ENVIRONMENTAL VISIONS FOR THE CONCRETE INDUSTRY

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ERMCO Secretary General

1. Sustainable development: what's and when's
2. SD strategy and policies
3. SD and the concrete industry
   - 3.1. Cement
   - 3.2. Aggregates
   - 3.3. Concrete
4. From materials to sustainable concrete solutions
5. Conclusions

SD: A CHALLENGE FOR THE 21st CENTURY

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- In the 20th century, **concrete** dominated the construction industry scene, with its widespread availability, versatility and low cost.
- Concrete has been recognized as the efficient and cost-effective solution for the execution of more and more performance-demanding concrete works.

What about the foreseeable future?

"….the future of the cement and concrete industries would very much depend on the ability to inter-link their growth with the goal of sustainable development…" (P.K. Mehta)

1. SUSTAINABLE DEVELOPMENT: DEFINITION

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"DEVELOPMENT is SUSTAINABLE when it meets the needs of the present without compromising the ability of future generations to meet their own needs."

(1st EARTH SUMMIT, Rio de Janeiro, 1992)

TODAY, SUSTAINABILITY IS UNDERSTOOD TO BE SOMETHING WHICH GOES WELL BEYOND SIMPLE ENVIRONMENTAL PROTECTION

(2ND EARTH SUMMIT, Johannesburg, 2002)

an improved use of natural and human resources, which does not impair the development of the economy

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IT IS NOT SIMPLY A MATTER OF ISSUING (ENVIRONMENTAL) LEGISLATION.

FOR A SUSTAINABLE FUTURE WE HAVE TO ENSURE, AT THE SAME TIME:

- ENVIRONMENTAL PROTECTION
- ECONOMIC GROWTH
- SOCIAL COHESION

TO OBTAIN RESULTS, THE INDUSTRY MUST BE INVOLVED

THE INDUSTRY WAS FIRST FORCED THEN CONVINCED TO OPTIMIZE INPUTS AND OUTPUTS BY:

- REDUCING CONSUMPTION OF VALUABLE RESOURCES (RAW MATERIALS – ENERGY - HUMAN)
- MINIMIZING WASTE BY REUSE/RECYCLING

WHILE MAINTAINING BOTH THE TECHNICAL AND ECONOMIC EFFICIENCY OF THE SUPPLIED PRODUCTS

From “sustainable development”

to sustainability as a “ development tool”

WBCSD "ECO-EFFICIENCY" SET OF INDICATORS SUGGESTED TO COMPANIES FOR MEASURING THEIR ENVIRONMENTAL PERFORMANCES

THOSE RELEVANT TO THE CONSTRUCTION INDUSTRY ARE:

- MATERIAL AND PRODUCT CONSUMPTION
- ENERGY CONSUMPTION
- WATER CONSUMPTION
- EMISSIONS (GREENHOUSE GAS AND OZONE DEPLETING SUBSTANCES)
- WASTE
- TRANSPORT (ENERGY AND GREENHOUSE GAS EMISSION)

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IN GENERAL, EMISSIONS ARE RELATED TO THE PRODUCTION, USE AND DEMOLITION PHASES OF A CONSTRUCTION PRODUCT

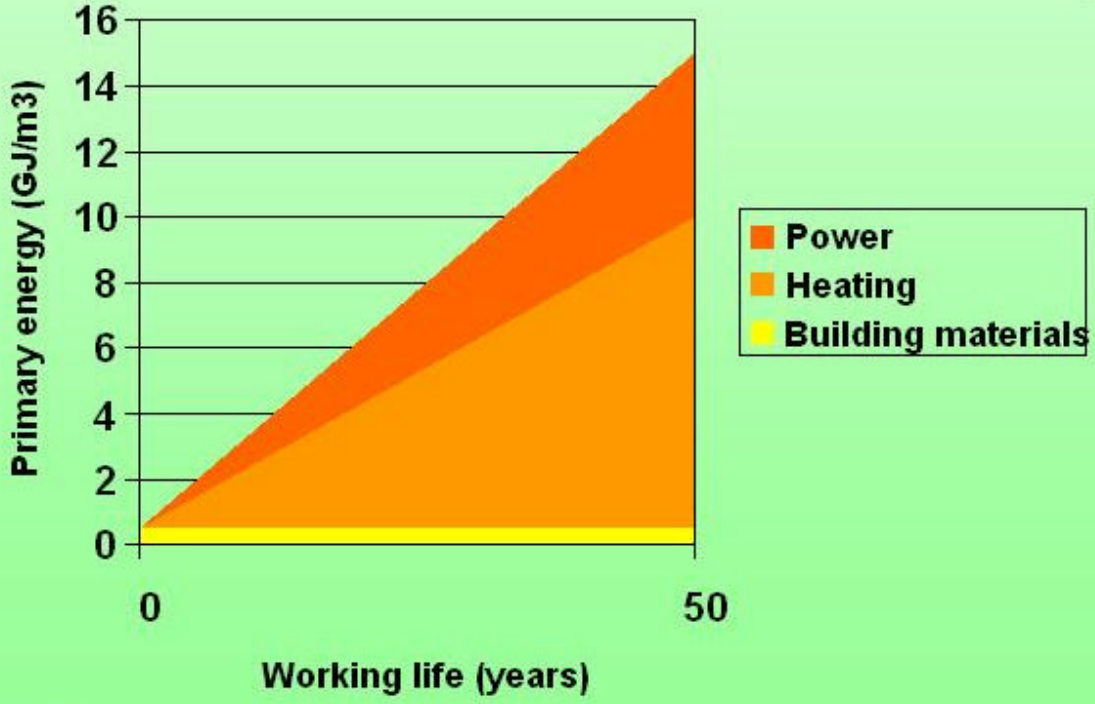
- MINERAL EXTRACTION
- TRANSPORT OF MATERIALS TO THE PLANT
- PRODUCT MANUFACTURE
- TRANSPORT OF PRODUCTS TO THE CONSTRUCTION SITE
- TRANSPORT OF PRODUCT WASTE FROM THE PLANT
- CONSTRUCTION AND DEMOLITION ACTIVITIES,
- TRANSPORT OF CONSTRUCTION AND DEMOLITON WASTE

“CRADLE TO GRAVE” APPROACH

Danish Centre for Green Concrete

DANISH TECHNOLOGICAL INSTITUTE

Reinforced concrete office building



Kuhlmann & Paschmann, 1997

WASTE PRODUCTION IN THE CONSTRUCTION SECTOR

Material resources incorporated in the built environment	100.0
Energy used (oil equivalent)	2.1
Emissions generated	8.3
Wastes generated	42.0
Quarry wastes	16.3
Waste from material and product manufacture	0.6
Construction and demolition waste	25.1

(Source: Viridis Report, 2002)

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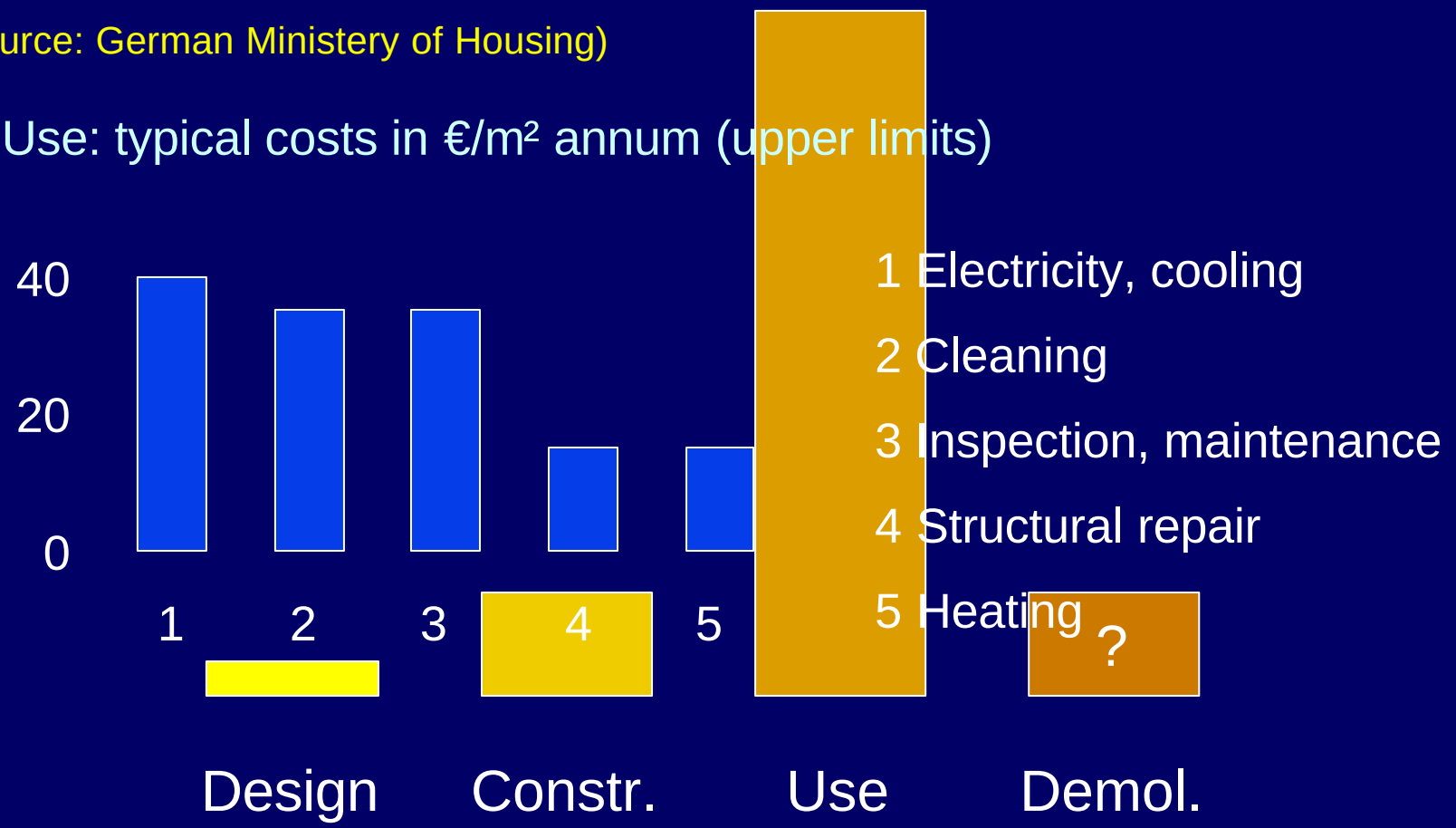
(source: German Ministery of Housing)

Use: typical costs in €/m² annum (upper limits)



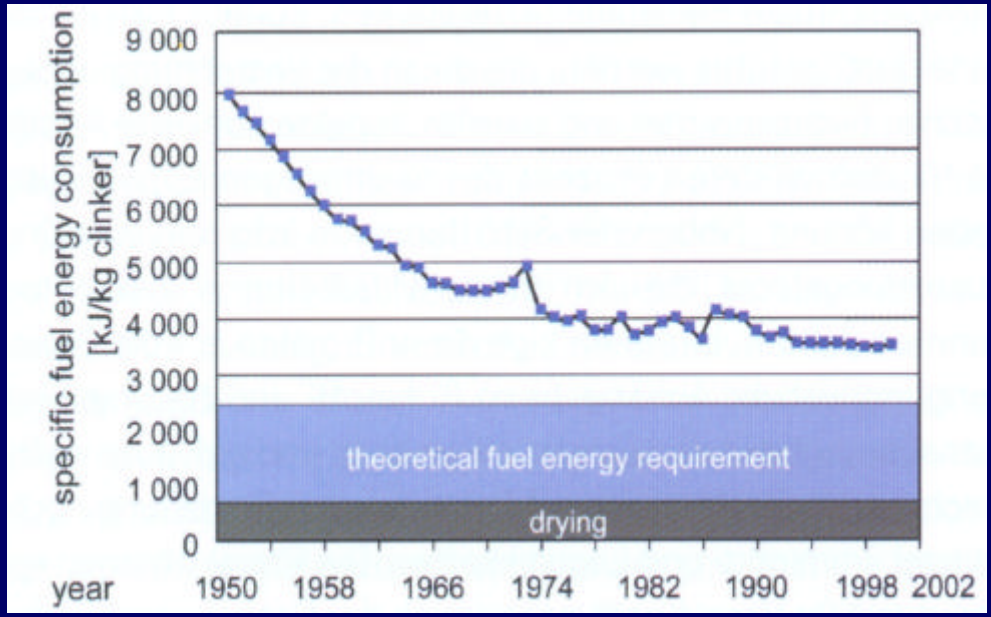
THE CEMENT INDUSTRY IS SHOWING THE WAY

1) CEMENT SUSTAINABILITY INITIATIVE WITHIN THE WBCSD PROGRAMME

Key points:

- Climate protection
- Use of fuels and raw materials
- Emission abatement
- Industrial H&S of employees
- Local factors and internal business processes

CEMENT PRODUCTION: AN ENERGY-INTENSIVE PROCESS



- ENERGY CONSUMPTION PER TON HAS BEEN REDUCED BY ABOUT 60% SINCE 1950
- FURTHER ENGINEERING PROCESS IMPROVEMENTS ARE EXPECTED TO HAVE LIMITED EFFECTS ONLY

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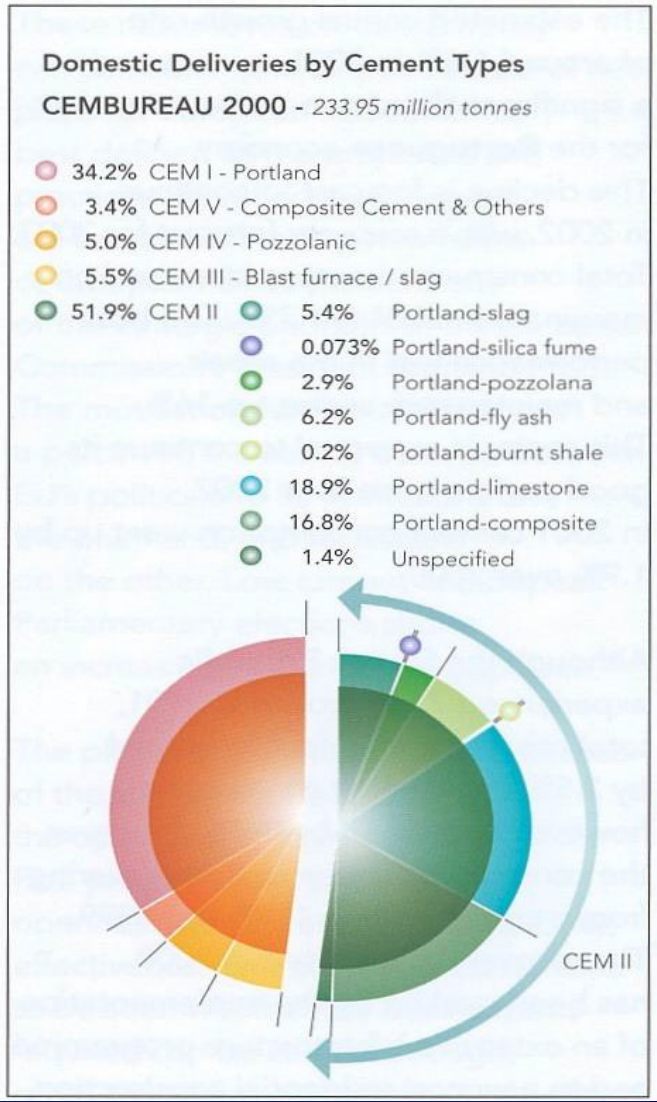
TO REDUCE CO_2 EMISSIONS,
THE USE OF "BINDERS"
(CLINKER + OTHER CONSTITUENTS)
SEEMS THE MOST EFFECTIVE

ENVIRONMENTAL

TECHNICAL

ECONOMIC SOLUTION

THIS IS CONFIRMED BY THE
SUCCESS OF CEM II TYPE CEMENTS
ALL OVER EUROPE AND THE
GROWING INTEREST FROM THE USA



OTHER OPTIONS

1. IMPROVED USE OF SECONDARY FUELS:
   A SENSITIVE OPTION REQUIRING A PROPER SOCIAL AND LEGAL FRAMEWORK
2. IMPLEMENTATION OF KYOTO EMISSION CERTIFICATE TRADING SYSTEM:
   A PROPER SOLUTION DEPENDS ON THE CERTIFICATE'S VALUE

REMARKS

ANY SOLUTION WILL AFFECT THE COMPETITIVENESS OF THE ENTIRE CONCRETE INDUSTRY

IN THE EU SCHEME, HAVE SIDE-EFFECTS BEEN PROPERLY TAKEN INTO CONSIDERATION ?

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- 70-75% OF CONCRETE VOLUME ≈ 35-50% OF CONCRETE COST
- PROACTIVE APPROACH OF "RAW MATERIAL SUPPLY GROUP" IN COOPERATION WITH EU DG ENTERPRISE - NON-ENERGY EXTRACTIVE INDUSTRIES LEADING TO 20

"SUSTAINABLE DEVELOPMENT INDICATORS" (SDIs)

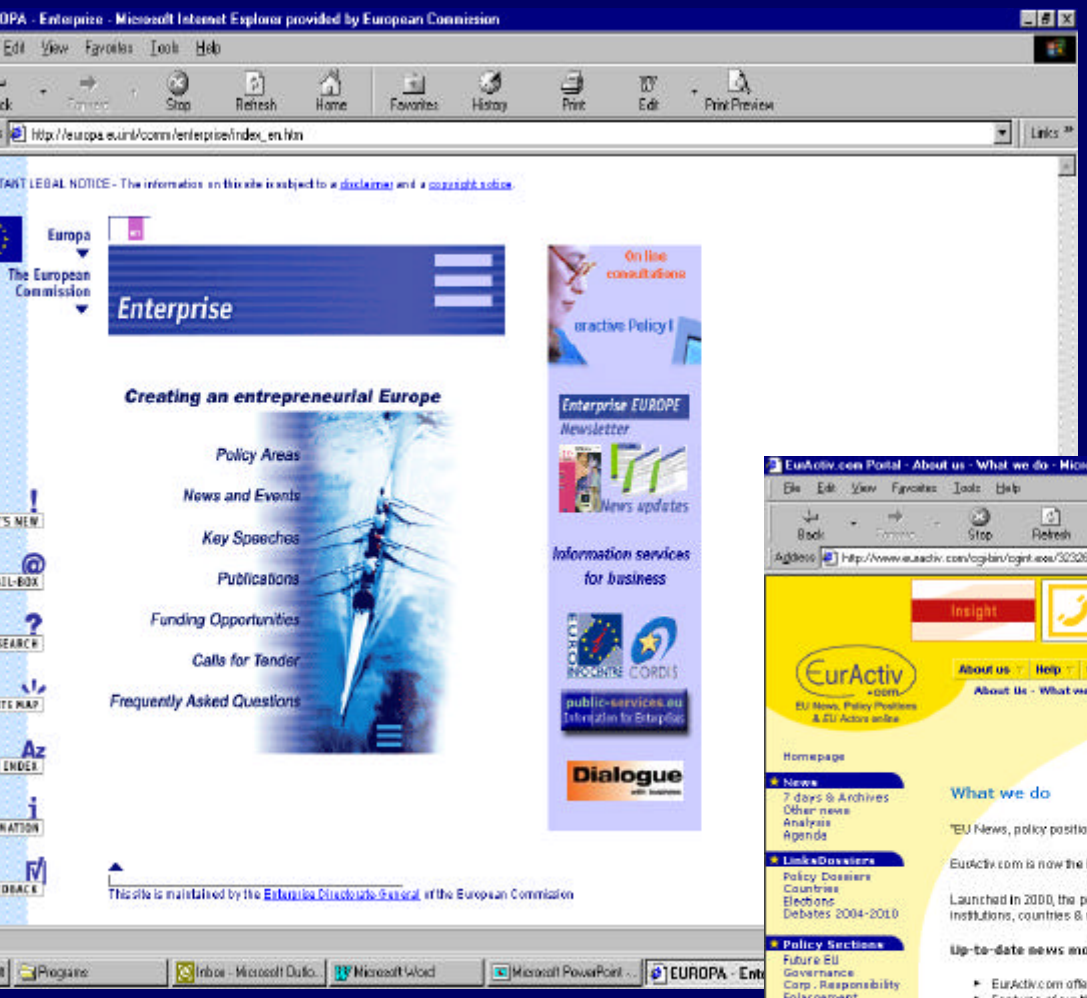
INTENDED FOR DIFFERENT INTEREST GROUPS:

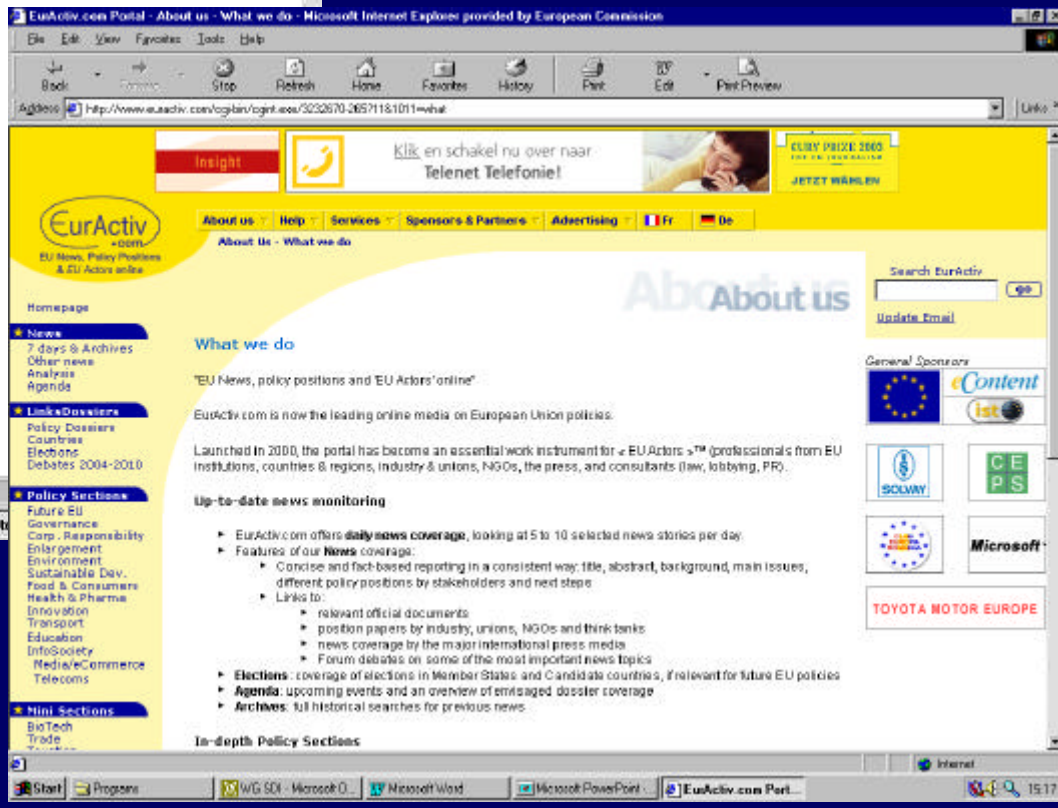
- COMPANIES
  (TO PROVE SD PERFORMANCE IN EXTRACTIVE OPERATIONS)
- NATIONAL, REGIONAL, LOCAL ADMINISTRATIVE STRUCTURES
  (TO GRANT PERMITS, EXTENSIONS, ACCESS BASED ON SD PERFORMANCE)
- GENERAL PUBLIC
  (EMPLOYMENT, SAFETY, QUARRY, RESTORATION ETC.)

3.2 SDIs FOR AGGREGATES

Indicators	Measure
Sustainable access to resources	Number of extraction permits granted / number of extraction permits inquired
Land granted for minerals extraction	Land area permitted for mineral extraction / National area
Material demand	Material demand per capita
Contribution to GDP	Turnover / GDP (MSs, EU) *Turnover should be given as "ex-work", i.e. without costs of transport to customers.*
Trade balance	Mined/extracted products within the EU vs. Mined/extracted products imported from outside (tonnes)
Sensitivity	Number of Natura 2000 sites in which a company operates extraction activities (or which are adjacent to extraction sites)
External co-operation in sustainable development of the non-energy extractive industry	Existence of external co-operation programmes covering sustainable development of the non-energy extractive industry

3.2 SDIs FOR AGGREGATES





3.3 FACTS ABOUT RECYCLED AGGREGATES

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- It is still under debate whether RECYCLING of hardened concrete has a clear environmental advantage
- Energy requirements are high
- The environmental profile of recycled aggregates does not always sound not so strong
- Could be a more political rather than technical or economical decision
- Does the “polluter pays” approach apply to this case ? Who is the polluter? The concrete industry? The construction industry?

- Since 1960, over 200 Environmental Directives adopted by the EU are based on a “multilevel” approach:
  - any possible waste has to be avoided;
  - if this is not possible, the waste has to be re-used;
  - if the reuse is impossible, the waste must be disposed of

- It is not generally recognised that the industrial production of fresh concrete may have a low impact on the environment and that concrete is going to be a no-waste product.

- BATs: re-use of wash water; re-use of industrial by-products; re-use of fresh concrete for concrete production

SUSTAINABLE = WHAT CAN BE CARRIED ON WITHOUT IMPAIRING THE SURVIVAL OF THE INDUSTRY

ECONOMICS HAVE THE SAME IMPACT AS OTHER FACTORS

“BOTTOM-UP” APPROACH:

1. PRODUCTION
2. USE
3. CONTRIBUTION OF CONCRETE TO THE BUILT ENVIRONMENT

SUGGESTIONS CAN BE DISAGREED,
DEBATE IS NECESSARY

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- ONE OF THE SIMPLEST APPROACHES IN ORDER TO PROVIDE NUMERICAL EVALUATION
- UNDERLYING PRINCIPLE: WITHIN A CLOSED SYSTEM, THE TOTAL MASS IS CONSTANT - MASS CANNOT BE CREATED NOR DESTROYED
- PURPOSE: TO ‘BALANCE’ THE MASSES OF ALL INPUTS OF AN ACTIVITY WITH THE OUTPUTS FROM THIS ACTIVITY

3.3 THE "MASS BALANCE" SCHEME

- APPROACH USED AT DIFFERENT LEVELS, FROM THE OVERALL CONSTRUCTION INDUSTRY LEVEL (VIRIDIS REPORT, UK, 2002) TO SINGLE PROCESSES

- USED AT PLANT LEVEL, DURING THE DATA COLLECTION FOR THE LCI/LCA ANALYSIS OF CONCRETE FUNCTIONAL UNITS

- PROBLEMS WITH PROPER EVALUATION OF EMISSIONS TO AIR AND TO WATER

3.3 READY-MIXED CONCRETE MASS BALANCE SCHEME

Conclusions

	Water	*Cement*	*Gravel*	*Sand*
Design	*155 l*	*375 kg*	*1334 kg*	*555 kg*
Recycl	183 l	382,6 kg	1367 kg	589,7 kg
NO Recycl	380 l	382,6 kg	1380,3 kg	599,1 kg

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FOR A MORE SOPHISTICATED APPROACH TO PROCESS EVALUATION, THE "LIFE CYCLE" APPROACH CAN BE USED

LCI = LIFE CYCLE INVENTORY = EVALUATION OF RESOURCES REQUIRED FOR THE PRODUCTION OF AN UNIT OF PRODUCT (MATERIALS, ENERGY, EMISSIONS, WASTE)

LCA = LIFE CYCLE ASSESSMENT OF SELECTED FUNCTIONAL UNITS ("CRADLE TO GATE")

THIS WAS THE ORIGIN OF THE ECOCONCRETE PROJECT

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A credible life cycle approach developed on a pan-European basis with all concerned representatives :

- BIBM International Bureau for Precast Concrete
- CEMBUREAU European Cement Association
- EFCA Eur. Fed. of Admixtures Associations
- EISA Eur. Independent Steelworks Association
- ERMCO Eur. Ready-Mixed Concrete Organization
- UEPG Eur. Association of Aggregate Producers

- To demonstrate that concrete is a green and sustainable construction material
- To develop (and maintain?) a European database of LCI data on concrete and concrete constituents
- To develop an easily adaptable tool for LCA studies, based on simple concrete functional units (EcoConcrete)
- To contribute to the European concrete industry's strategy producing reliable (marketing) arguments

- 10 functional units (5 precast, 5 ready-mixed)

  Flat slab, continuous beam, foundation pile, road pavement, bridge pylon, …

- Process tree (“cradle to gate”)

  Mining, transport, production, construction site, use, maintenance, reuse, disposal

- Relevant data selection

  Energy, emissions, waste

- ERMCO participants: 417 RMC plants over 10 countries

Impact Assessment Methodologies

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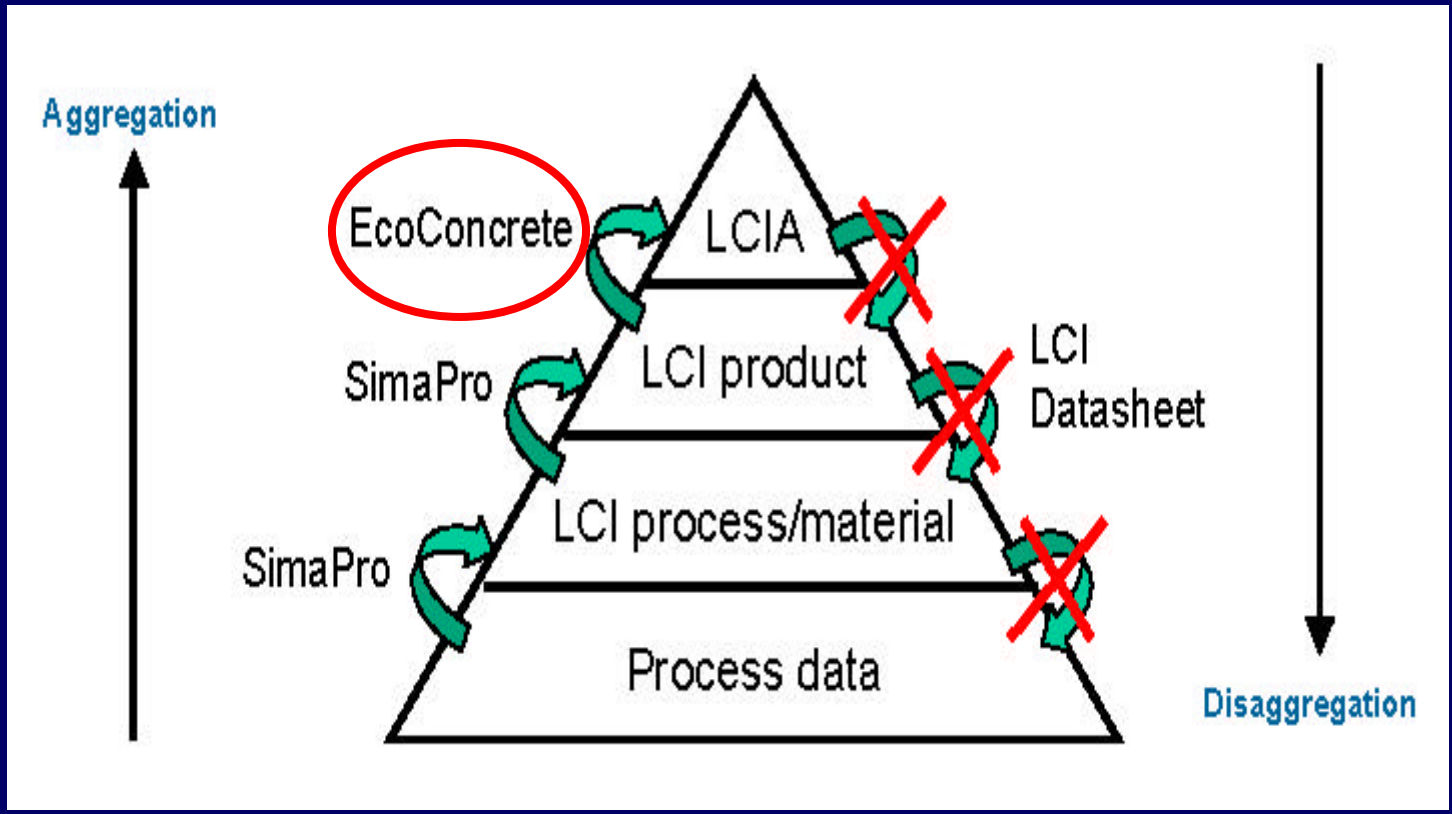

RMC PRODUCTION PROCESS

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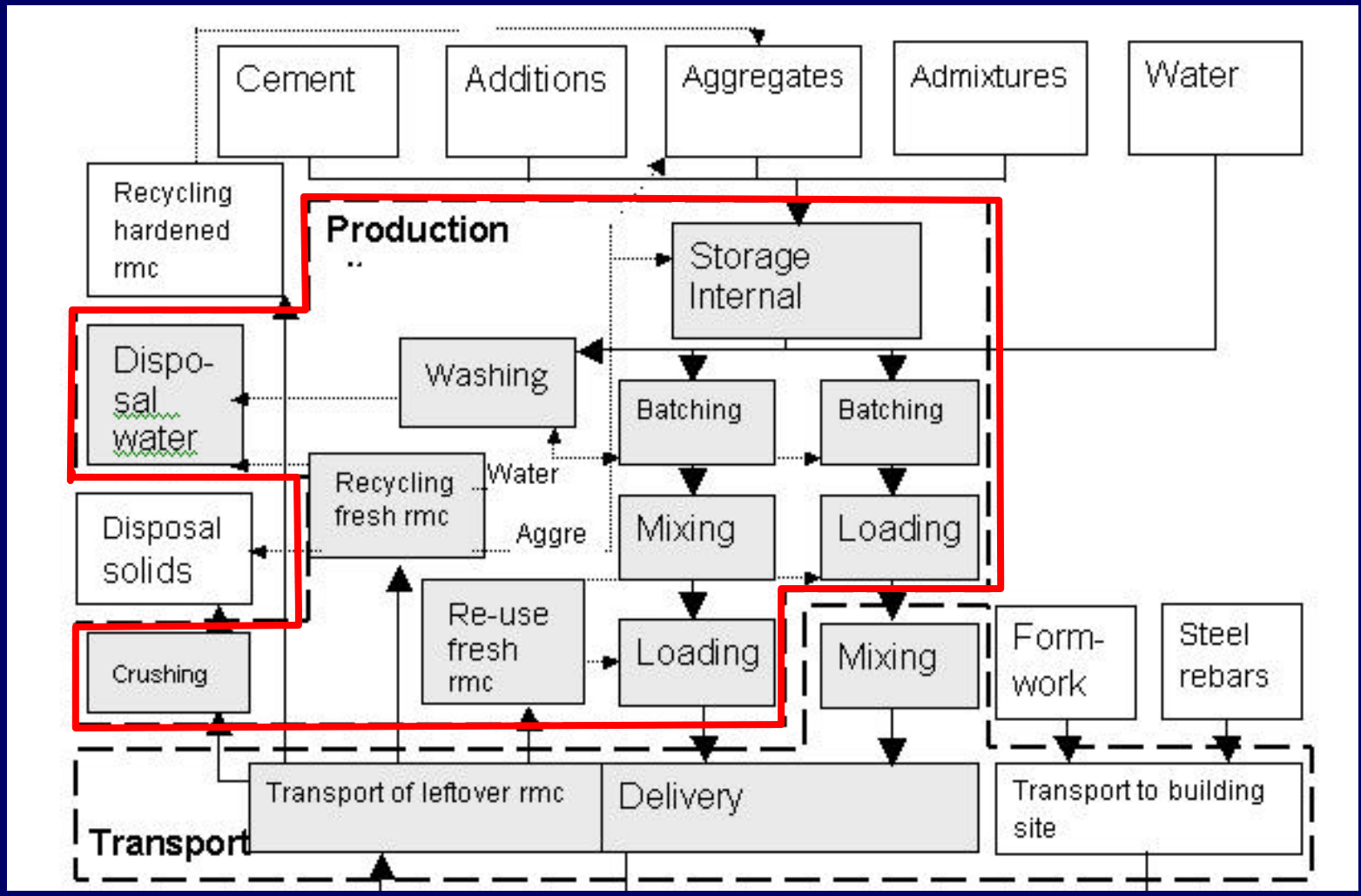


Impact Assessment – CML Measures

File Edit View Insert Format Tools Data Window Help Acrobat

EcoConcrete

Before Starting
- Essential Information

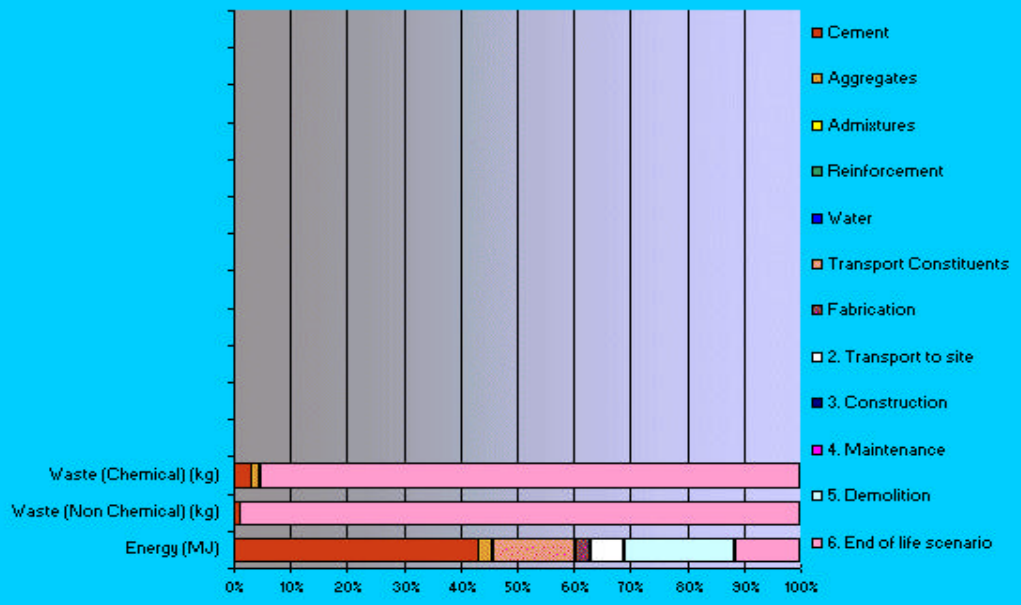
Life Cycle Phases
- Start Input
- 1. Product
- 2. Functional Unit
- 3. Composition
- 4. Life Cycle

Services
- Show Table
- Overview Input
- Print Results
- Export Results
- Questions?

User contract
- Licence Agreement
- Disclaimer

Product	Functional Unit	Date
Precast Pavement blocks	**1 m2**	**27 February 2003**

(•) CML Measures ( ) CML Profile ( ) EI 99 - Indicator ( ) EI 99 - Profile ( ) EDIP



Validation indicators	3. Composition (kg/m3)	Overview Mass balance	Default settings?
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	OK	OK	Yes

Impact Assessment – CML Profile

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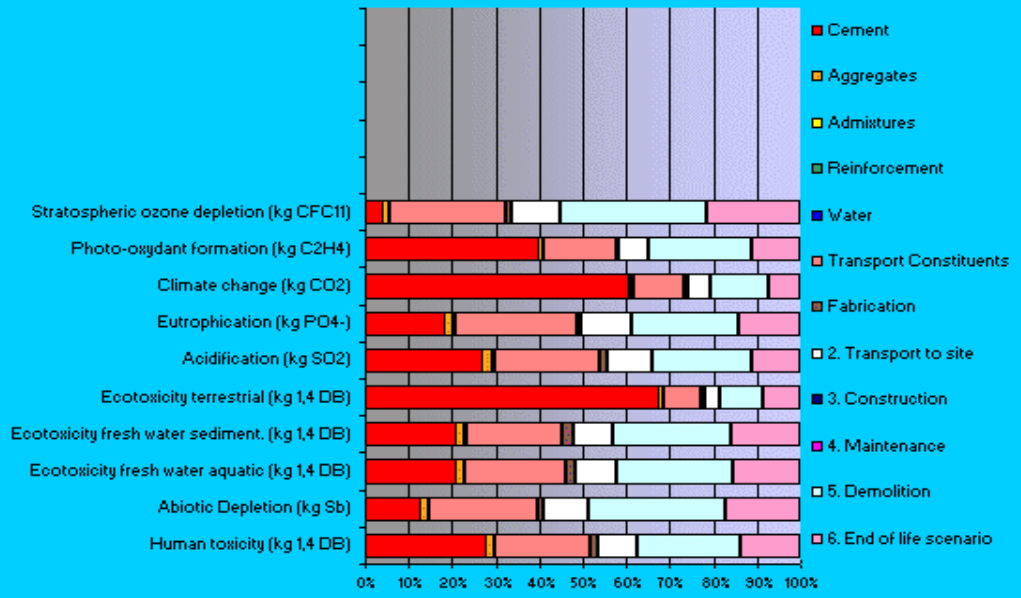

Validation indicators	3. Composition (kg/m3)	Overview Mass balance	Default settings?
	2398	100%	
	OK	OK	Yes

SUSTAINABLE DEVELOPMENT FIRST RULE:

REDUCE USE OF VALUABLE RESOURCES TO A MINIMUM

- USE CEMENTS WITH LOWER CLINKER CONTENT
- USE PROPERLY VALUED ADDITIONS

*"...Designing materials to enable the best use of concrete, designing concrete to make the best use of available materials: these are the basis of any successful (*AND ENVIRONMENTALLY FRIENDLY) *concrete production…" (A. Neville)*

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Country		% per strength class		
	< C15	C15 - C25	C25.5 - C35	>35
Austria	10	35	40	15
Belgium	5	20	70	5
Finland	0	5	85	10
Germany	4	13	62	21
Ireland	5	15	40	40
Italy	9	61	29	1
Norway	0	23	54	23
Portugal	0	80	15	5
Spain*	5	5	80	10
Sweden	0	5	63	32
Un. Kingdom	9	21	46	24
Average	**4,3**	**25,7**	**53,1**	**16,9**

Concrete classes C20/25 – C25/30 represent about 80% of European ready-mixed concrete production (source: ERMCO)

Concrete performances :

f_{ck} f_{ctm} E_{cm}

	Strength classes for concrete							
$f_{ck,cyl/cube}$	12/15	16/20	20/25	25/30	30/35	35/45	40/50	45/55
f_{ctm}	1,6	1,9	2,2	2,6	2,9	3,2	3,5	3,8
E_{cm}	27085	28608	29962	31476	32837	34077	35220	36283

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	Strength classes for concrete							
$f_{ck,cyl/cube}$	12/15	16/20	20/25	25/30	30/35	35/45	40/50	45/55
f_{ctm}	1,6	1,9	2,2	2,6	2,9	3,2	3,5	3,8
E_{cm}	27085	28608	29962	31476	32837	34077	35220	36283

$f_{ck,cyl/cube}$	12/15	16/20	20/25	25/30	30/35	35/45	40/50	45/55
$f_{ck,cyl,norm}$	60%	80%	**100%**	125%	150%	175%	200%	225%
$f_{ctm,norm}$	71%	86%	**100%**	116%	131%	145%	159%	172%
$E_{cm,norm}$	90%	95%	**100%**	105%	110%	114%	118%	121%

All data normalized to a “reference concrete”

Strength in compression: +125%; in traction: + 72%
Modulus of elasticity: + 21%

3.4 MATERIALS' BASIC PARAMETERS:

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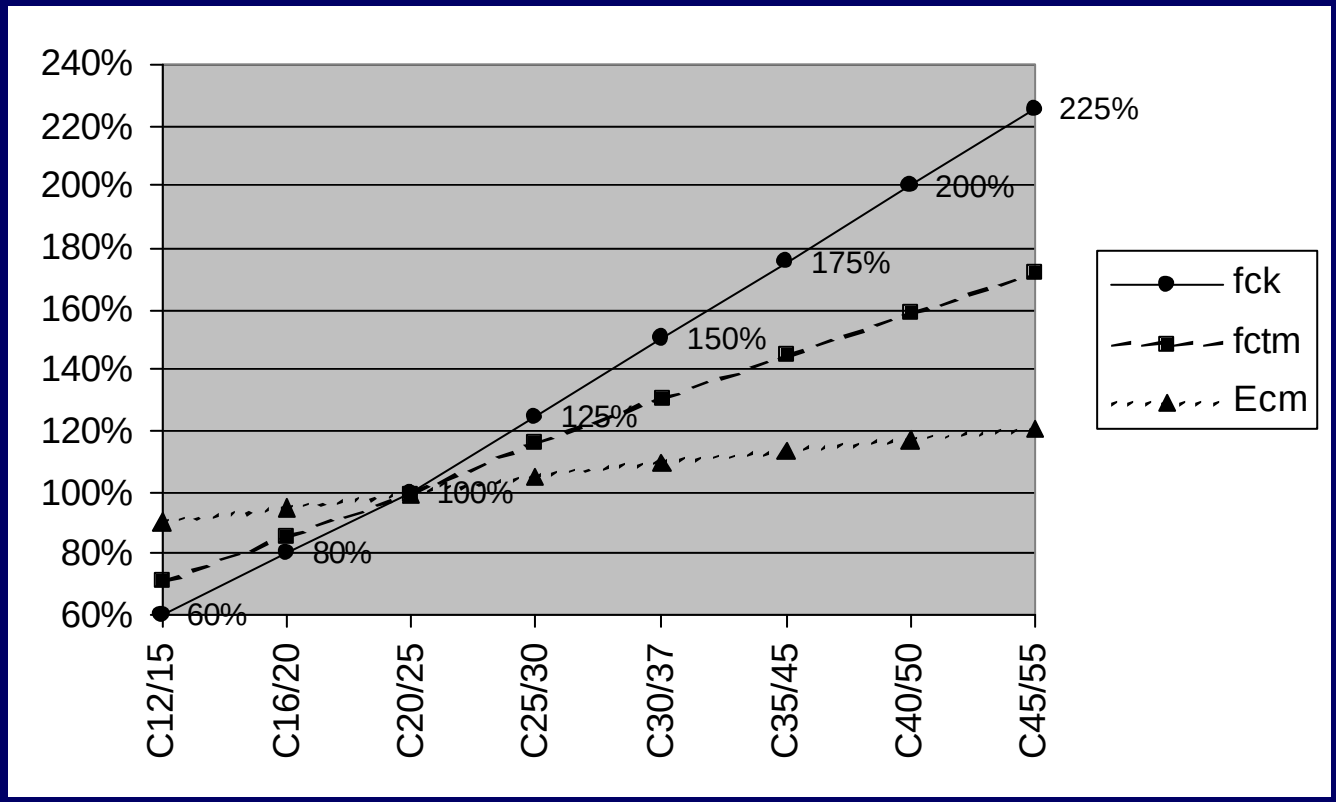

Increasing strength, all concrete performances increase

⇩

concrete can be "tuned" to match any required performance

3.4 MATERIALS' BASIC PARAMETERS: STEEL

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	Strength classes for steel		
	Fe360	Fe430 FeE275	Fe510 FeE355
f_{yk}	235	275	355
$f_{yk}/f_{yk,275}$ (%)	86%	**100%**	129%
E_{cs}	200.000		

Variations: strength in compression/traction: -14% +29% ;
modulus of elasticity: 0%

"Tuning" steel to required performance(s) looks more limited!

OBJECTIVE: AN "HOLISTIC" APPROACH

optimal use of constituents and production processes

in order to supply an economical construction product of constant quality

optimal design of products

in order to minimize the quantities involved

optimal use (and re-use) of products

in order to minimize the environmental impact of the whole