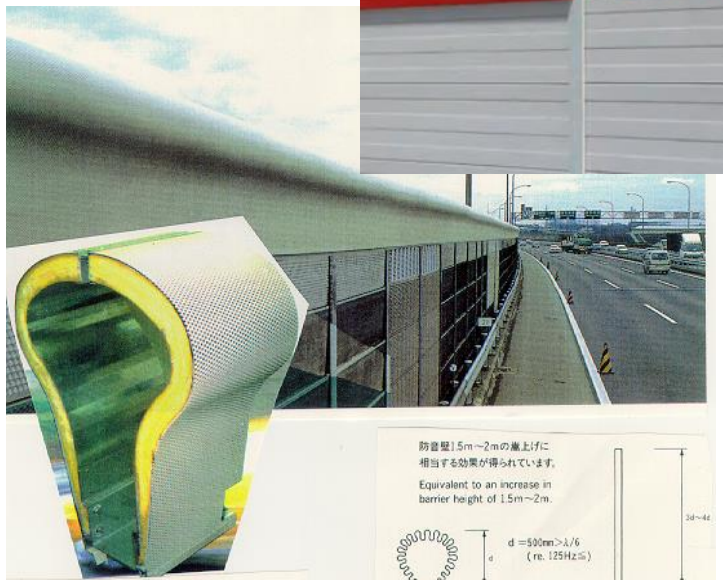
Abaque 4,130 : Voie de 12 m de largeur, au niveau du sol. Isoatténuations apportées par une couverture partielle couvrant la moitié de la chaussée.



Abaque 4,131 : Route à 2 x 2 voies au niveau du sol. Isoatténuations apportées par une couverture partielle couvrant la moitié de la première chaussée.

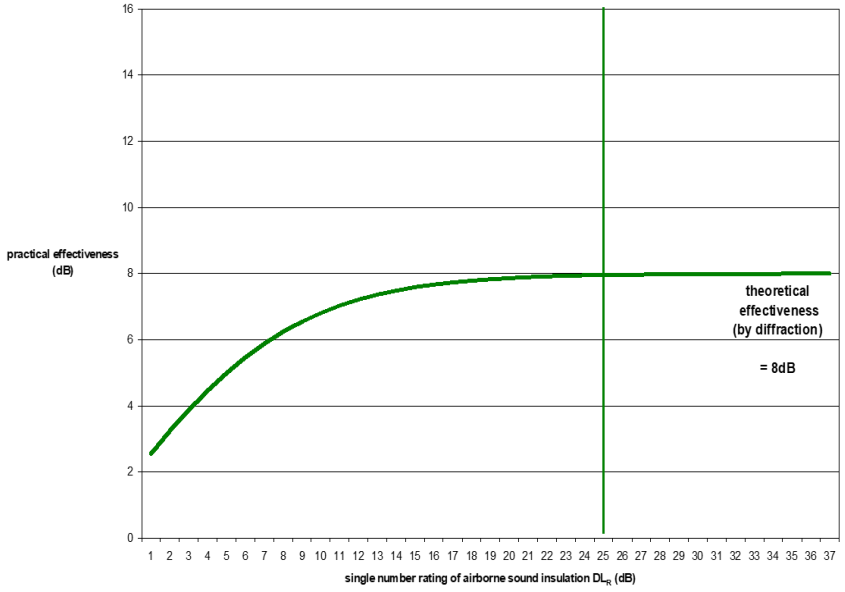
Diffraction effect calculation

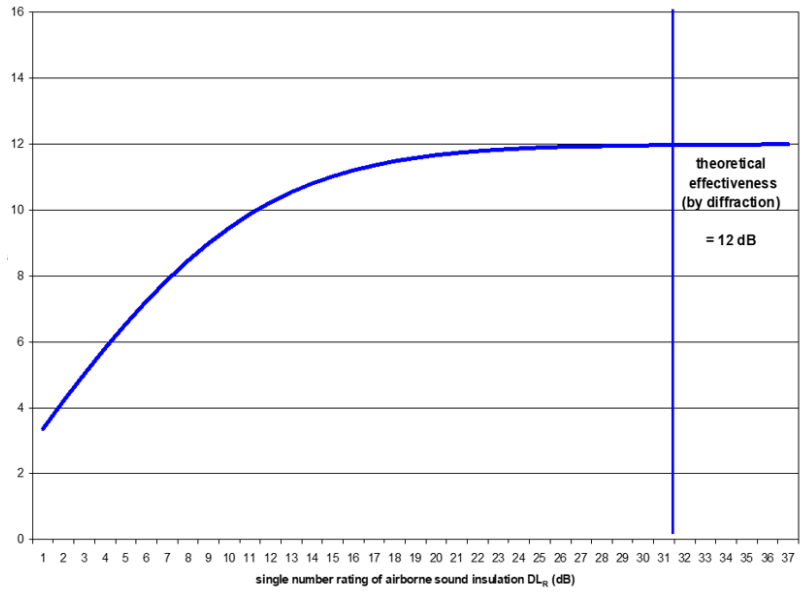


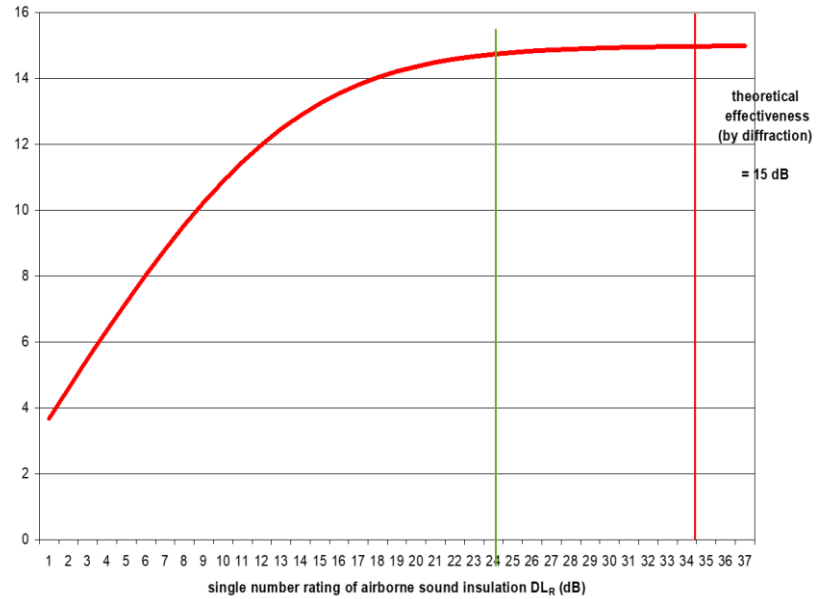


Once the expected effectiveness by diffraction is defined,

- the optimal acoustic insulation is calculated
- choice of the materials (depending on the surface mass)

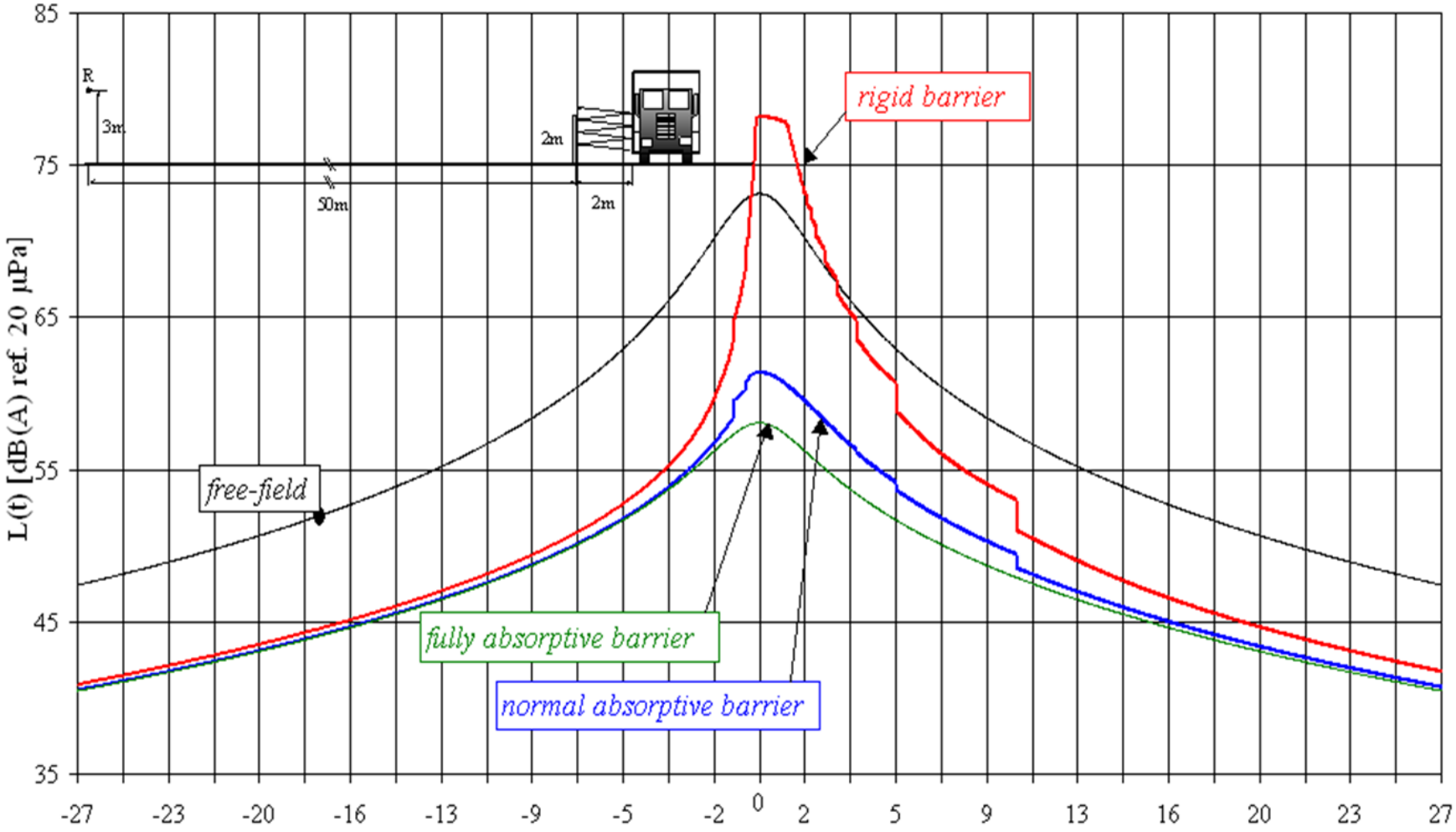




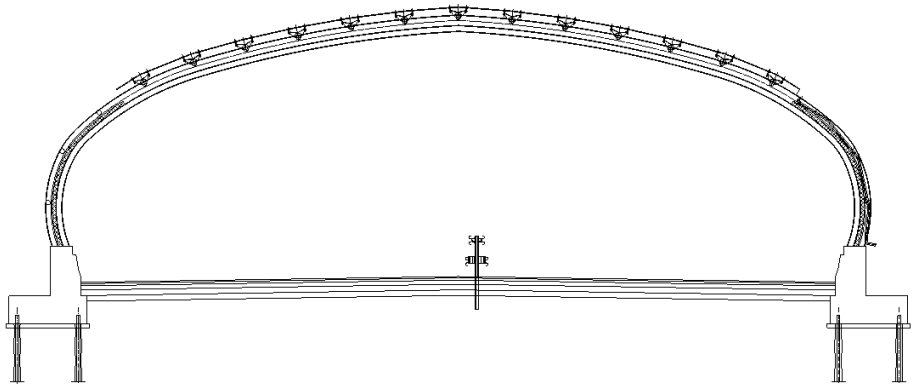


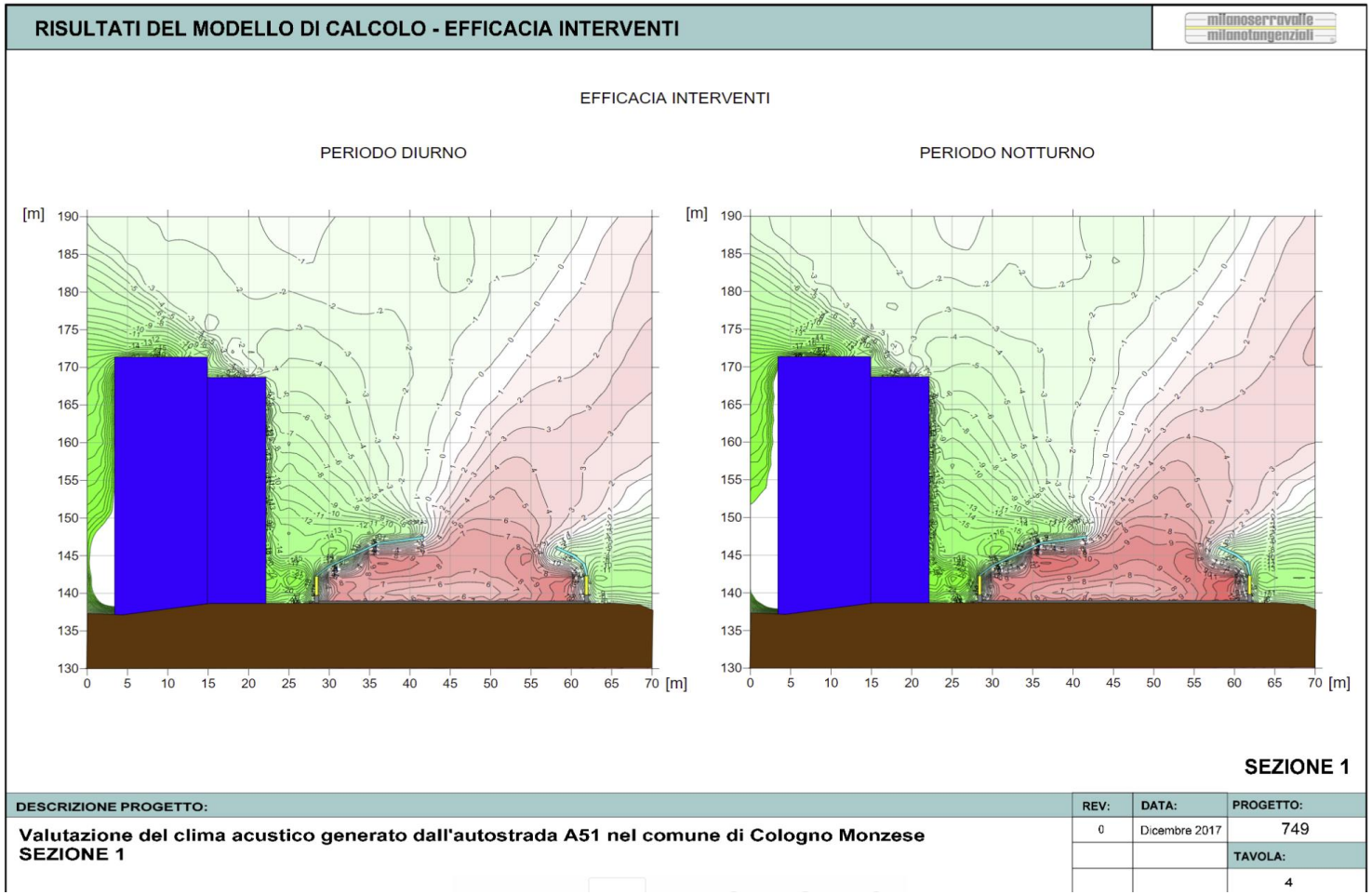
Minimizing the noise reflected by the barrier to:

- avoid any increase of noise levels in the screened area behind the barrier.
- Minimise the multiple reflection effect between the vehicles and the barriers (the figure aside show the potential consequences at the receiver point for a truck pass-by measurement)

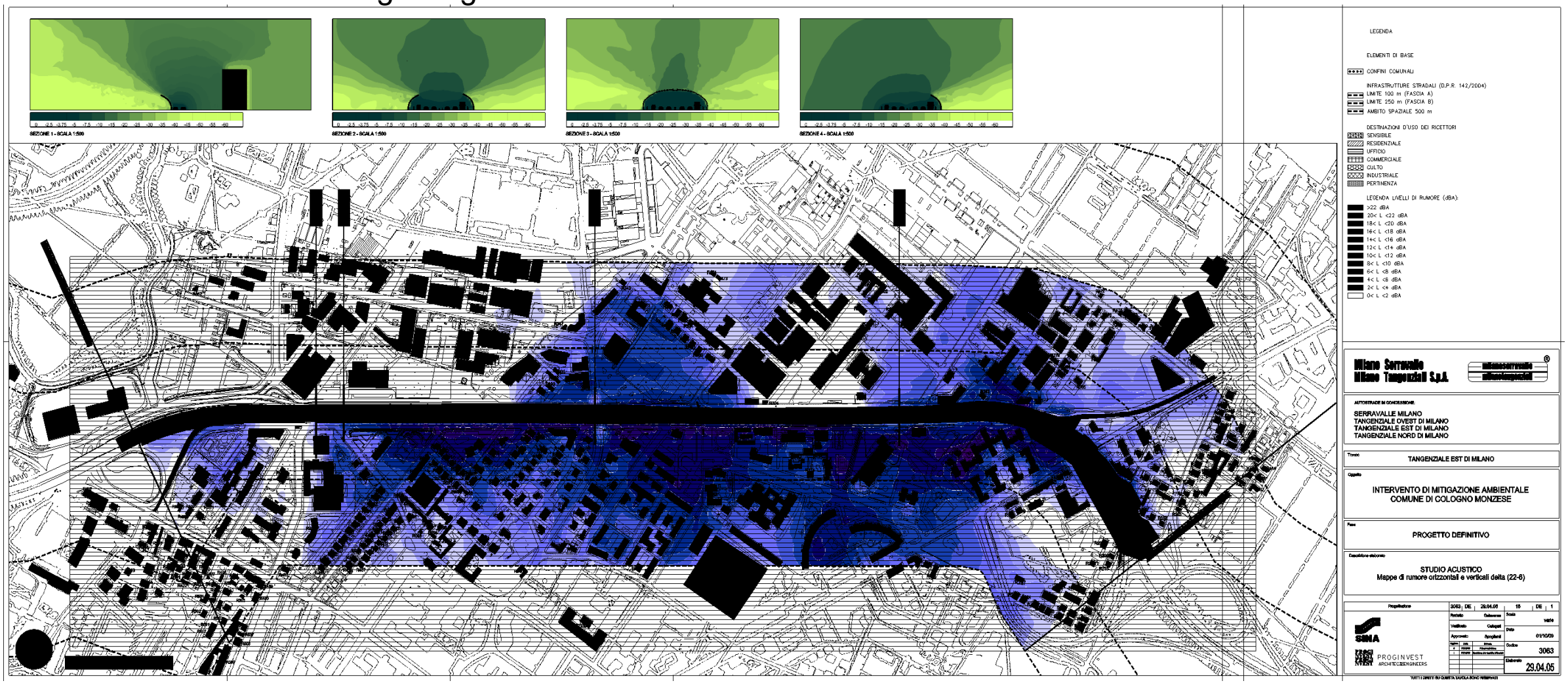


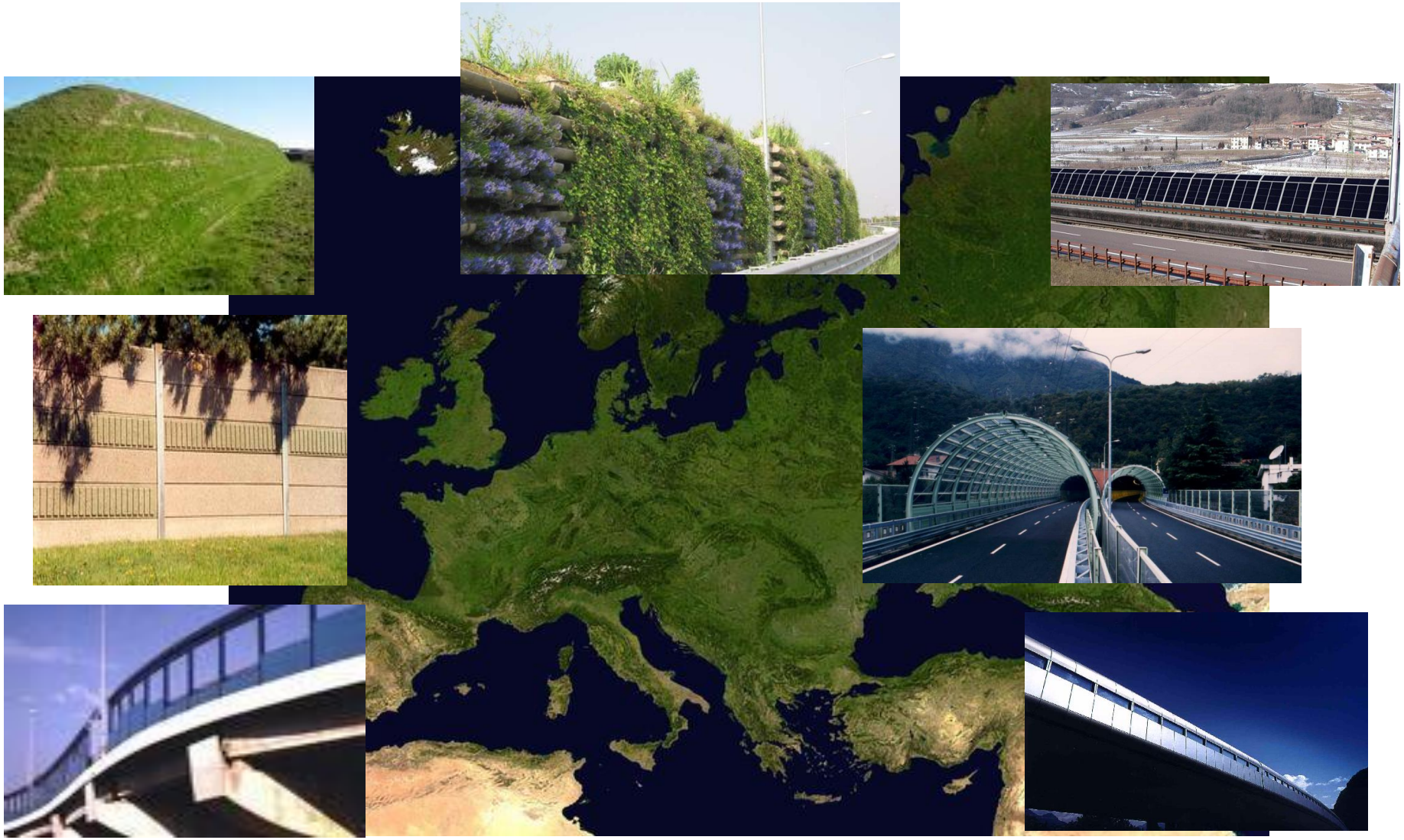
Noise covering design





Noise covering design





Different approaches:

- Minimizing impact on landscape
- Achieving acoustic results and ensuring functionality
- Minimizing costs

NOISE BARRIER DESIGN

Giovanni Brero ENBF
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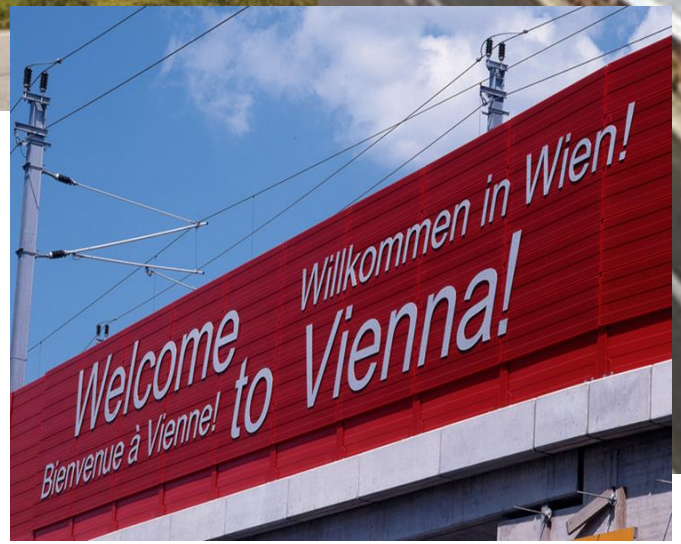
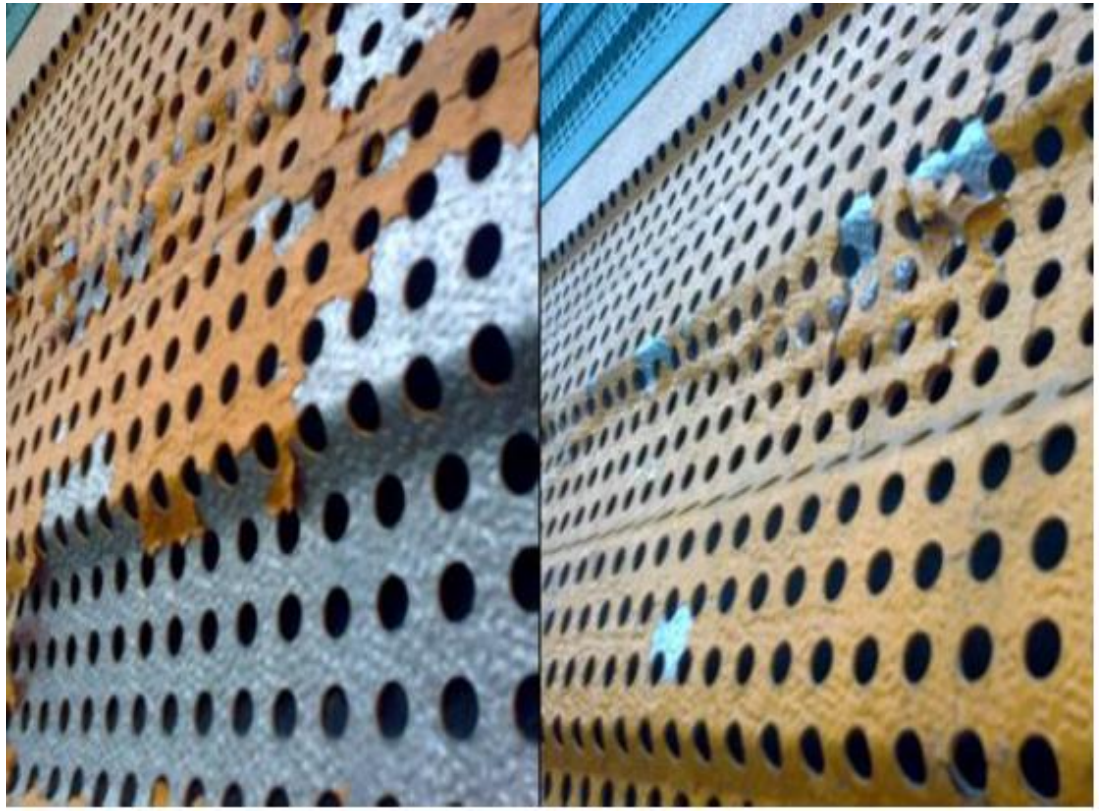
PVNB Noise barriers



NOISE BARRIER DESIGN also includes:

- Structural calculations
- Safety issues related to traffic
- Materials selection and durability
- Installation and maintenance issues
- Sustainability evaluation
- …..

Durability (reference standard EN 14389)
Product durability : metal or timber protection



Durability of the product

Durability of the support

Durability affected by vandalism or accident combined with lack of maintenace

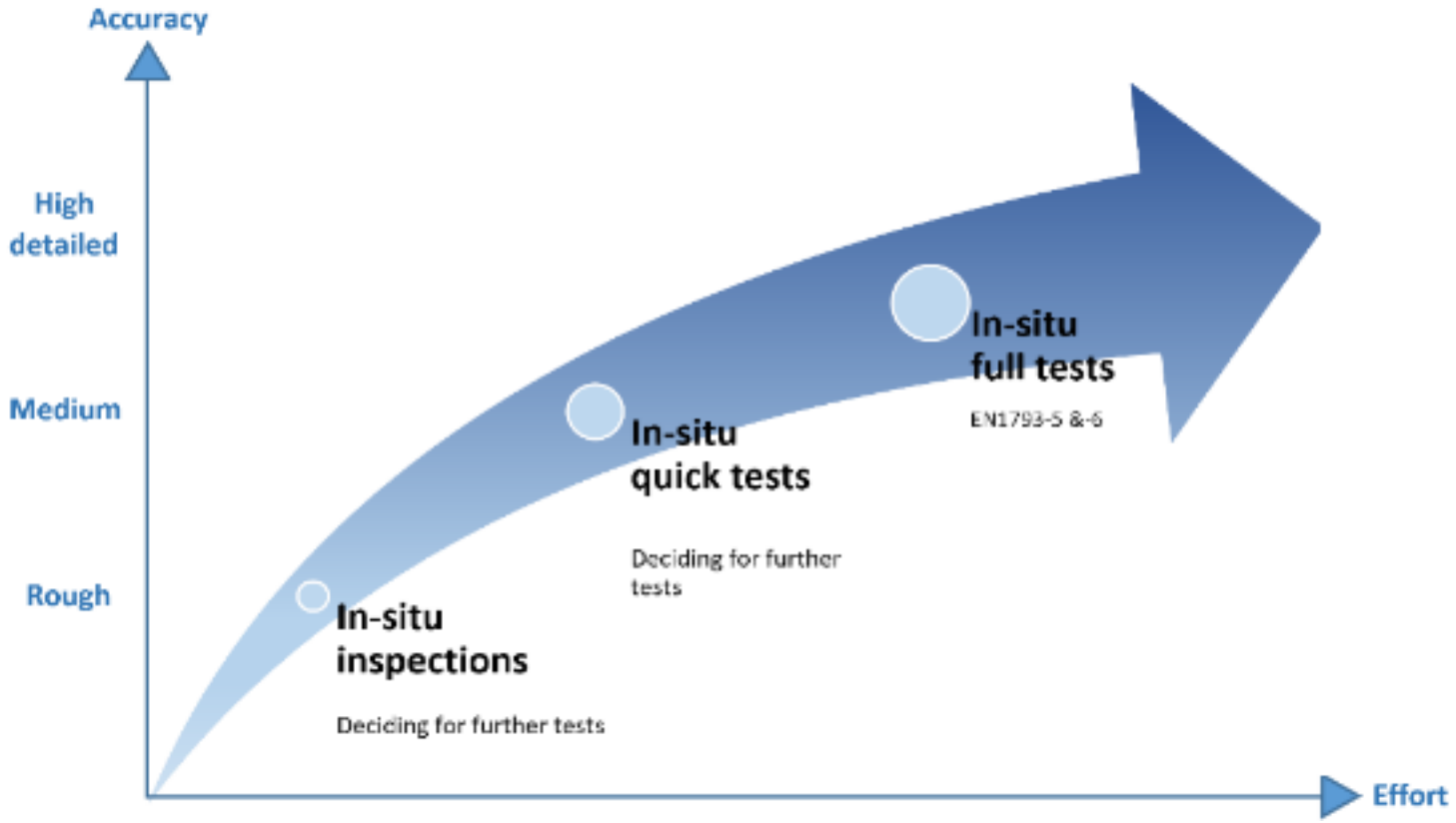
Research project : SOPRANOISE

- **S**ecuring and **O**ptimizing the **P**erformance of **R**oad tr**A**ffic noise barriers with **N**ew meth**O**ds and **I**n- **S**itu **E**valuation

- European research
  funded by **CEDR** (Conference of European Directors of Roads)

- Simplified methods to characterize the in-situ intrinsic acoustic performances of noise barriers

How to characterize the *intrinsic (product)* acoustic performances (absorption, insulation)?



Visual inspections easy to do during roads monitoring visits

NB inspection protocol
Sheet 3: Defects

field no.	NB side	field height /m	defect location	type/cause of defect: impact	deformation	rust	vegetation	degradation	lacking material	view through	position /m: vertical	position /m: horizontal	size /cm: vertical	size /cm: horizontal	additional notes (e.g. on visual/aural impression, absorption material, environmental conditions, general condition, reference to photographs ...)
35	front	2	at element	☑	☐	☐	☐	☐	☑	yes	1.5 - 2.0	middle	15 - 35	65 - 125	
57	front	2	at element	☑	☐	☐	☐	☐	☑	yes	1.5 - 2.0	middle	35 - 65	65 - 125	
83	front	2	at element	☑	☐	☐	☐	☐	☑	yes	1.5 - 2.0	middle	35 - 65	125 - 235	
84	front	2	at element	☑	☐	☐	☐	☐	☑	yes	1.5 - 2.0	middle	15 - 35	125 - 235	
86	front	2	at element	☑	☐	☐	☐	☐	☑	yes	1.5 - 2.0	middle	15 - 35	65 - 125	
87	front	2	at element	☑	☐	☐	☐	☐	☑	yes	1.5 - 2.0	middle	35 - 65	65 - 125	
89	front	2	at element	☑	☐	☐	☐	☐	☑	yes	1.5 - 2.0	middle	35 - 65	125 - 235	

NB inspection protocol
Sheet 1: Location

road name	B42	
near	Oberwalluf	
emergency lane	yes	
from/to km	45.7	46.5
direction	Frankfurt	
from/to coordinates	50.044433	8.137693
	50.044482	8.137751

NB inspection protocol
Sheet 2: Construction

main construction material	absorbing front?	absorbing back?	material of posts
acrylic glass	no	no	steel
combined with			
combined with			

NB inspection protocol
Sheet 4: Acoustic assessment

Assessment for each NB field individually

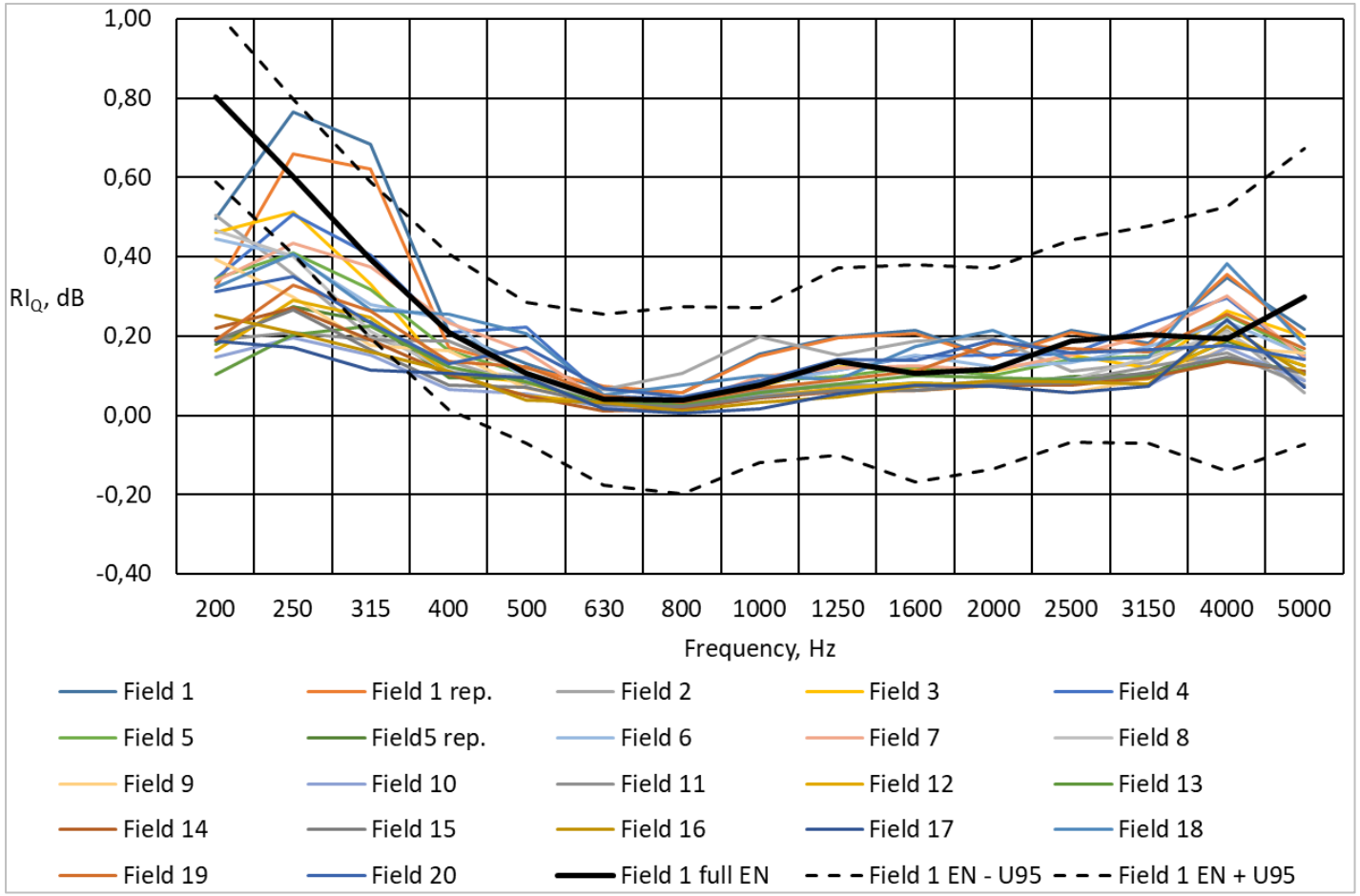
field no.	acoustic condition	critical radius /m
35	G	5
57	G	9
83	Q	17
84	G	8
86	G	5
87	G	9
89	Q	17

Estimated overall assessment (superposition)

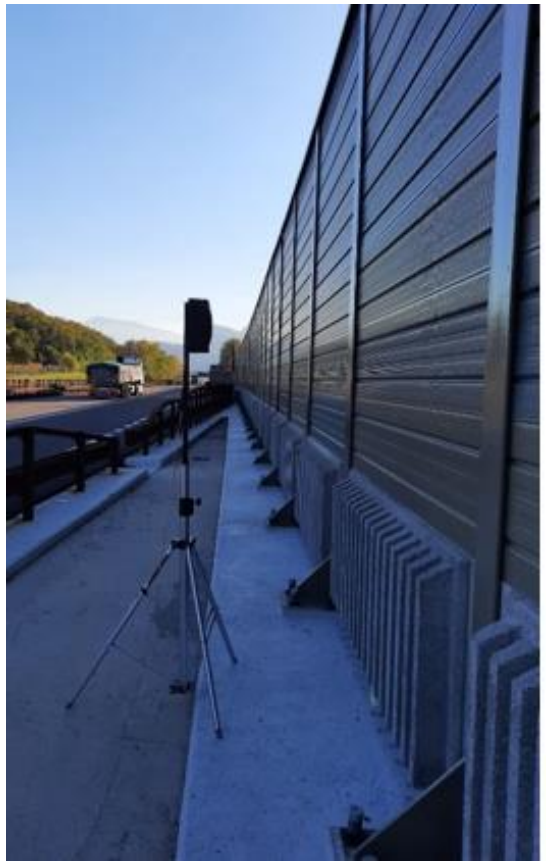
field no.	acoustic condition	critical radius /m
35	G	5
57	G	9
83	Q	39
84	Q	44
86	Q	48
87	Q	46
89	Q	38

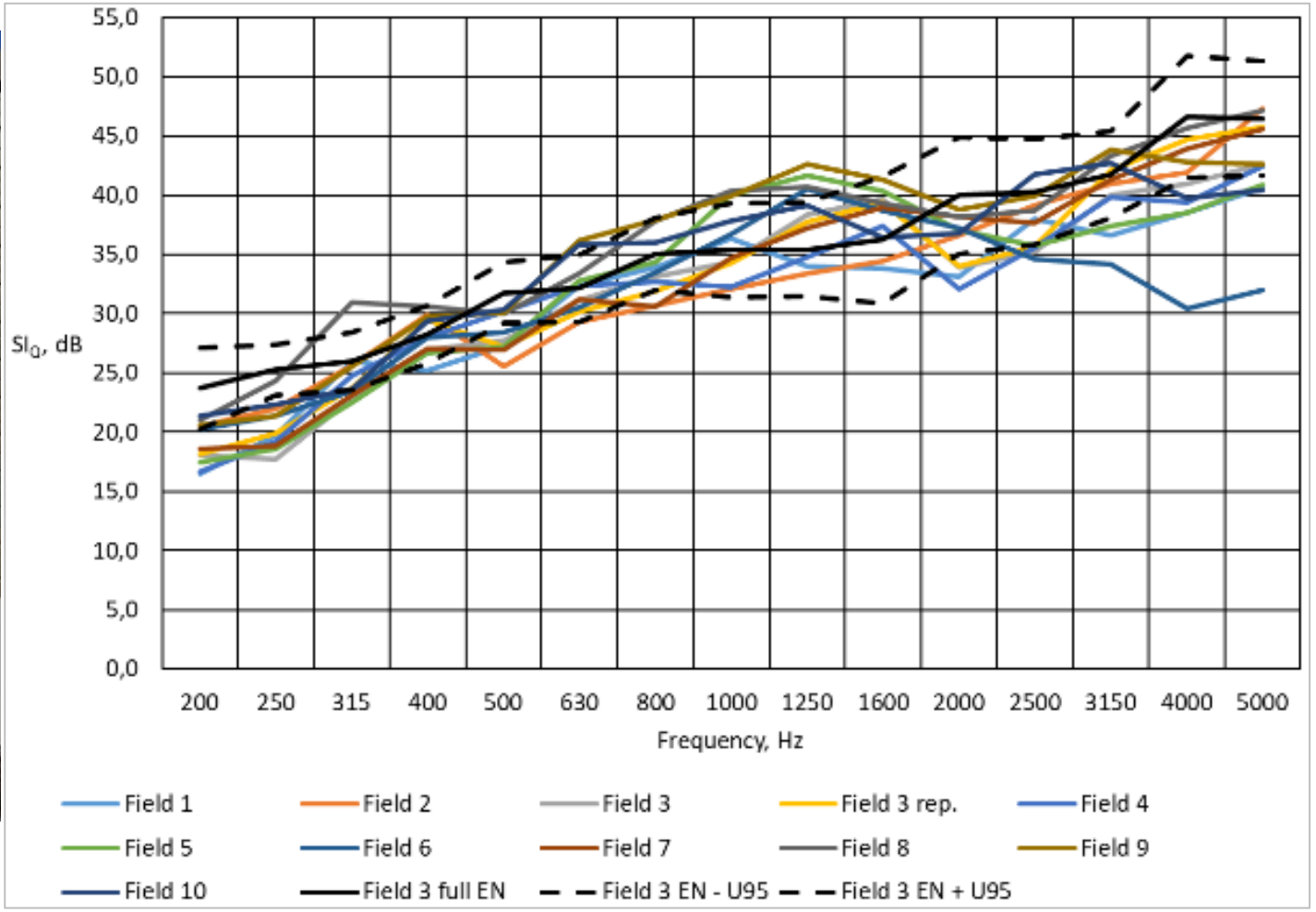
In-situ *measurements*

In-situ *measurement of sound reflection*



In-situ *measurement of sound insulation*





How can we represent sustainability ?

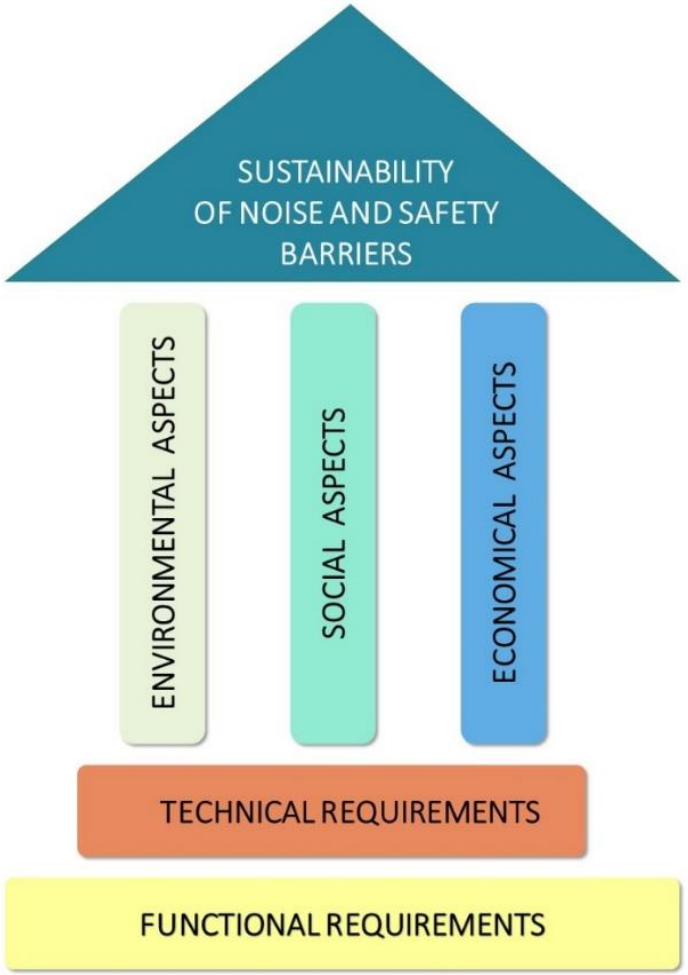
for a noise barrier project:

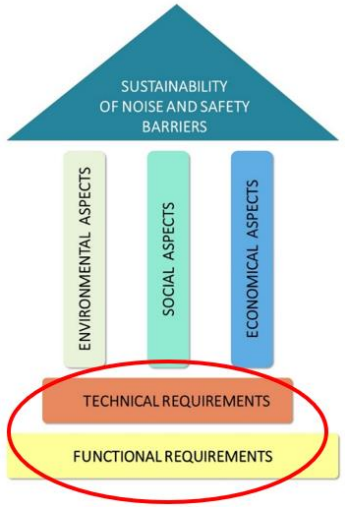
technical (and functional) requirements represents the basement design technical specification to be fulfilled, on the top of that for each project:

economic,

social,

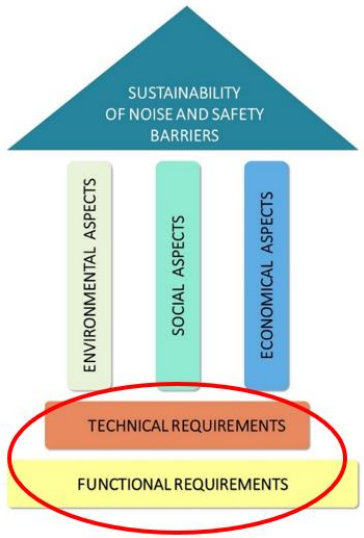
and environmental requirements need then to be considered.





ESSENTIAL REQUIREMENTS FOR NOISE BARRIERS ACCORDING TO CPR 305/2011 (today under revision)

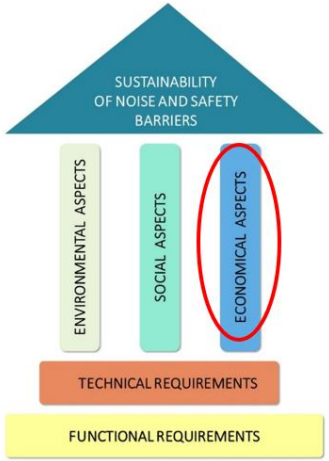
1. Mechanical resistance and stability
2. Safety in case of fire
3. Hygiene, health and the environment
4. Safety and accessibility in use
5. Protection against noise
6. Energy economy and heat retention
7. Sustainable use of natural resources



Construction Products Regulation 2.0

New requirements ensuring the functioning of the product when inserted in the costruction:

- installation requirements
- maintenance requirements (periodic inspection)
- environmental sustainability



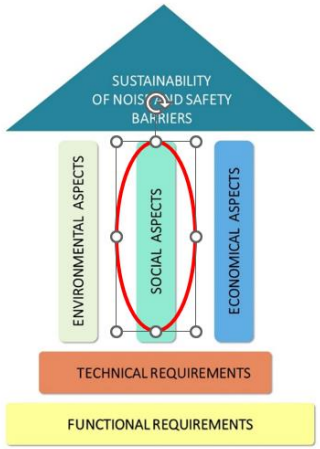
Economic sustainability

different approaches for Noise barriers:

- Cost / Benefit evaluation

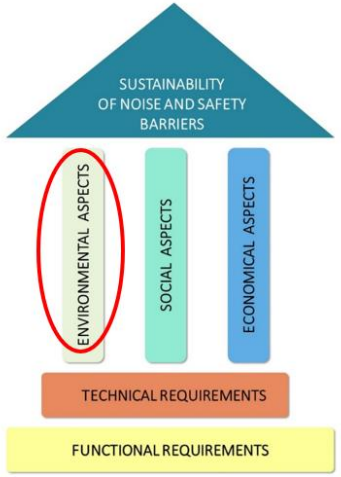
(take into account new functionalities of Noise barriers (energy production, use of the surface…)

- Willingness to pay for noise reduction



Social sustainability:

- Impact on landscape
- Obstruction of the view
- Shadowing
- Security

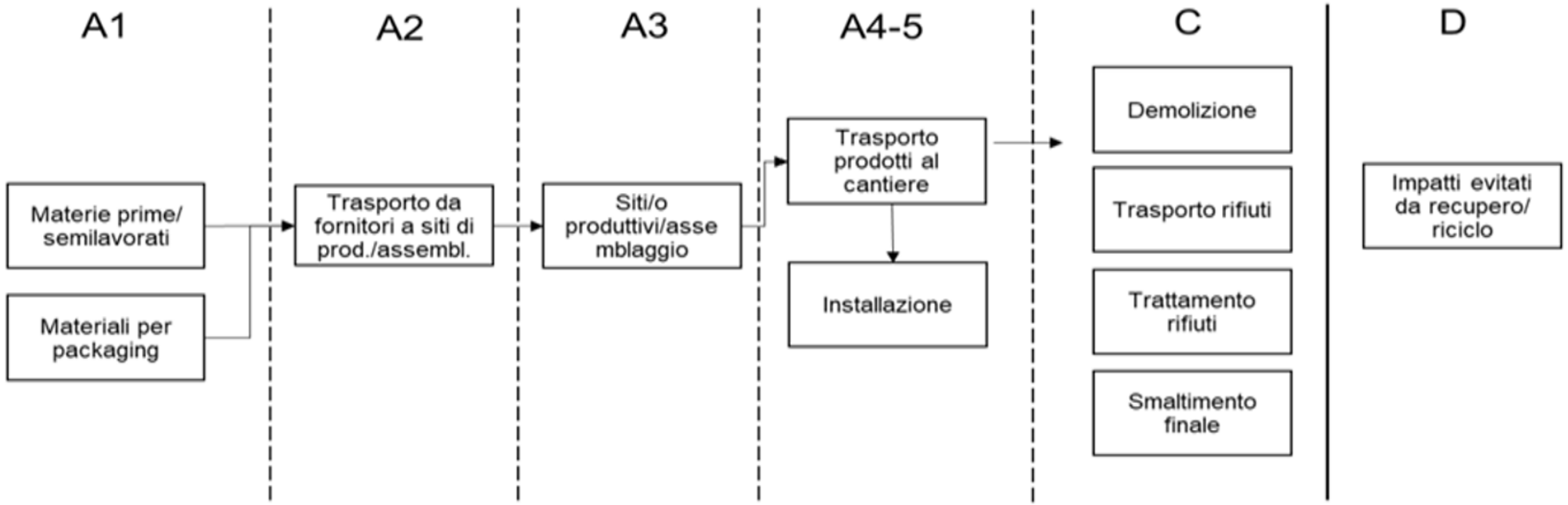


Environmental sustainability:

Pr EN 17383

http://www.environdec.com/

LCA based on the set of indicators over the whole life cycle defined in EN15804:2019.



PROCEEDR
OPTIMISING RESOURCE USE
FOR ROADSIDE INFRASTRUCTURES

PROCEEDR - OPtimising Resource Use for Roadside Infrastructures

PROCEEDR
OPTIMISING RESOURCE USE FOR ROADSIDE INFRASTRUCTURES

CEDR TRANSNATIONAL ROAD RESEARCH PROGRAMME

Call 2020

Resource Efficiency and the Circular Economy

CEDR Transnational Road Research Programme

funded by

Denmark, Ireland, Netherlands, Norway, Sweden, Switzerland and the United Kingdom

5.1 Topic A: Measuring and managing performance

5.2 Topic B: Public procurement to foster circular innovation

5.3 Topic C: Material research for roadside infrastructure

PROCEEDR
OPTIMISING RESOURCE USE
FOR ROADSIDE INFRASTRUCTURES

Material	Details
Aluminium	Rock wool or polyester filling
Steel	Rock wool or polyester filling
Recycled PVC	polyester filling
Glass	+ steel frame + EPDM gaskets
PMMA	+ steel frame + EPDM gaskets
Wood	Timber frame + HDPE sheet

Life cycle stages to be considered

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	x	x	x	x	x	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	IT	IT	IT	RER									RER				-
Specific data used	X			X	-	-	-	-	-	-	-	-	-	-	-	-	x

Mandatory impact category indicators according to EN 15804

Results per declared unit									
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-fossil	kg CO_2 eq.	1,6E+01	1,6E+00	2,31E-02	5,12E-04	1,62E-01	2,5E+00	1,0E+00	-4,28E+00
GWP-biogenic	kg CO_2 eq.	6,18E-02	1,60E-03	-9,9E-01	3,13E-07	1,10E-05	1,10E-03	4,66E-05	-1,18E-02
GWP-luluc	kg CO_2 eq.	2,41E-03	5,65E-04	6,84E-06	2,82E-08	1,30E-06	1,09E-04	1,32E-05	-7,64E-03
GWP-total	kg CO_2 eq.	1,6E+01	1,6E+00	-9,7E-01	5,13E-04	1,62E-01	2,5E+00	1,0E+00	-4,30E+00
ODP	kg CFC 11 eq.	3,15E-06	3,25E-07	2,48E-09	4,32E-11	3,82E-08	1,59E-07	7,04E-09	-1,83E-05
AP	mol H^+ eq.	3,79E-02	1,03E-02	1,52E-04	1,07E-06	7,30E-04	4,72E-03	2,92E-04	-2,38E-02
EP-freshwater	kg P eq.	2,32E-04	2,62E-05	3,44E-07	1,62E-08	8,23E-08	4,78E-05	3,92E-07	-2,49E-04
EP-marine	kg N eq.	8,62E-03	3,98E-03	6,47E-05	2,64E-07	2,68E-04	1,46E-03	4,09E-04	-4,93E-03
EP-terrestrial	mol N eq.	9,33E-02	4,38E-02	7,17E-04	2,99E-06	2,95E-03	1,61E-02	1,37E-03	-4,70E-02
POCP	kg NMVOC eq.	2,38E-02	1,06E-02	1,63E-04	7,93E-07	7,15E-04	4,08E-03	3,75E-04	-1,25E-02
ADP-minerals&metals*	kg Sb eq.	9,07E-06	7,00E-08	9,85E-10	1,60E-11	6,99E-09	6,68E-08	5,55E-09	-5,27E-06
ADP-fossil*	MJ	2,7E+02	2,4E+01	2,24E-01	1,22E-02	2,3E+00	3,8E+01	2,74E-01	-1,14E+02
WDP*	m^3	7,5E+00	5,12E-02	6,02E-04	2,43E-05	-3,9E-04	8,63E-02	8,11E-03	-4,15E+00
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption								

GWP-GHG[1]	kg CO_2 eq.	1,64E+01	1,57E+00	2,35E-02	5,13E-04	1,62E-01	2,49E+00	1,01E+00	-4,3E+00
Particulate matter emissions	Disease incidence	1,96E-07	1,32E-07	1,58E-09	8,04E-12	1,45E-08	5,54E-08	3,96E-09	-2,52E-07
Ionizing radiation, human health	kBq U235 eq.	2,42E-01	1,27E-01	1,41E-03	1,70E-04	9,91E-03	4,92E-01	1,49E-03	-1,77E-01
Eco-toxicity (freshwater)	CTUe	7,97E+01	9,57E+00	1,52E-01	3,91E-03	1,00E+00	1,60E+01	2,81E+00	-8,6E+01
Human toxicity, cancer effects	CTUh	9,76E-09	1,34E-10	9,07E-11	1,20E-12	1,40E-11	3,66E-09	1,44E-10	-9,43E-10
Human toxicity, non-cancer effects	CTUh	5,36E-08	1,58E-08	4,10E-10	1,69E-12	1,96E-09	1,38E-08	1,61E-09	-5,59E-08
Land use related impacts/Soil quality	dimensionles	1,23E+02	6,73E-01	1,44E-02	1,49E-03	6,72E-03	4,40E+00	4,32E-01	-4,6E+00

Additional voluntary indicators e.g. the voluntary indicators from EN 15804 or the global indicators according to ISO 21930:2017

Resource use indicators

Results per declared unit									
Indicator	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	3,47E+01	9,02E-01	1,20E-02	4,45E-04	3,50E-03	1,30E+00	2,95E-02	-3,9E+00
PERM	MJ	1,12E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	4,58E+01	9,02E-01	1,20E-02	4,45E-04	3,50E-03	1,30E+00	2,95E-02	-3,9E+00
PENRE	MJ	2,64E+02	2,38E+01	2,24E-01	1,22E-02	2,28E+00	3,77E+01	2,74E-01	-1,1E+02
PENRM	MJ	9,71E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ	2,74E+02	2,38E+01	2,24E-01	1,22E-02	2,28E+00	3,77E+01	2,74E-01	-1,1E+02
SM	kg	1,81E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	1,73E-01	4,23E-03	1,94E-04	2,00E-06	5,86E-06	7,43E-03	3,86E-04	-8,59E-02

Acronyms	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

Waste indicators

Results per declared unit									
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1,32E-01	4,69E-03	5,00E-03	3,06E-06	6,93E-05	4,27E-01	1,05E-02	-8,43E-02
Non-hazardous waste disposed	kg	8,08E-02	4,16E-03	3,36E-01	1,53E-06	5,64E-05	1,47E+00	4,87E+00	2,43E-01
Radioactive waste disposed	kg	3,26E-04	1,71E-04	1,46E-06	8,52E-08	1,63E-05	2,52E-04	1,60E-06	-1,39E-04

Output flow indicators

Results per declared unit									
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**C1**	**C2**	**C3**	**C4**	**D**
Components for re-use	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Material for recycling	kg	1,79E+00	0,00E+00	4,34E-01	0,00E+00	0,00E+00	1,99E+01	0,00E+00	0,00E+00
Materials for energy recovery	kg	1,43E-03	0,00E+00	7,44E-02	0,00E+00	0,00E+00	0,00E+00	2,00E-01	0,00E+00
Exported energy, electricity	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy, thermal	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

How to implement environmental sustainability in GPP ?

- Confine declarations to modules A
- Eventually extended to modules C
- Clarify the use of module D
- Defined appropriate scenario for modules B

- Identify a global indicator i.e.:

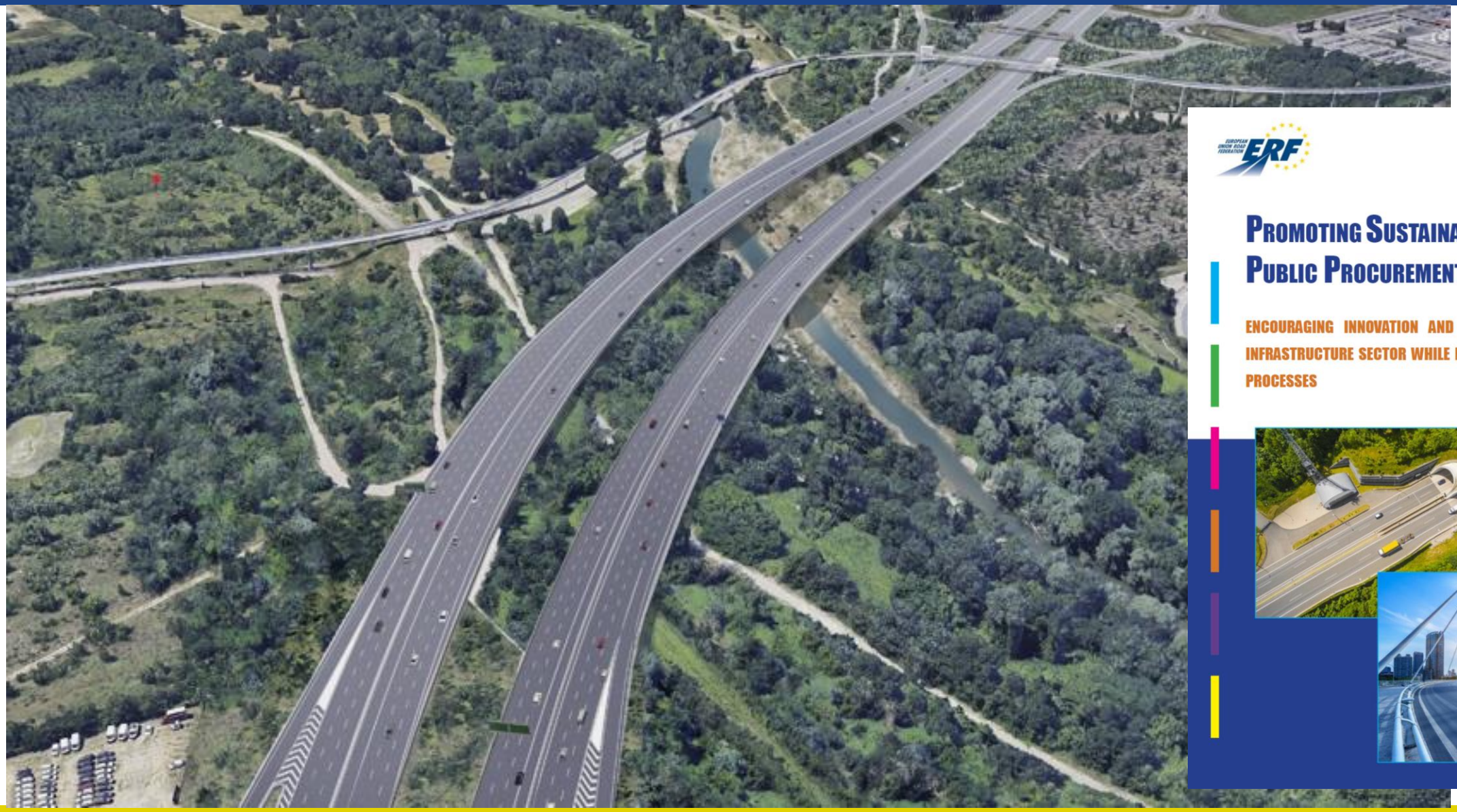
The Environmental Cost Indicator (ECI) is a single-score indicator expressed in Euro.

Some sustainable case histories considered in Proceedr research

Use of pregalva steel

Integrated noise and safety barriers

Special foundation systems



Promoting Sustainable Roads Through Public Procurement

ENCOURAGING INNOVATION AND SUSTAINABILITY IN THE ROAD INFRASTRUCTURE SECTOR WHILE MODERNISING PUBLIC TENDERING PROCESSES

Thanks for your attention

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