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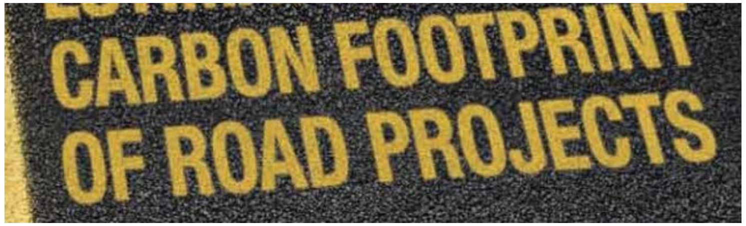
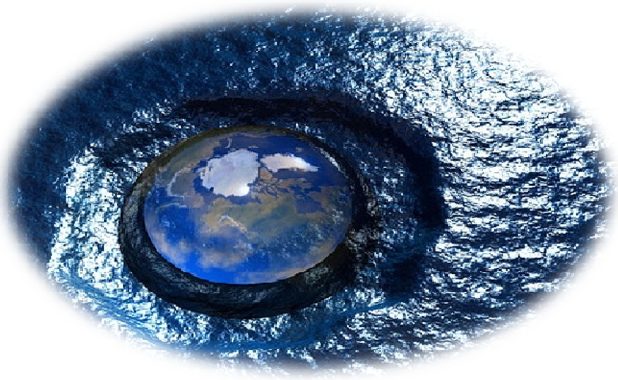
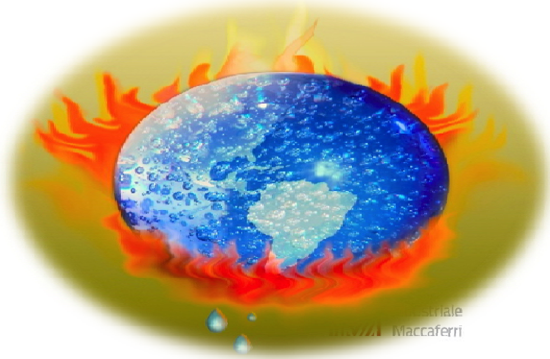
Calculations of CO_2 Emissions and Subsequent Implementation During Design and Operations

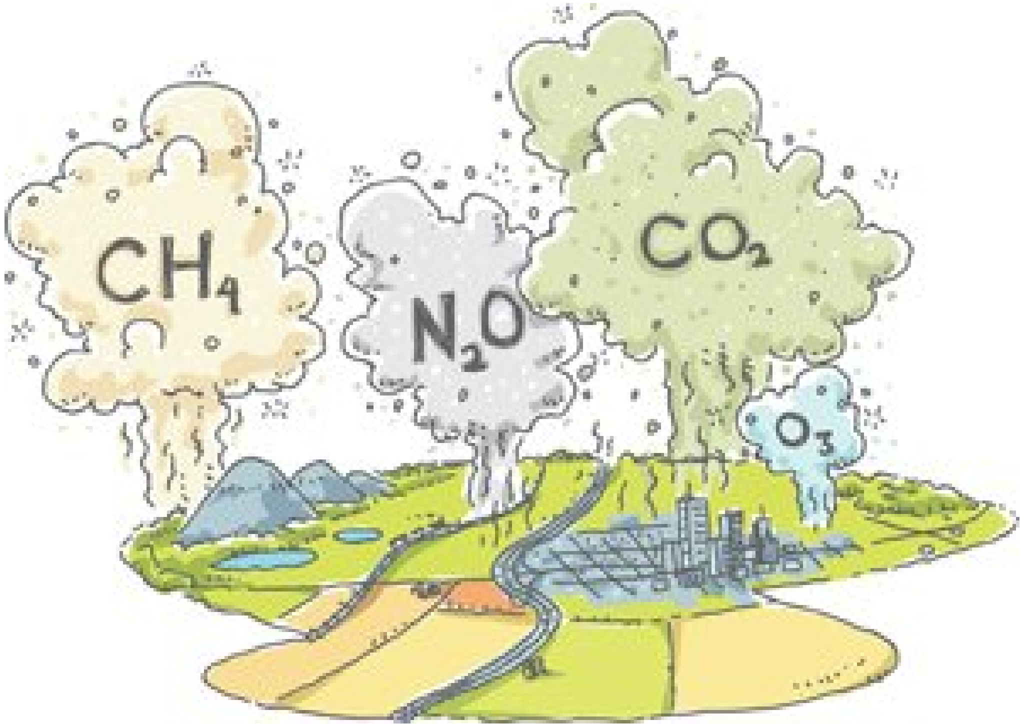


GLOBAL WARMING





- CO2
- Methane
- Nitrous Oxide
- Hydroflourocarbon
- Sulphur Hexaflouride
- Perflourocarbon



In 1992, Rio Brazil

Objective…

Green House Gases should be stabilized within a time frame.

The KYOTO PROTOCAL...

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The Japan Times

Conference adopts Kyoto Protocol

reenhouse gas emissions
o be cut by average of 5.2%

Kyoto convention's success open to debate

Gist of Kyoto Protocol

An agreement signed in December 1997 in Kyoto, Japan

Objective

Reduction of Green House Gases emission by developed countries in the The First Commitment Period

(2008-2012)

What is Carbon Credit under the KYOTO PROTOCOL??

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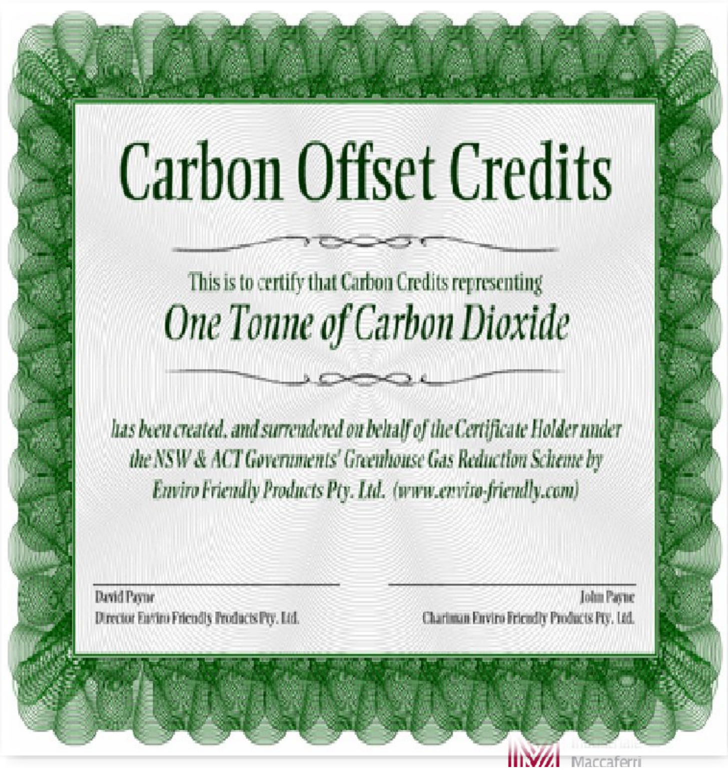
A credit for reducing 1 ton of CO_2 (Green House Gases) from the atmosphere



A carbon footprint id defined as:

The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of CO_2.

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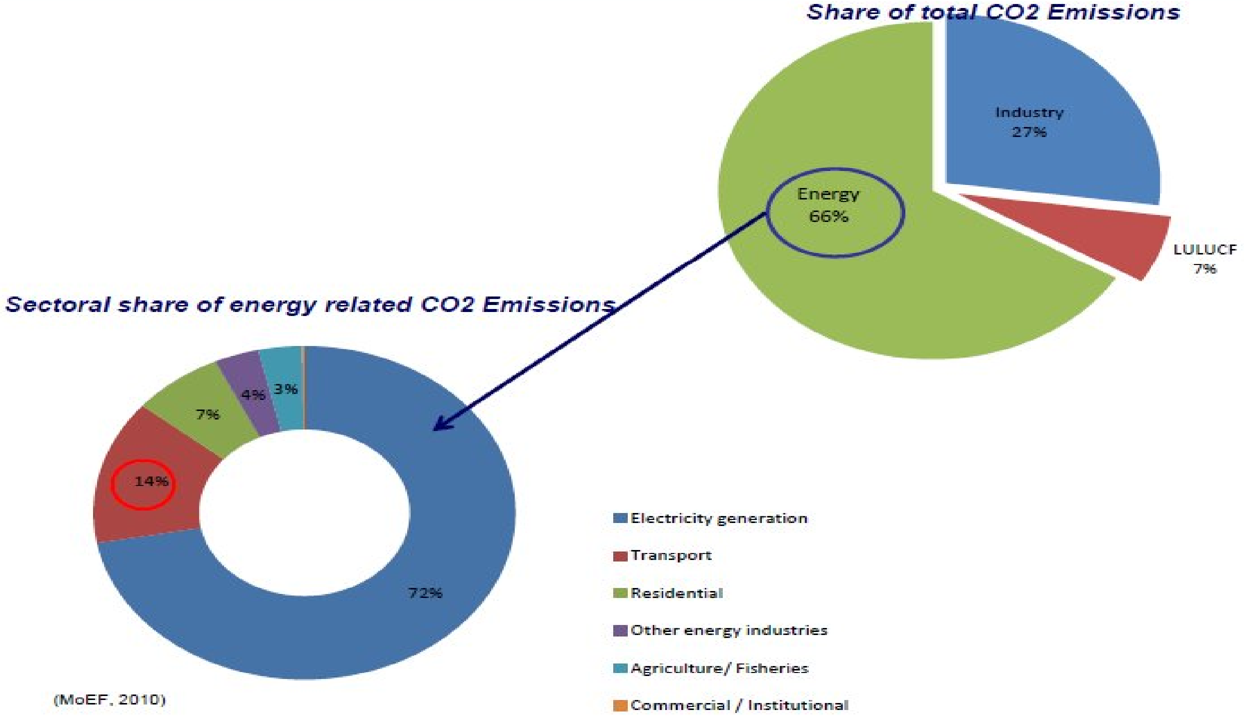
Transport in India's Carbon Emissions



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•Transportation - major contributor to global climate change, accounting for 14% of energy-related carbon dioxide (CO2) emissions.

•Many experts foresee a three to five times increase in CO2 emissions from transportation in Asian countries by 2030 Compared with emissions in 2000 if no changes are made to investment strategies and policies.

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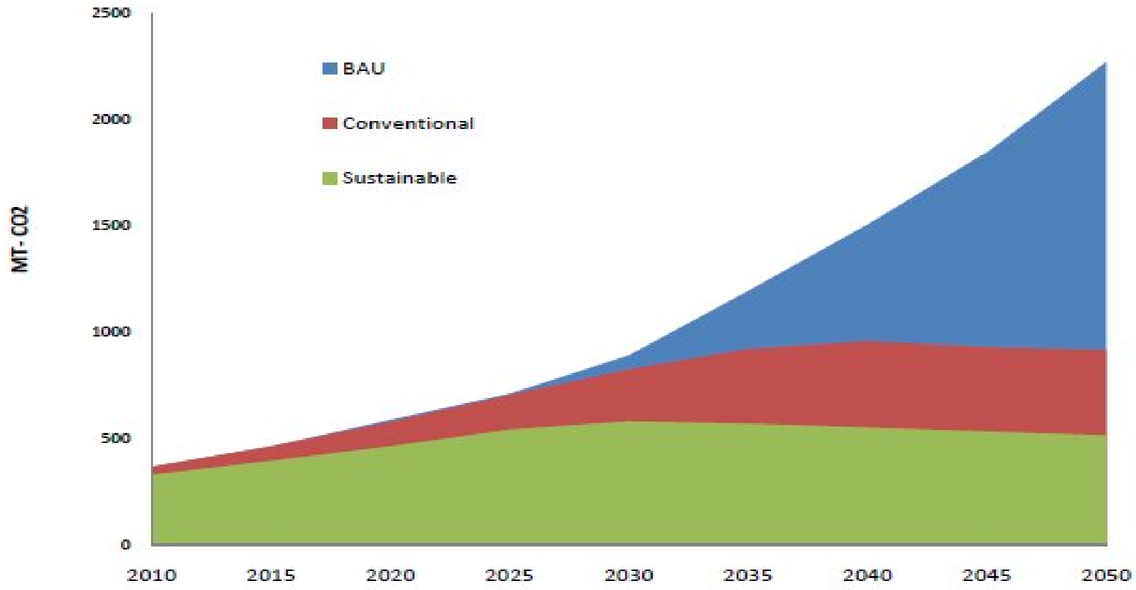
Transport Emissions (2010-2050): India



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Road sector is responsible for large share of emissions from transport sector

Mt eq. Co2 GHG Emissions 2005

	Total	Transport	%	Road (%)
World	38725	5378	14	72
Asia	14236	1098	8	95-100
Europe	8141	1244	15	93
North America	7384	1973	25	85
Central American & Caribbean	773	161	21	N.A.
MENA	2566	388	15	N.A.
South Africa	2124	286	14	>50
Sub-Saharan Africa	1083	104	10	N.A.
Oceania	647	93	14	84

- Contribution of the road construction industry to global warming can no longer be ignored.
- Construction of Road in conventional way, consume energy in a number of ways.
- Energy consumption in road construction occurs in five phases.

- The cost-effective and alternate construction technologies, which apart from reducing cost of construction by reduction of quantity of road material by using alternate low energy consuming materials, can play a great role in reduction of CO2 emission and thus help in the protection of the environment.

•While road construction GHG emissions only represent 5-10% of total GHG emissions in the sector, they are growing rapidly in Asia, especially in India due to major ongoing road programs to support economic development.

•Moreover, most road agencies in India are not yet aware of the impact of their activities on GHG emissions, even though Asia is at the center of road construction actions.

•It is therefore important to raise the awareness of the stakeholders to improve current practices and to facilitate more informed decision making.

The construction of an average single lane-mile of freeway produces enough pollution to equal up to 1,200 tons of CO2 - roughly the same amount as the total annual emissions of 210 passenger cars.

- **Step-1 Determine Carbon Footprint**
- **Step-2 Reduce Carbon Footprint**
- **Step-3 Offset**

HOW CAN WE REDUCE CARBON EMISSIONS FROM TANSPORT?

- Fuel Switching
- Improving Fuel Efficiency with Advanced Design, Materials, and Technologies
- Improving Operating Practices
- Reducing Travel Demand
- Using trees to offset carbon
- New Technology
- Sustainable Pavements
- Warm Mix
- RAP
- Plant O & M
- Truck and other equipment maintenance

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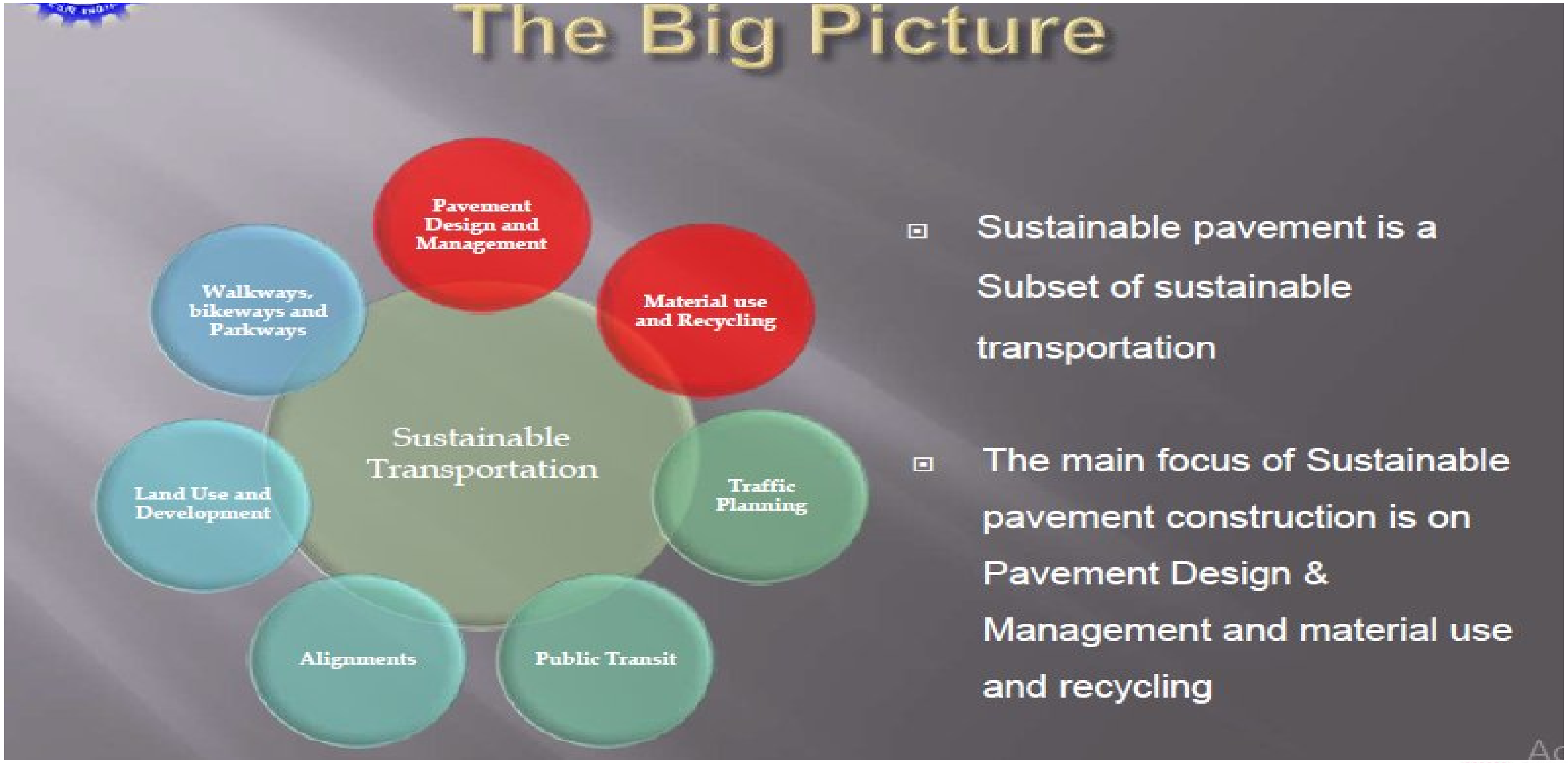

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Reduction Opportunities in the Transportation Sector

- Reduce hauling costs
- Conserve native materials
- Substitute less expensive material
- Reduced CO_2 & NO_x emissions
- Use of Locally available material

Towards increased use of local materials

• Better and increasing use of local materials found in the right-of way is becoming a necessity for social acceptance and environmental considerations.

• But at the same time, it helps preserving resources of quality aggregate, it reduces transportation of road materials imported from or exported outside the limits of building, it reduces damage caused to adjacent road networks, all these aspects contributing to a reduction of the carbon footprint of road construction.

Reduce the thickness of pavement layers

USE OF ADVANCED MATERIALS LIKE GEOSYNTHETICS IN ROADWORK TO REDUCE CARBON FOOTPRINTS

Geosynthetic materials significantly reduces carbon emission or equivalent green house emission by following ways:

- By reducing raw materials (gravel)
- By reducing transports (of raw materials to construction site).
- By minimising the use of building machine (includes construction requirements).

EAGM (European Association for Geosynthetic Products Manufacturers) carried out a set of comparative life cycle assessment (LCA) studies concentrating on various application cases namely:

- Filtration.
- Foundation stabilised road.
- Retaining structures

COMPARATIVE LIFE CYCLE ASSESSMENT OF GEOSYNTHETICS V/S CONVENTIONAL CONSTRUCTION MATERIALS, IN ROAD WORKS

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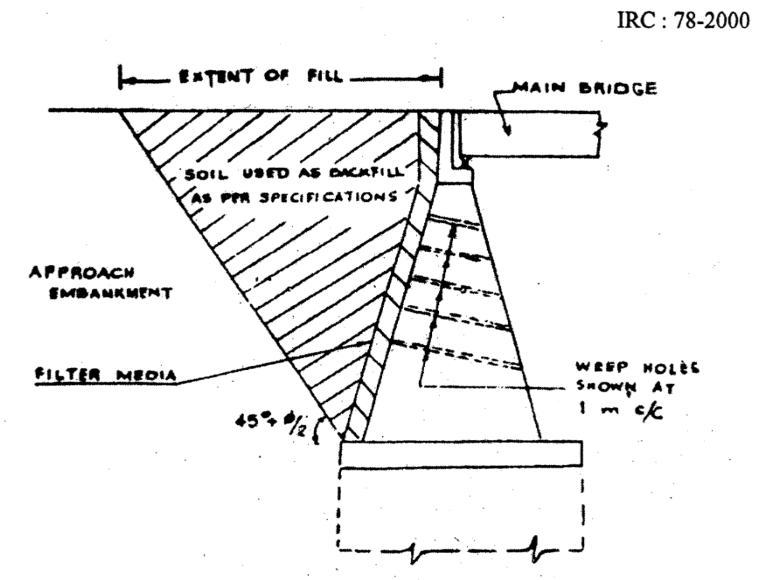
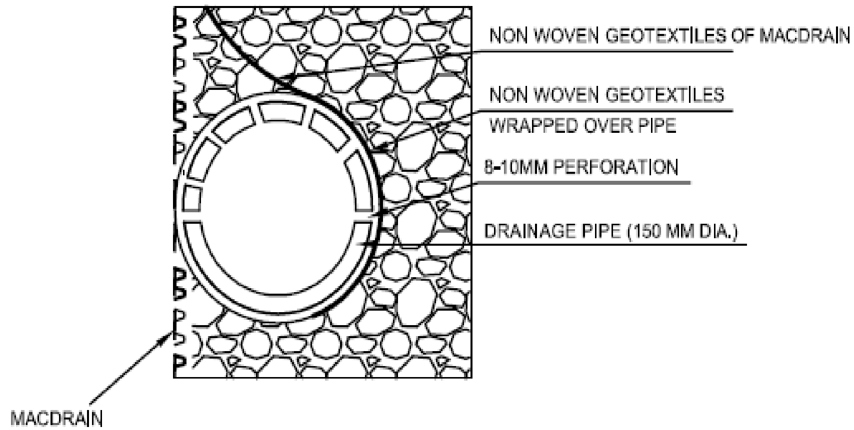
Filtration and Drainage :



Providing 600 mm Gravel layer and placed around the pipe



Geotextile drainage composite

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Comparison of Conventional Solutions with Innovative Solutions

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	AGGREGATES	GEOSYNTHETICS
SIMILARITIES		
-Risks of internal clogging by		
1. Finer particles of the soils to be filtered		
1. Aerobic bacterial activity (ochre clogging)		
1. Deicing salt preparation		
1. Ice lens formation within the frost penetration zone		
DIFFERENCES		
-Thickness	High (>150mm)	Low (<30 mm)
-Porosity	25-40%	75-95%
-Capillary rise hc	Important (hc<500 mm)	Low to none (hc<50mm)
-Tensile strength	None	Low to high
-Compressibility	Negligible	Medium to high
-Transmissivity under confining stress	Invariable	Variable
-Uniformity	Variable gradation as per barrow pit	Factory-controlled mass per unit area and thickness
-Durability	Completely inert	Altered by Ultraviolet rays
-Installation	Must not be contamined by the surrounding soil Compaction needed	Must be installed in intimate contact with the soil to be filtered Installation eased by seaming of the joints
-Risk of damage	None	Subject to puncture and tearing

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➢The filter with geosynthetics causes less than 25% of the impacts of a conventional gravel based filter.

➢The **non-renewable cumulative energy demand (CED)** of the construction of 1 square meter filter with a life time of 30 years is 131MJ-eq in case A and 19MJ-eq in case B ***almost 7 times lower!!!***

➢**The cumulative greenhouse gas emissions** amount to 7.8kg CO_2-eq/m^2 in case A and 0.81kg CO_2-eq/m^2 in case B ***almost 10 times lower !!!***

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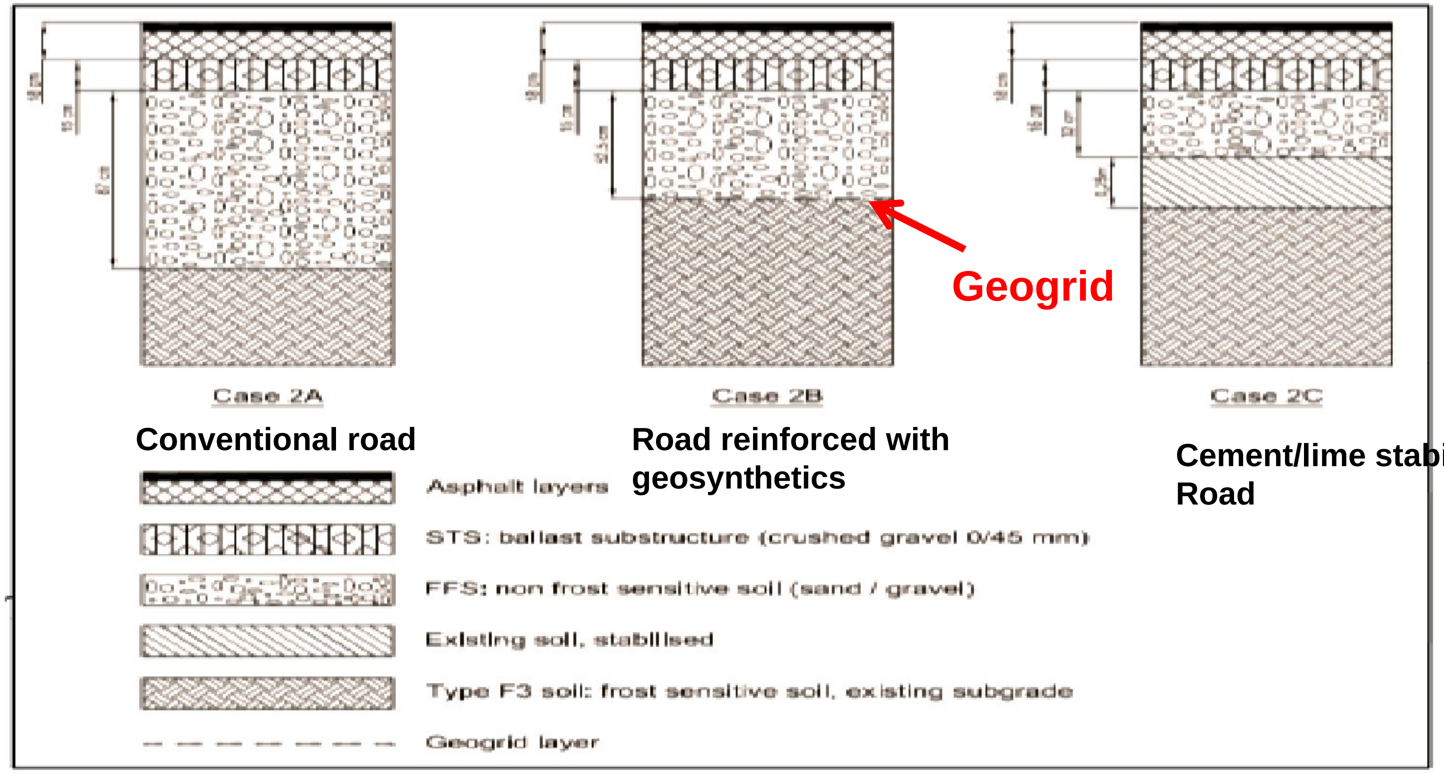

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The main difference lies in the amount of gravel needed, the cement and lime used in case 2C and the geosynthetics used in case 2B.

Compared to case 2A **about 28% less gravel** is used in case 2B and **45% less gravel** is used in case 2C

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If we compare a road reinforced with geosynthetics to a road stabilised with cement/lime the climate change impact of a class 2B road reinforced with geosynthetics is **about 300 tons CO2-eq per km lower compared to the impacts of road class 2C stabilised with cement/lime.**

This difference is equal to about 20% of the overall global warming impact of the construction and disposal efforts of an entire road during its 30 years lifetime (excluding traffic emissions)

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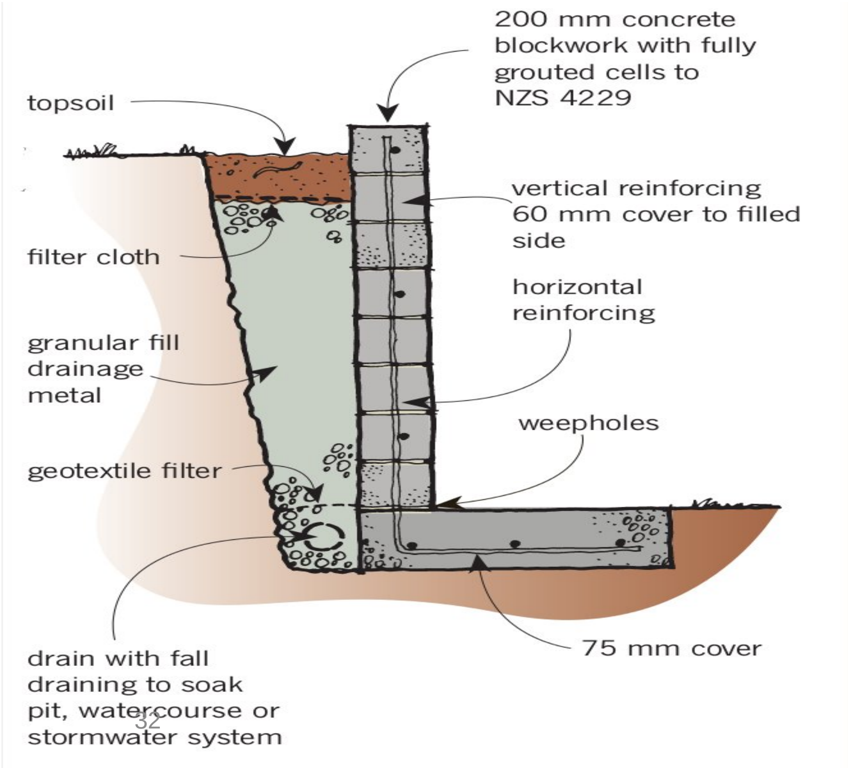
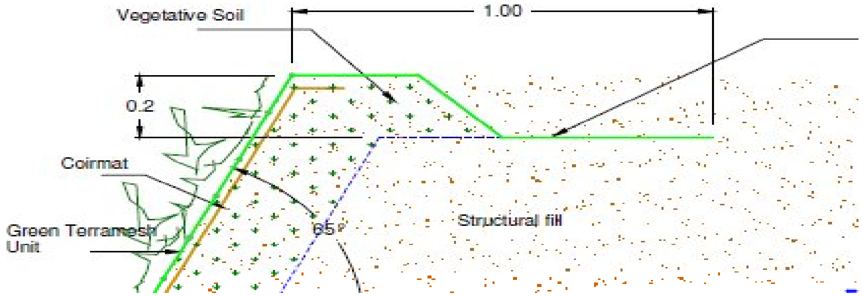
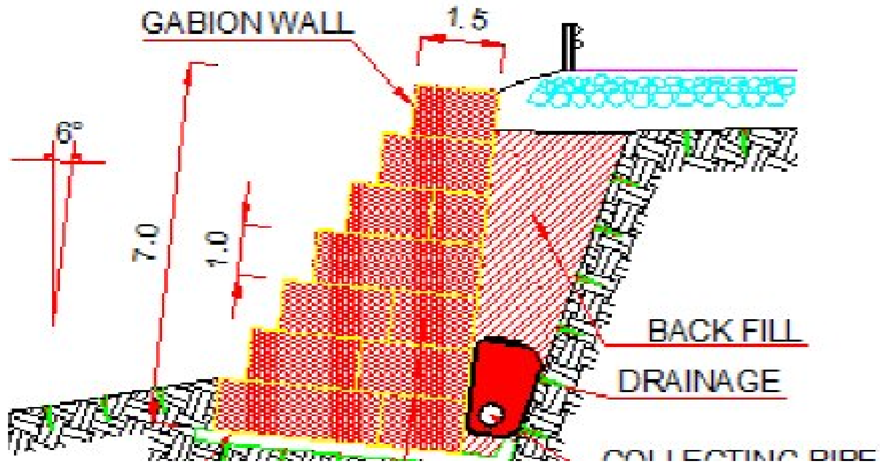
A retaining wall reinforced with concrete (case A) is compared to a soil wall reinforced with geosynthetics (case B).



V/s





- The non-renewable cumulative energy demand of the construction and disposal of 1 meter retaining structure with a height of 3 meters is 12,700MJ-eq in case 4A and 3,100MJ-eq in case 4B.

- The cumulative greenhouse gas emissions amount to **1.3t CO2-eq incase A** and **0.2t CO2-eq in case B !**

- Correspondingly, the cumulative greenhouse gas emissions of 300m retaining structure are 400t in case 4A and 70t in case 4B, respectively

➢The specific climate change impact of the construction of the retaining structure (1 linear meter of retaining structure with a 3 meter high wall) using geosynthetics is about **1 ton CO2-eq per meter lower compared to a conventional alternative.**

➢ **This difference is equal to about 84% of the overall climate change impact of the construction and disposal** efforts of an entire conventional retaining structure system during its 100 years lifetime

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CARBON FOOTPRINT OF DT PRODUCTS

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- Gabion mattresses and gabions, in addition to constructive and installation aspects, results dramatically “**environmentally friendly”** reducing impacts on climate change with a limited carbon footprint with respect to other traditional solutions

- The calculation of the carbon footprint is carried out using standard methodology and applied to real cases .

- The methodology that was chosen to calculate the carbon footprint of the DT products, is the recently released “**GHG Protocol Product Life Cycle Accounting and Reporting Standard”, by World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).**

Case Studies

The analysis was carried out for two representative DT “functional units”:

1. **Gravity wall made of gabions**
2. **River protection work made of Reno mattresses**

1. Gravity Wall

The gravity wall that was chosen to represent the functional unit 1 is 10 m long and 8 m high. The wall foundation is 4.5 m wide with a transversal area of 22.5 m2

Total gabion wall volume to be filled = 225 m3.

Total weight of stones needed to fill in all the gabions of the wall = 415 tone

The traditional solution that was considered is a concrete wall, Rck 45 class, with an equivalent section of 18.9 m2 and no reinforcement steel (the shape allows the concrete wall to work only in compression).

This means a volume of 189 m3 and a total weight of 465 tons of Rck 45 concrete.

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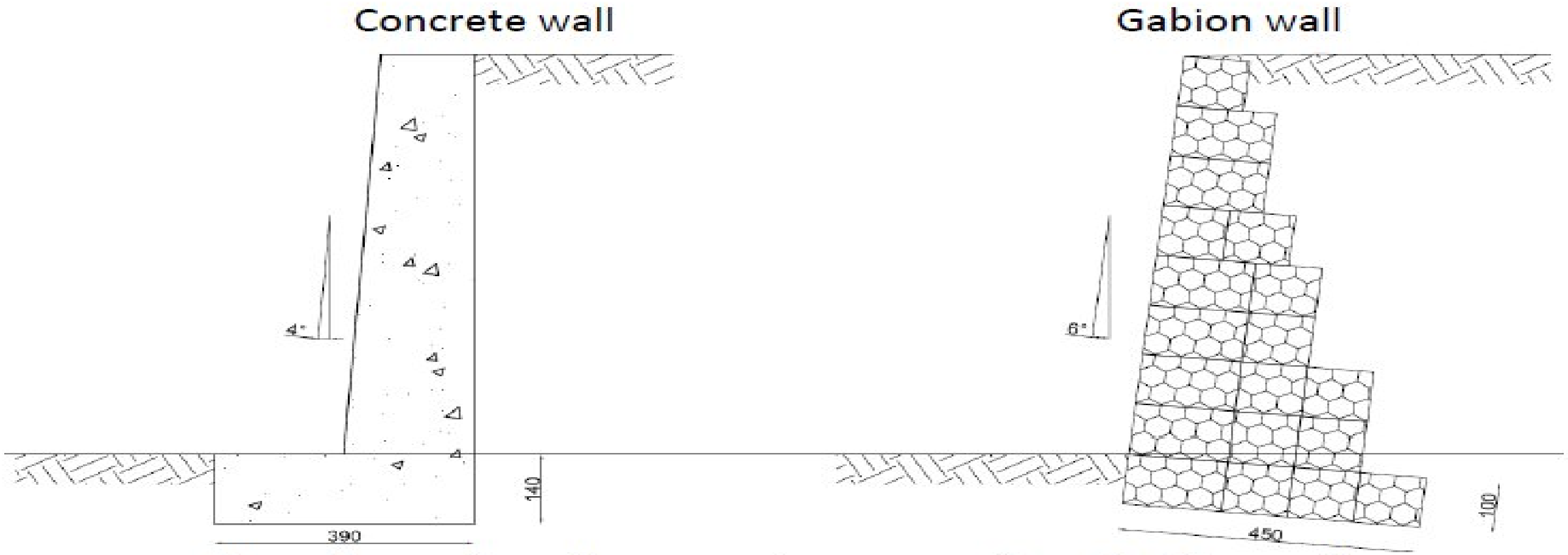

Figure 1: gravity walls comparison: concrete and gabion walls

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2. River protection work made of Reno mattresses

The river protection work that was chosen to represent the functional unit 2 regards the ‘Tenore’ river, an affluent of the Olona river in the Province of Varese. The work is part of a major project for the construction of the motorway ‘Pedemontana Lombarda’.

This specific work consists in the coverage of a surface of 5,400 m2 with Reno mattresses.

the total volume of stones that was needed = 1,620 m3.

The mattress has: mesh size 6x8, wire diameters 2.2/3.2 mm, GalmacTM and PVC coating. The mattresses were filled in with local river stones that have an equivalent weight of about 1,650-1,700 kg/m3.

The analysis was carried out also considering the transportation of the stone

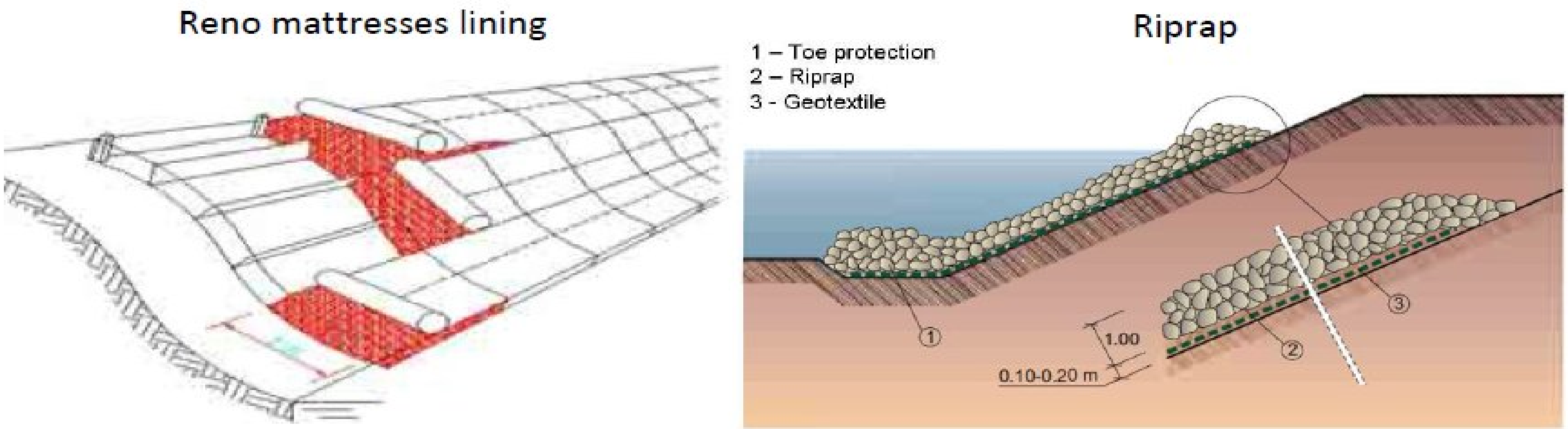

Figure 2: river protection works comparison: Reno mattress and riprap bank linings

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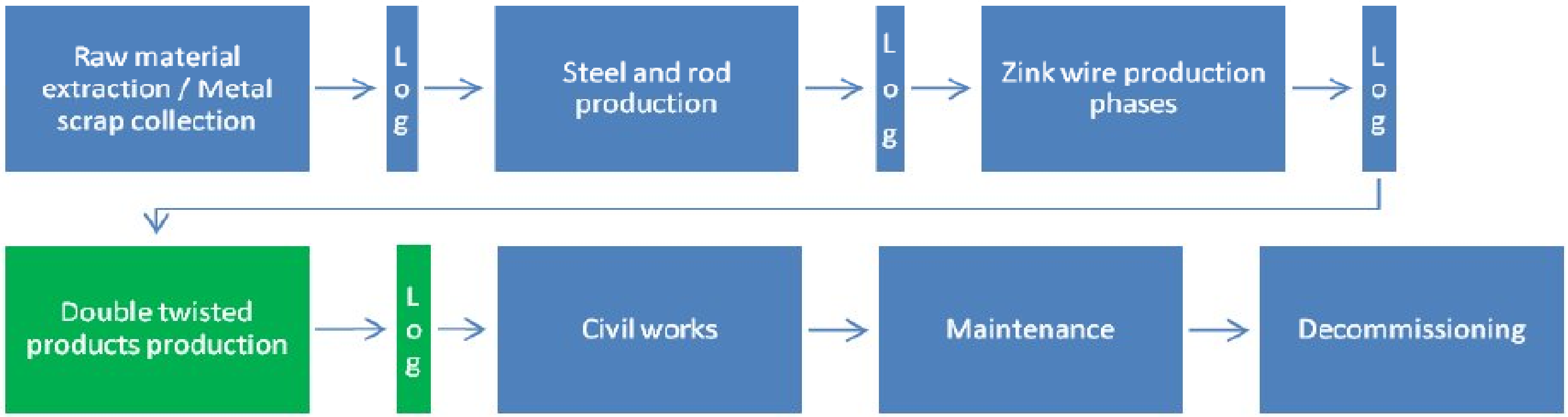
Process mapping and data gathering

The production process has been divided in the macro phases described in Figure 3.



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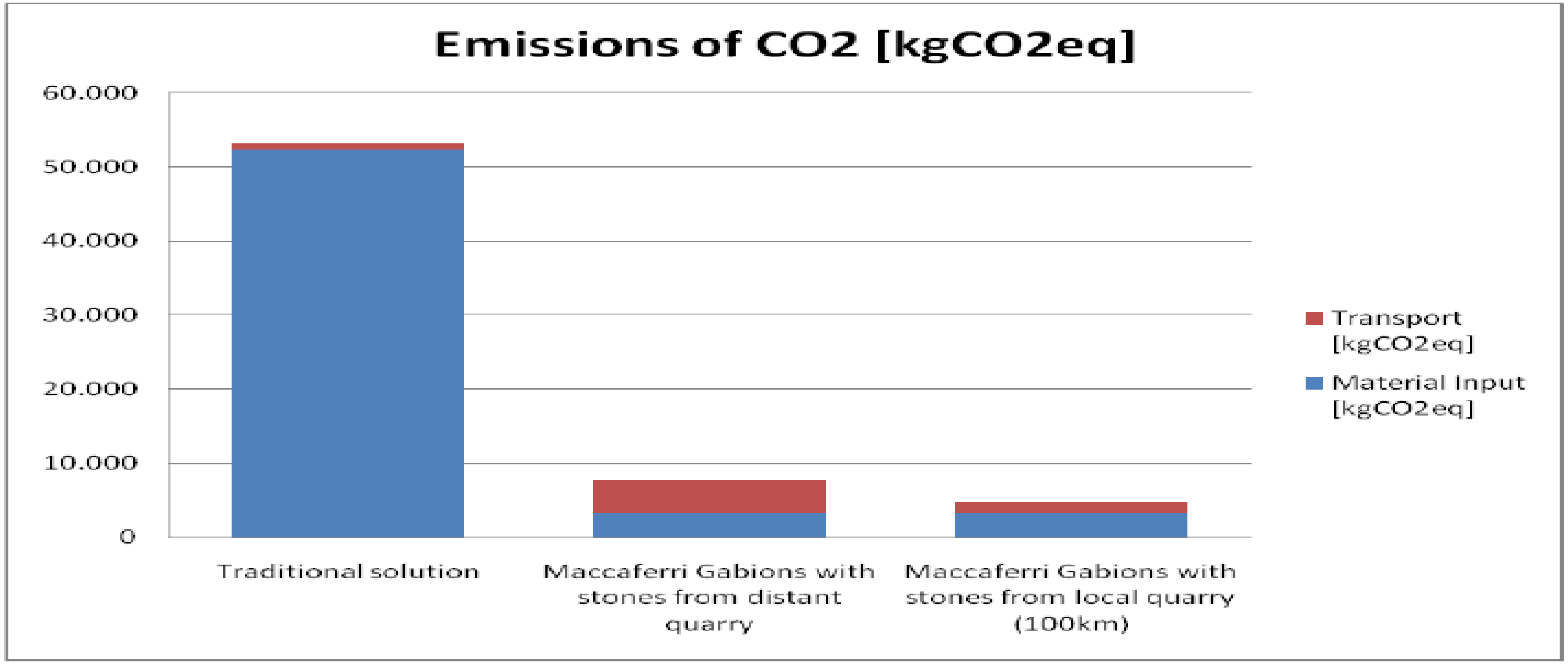
Carbon footprint calculation: Results



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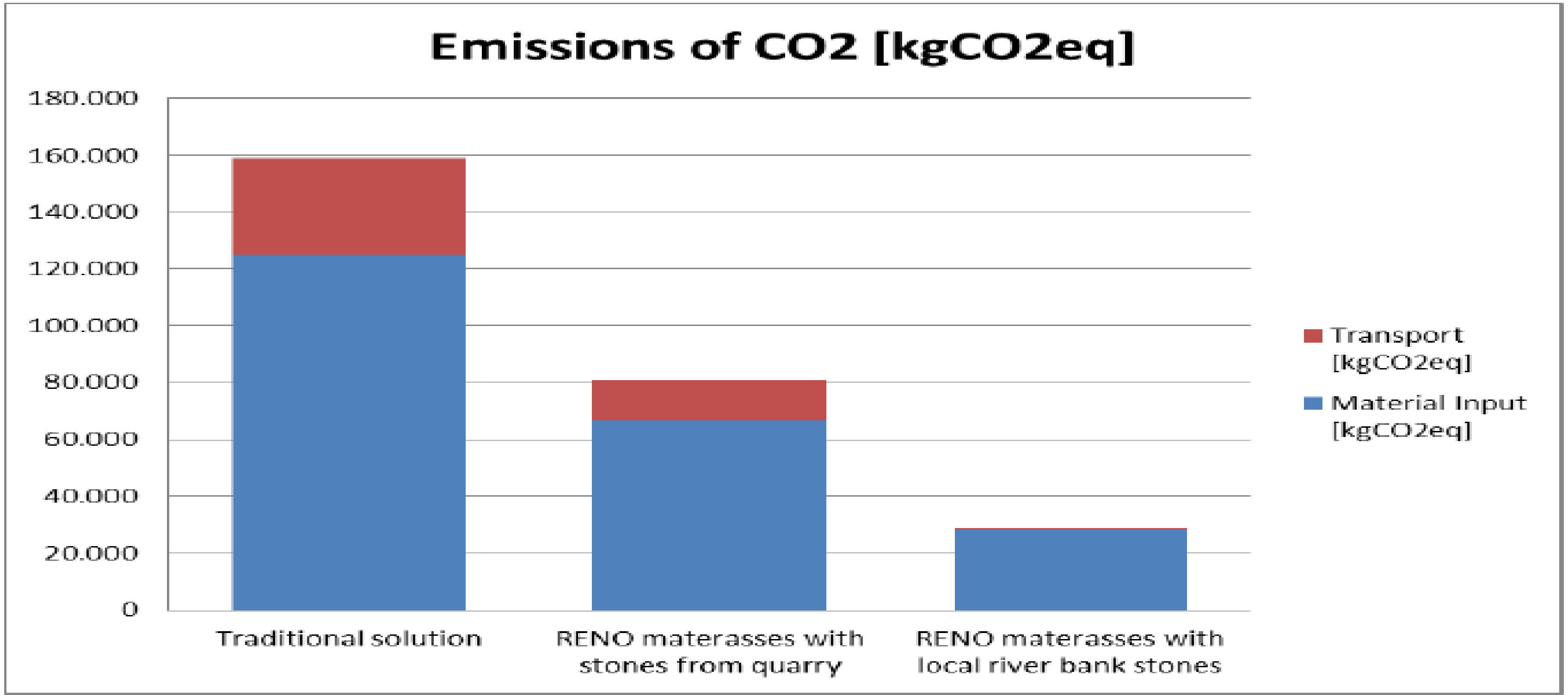
Carbon footprint calculation: Results



In the case of walls, the gabion solution is characterized by an emission **of 95t CO2/m2 instead of the 665t CO2/m2** released with the concrete wall solution.

When using locally available stones, the carbon footprint for gabion walls drops **to 58 t CO2/m2 only**.

In the case of revetments, Reno mattresses are characterized by an emission of 15t CO2/m2, **approximately half the quantity** of the 29t CO2/m2 released with the traditional solution (riprap).

- When using locally available stones (i.e. within 100 km from the jobsite, which is commonly the case due to the small D50 required for the filling) the **carbon footprint for mattresses drops to 5.4 tCO_2/m^2 only.**

- **It is therefore evident that the use of Innovative solutions leads to savings in terms of emissions up to 90% of the traditional solution emissions.**

- The limited carbon footprints of gabion and Reno mattress solutions highlight that these products are the best environmentally friendly solutions applicable in the field of civil works.

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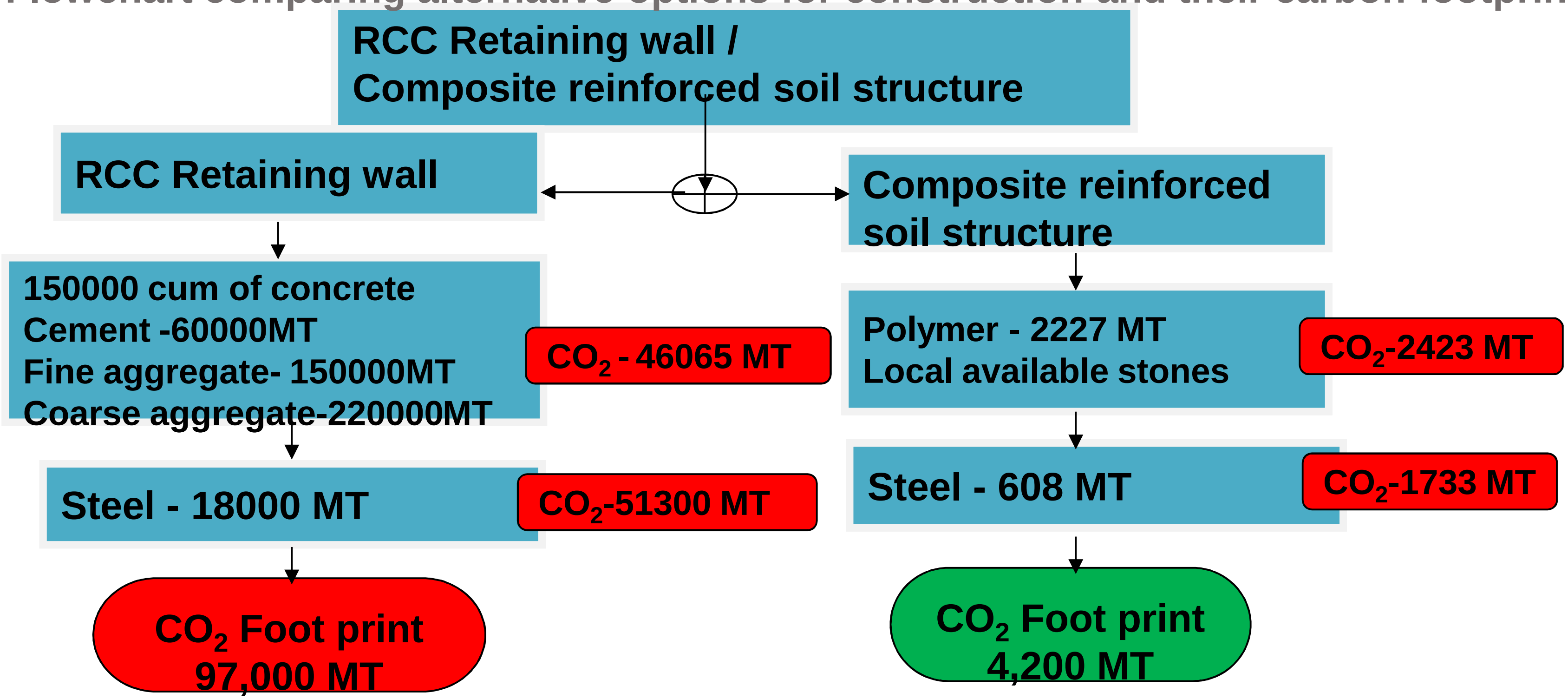
Environmental considerations – CFP Emission

Flowchart comparing alternative options for construction and their carbon footprint



Thus reducing carbon emission by 93000 MT

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Conclusion

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• Current Road building in India at high level.

➢ Future conventional maintenance will impose increased CO_2 emissions.

➢ Adopting preservation strategy will reduce level of emissions.

➢ Utilization of non conventional material in construction of highway can reduce carbon footprint by reducing the consumption of cement and other conventional material

➢ Strategy of plantation can improve the health of environment and counter the adverse effect of rural road construction

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Thank You......