Croatian Asphalt Association

RE-USE / RECYCLING OF CONSTRUCTION WASTE

PRACTICE IN FRANCE

28th of February 2012

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Other recycled aggregates

Recycled aggregates

Stake and problematic

- 100 million tons of demolition materials and excavation produced per year
- In general : Inert waste !
- Benefits of recycled Materials :
  - Economy of Natural size-graded aggregate
  - Limited tonnages of inert materials to be landfilled
  - Economy of handling
  - Reduced pollution due to transport traffic
- Specific development process

Legislation and referential standards for the classification of waste

- The circular of 15th of February 2000
  - Regulation of waste management for Public Work
  - Obligation to recycle and increase as musch as possible materials, waste coming from Building and Civil Engineering
- The decree of the 28th of October 2010. It gives :
  - The list of the inert waste admissible in the storage plant
  - Working conditions
- Standard NF EN 11 300
  - September 1992
  - Classification of materials for uses in the construction of road infrastructures (capping layer and earthworks)

Legislation and referential standards for the classification of waste

Description	Restriction
Concrete	Only construction waste and demolition selected. Excluding materials coming from contaminated sites
Bricks	Only construction waste and demolition selected. Excluding materials coming from contaminated sites
Tiles and ceramics	Only construction waste and demolition selected. Excluding materials coming from contaminated sites
Mixture of concrete, bricks, tiles and ceramic	Only construction waste and demolition selected. Excluding materials coming from contaminated sites
Glass	Construction and packaging
Soil and stone (including excavation)	With the exception of topsoil and peat; For stone and soils coming from contaminated sites, an acceptance procedure to be gone first.

List of inert waste and operating conditions

Recycled aggregates

Origins

- Raw materials :
  - Excess of classified excavation and characterized according to French Standard NF P 11-300
  - Concrete from demolition or deconstruction of civil engineering structures or building
  - Deconstruction of pavement base courses
  - Manufactured products from worksites (kerbs, pipes, masonry, etc.)
  - Concrete industry rejects available materials at prefabrication sites
- Controls and tests :
  - Presence of Plaster (Sulphate)

Process

- Homogenization of stocks
  - Stocks with average characteristics but regular

- Preparation before crushing
  - Hydraulic specific tools or hydraulic pliers

- Characteristics of production :
  - Iron removal (magnetic or electromagnetic process)
  - Use of a percussion mill
  - Manual sorting
  - Dust reduction

Product recycling

- After primary crusher :
  - A coarse gravel 0/D (D between 20 and 63 mm)

Coarse gravel of recycling 0/20mm

- With secondary crusher :
  - Production of size-graded aggregate (chipping and sand)

Recycled material 20/60mm

Recycled aggregates

Fields of use of recycled materials in road technique :

- Earthwork and capping layers (classed as F7 materials under the French Standard NF P 11 300)
- A single national classification (from regional book)
- Trench backfill
- Road base layers : untreated gravel (EN 13 285) or aggregates (EN 13 242) bound with hydraulic or bituminous binders

Recycled aggregates

Fields of use of recycled materials in road technique (IDRRIM note N°22)

Description	Materials for earthworks and capping layer		Size-graded aggregates for subbase		
	NF P 11-300		NF EN 13242 – NF EN 13285 – NF P 18-545		
Code	GR0	GR1	GR2	GR3	GR4
Maximal Grading	0/150	0/80	0/31,5	0/20	0/20
Code NF EN 13285			GNT 2	GNT 3	GNT 3
Production characteristics of chippings					
Production code according to Standard NF P 18-545			Code IV	Code III	Code III
Production characteristics of sand and coarse gravel					
Production code according to Standard NF P 18-545			Code c	Code b	Code b
Cleanliness VBS		≤ 0,2			
Intrinsic Characteristic					
LA		≤ 45	≤ 45	≤ 40	≤ 35
MDE		≤ 45	≤ 45	≤ 35	≤ 30
LA + MDE			≤ 80	≤ 65	≤ 55
Others Characteristics					
Water Soluble Sulfate NF EN 1744-1 art. 10.2	$SS_{0,7}$ (SSb)				
Identification of materials source NF EN 933-11			Rcug 70 X1 FL5		

Recycled aggregates

Field of application

- Coarse gravel :
  - GR0 and GR1 : only for earthworks (NF P 11-300)
  - GR2, GR3 and GR4 :

	Trafic class		
	≤ T4	≤ T3-	≤ T3+
Fondation course	GR2	GR3	GR3
Base course	GR2 (D ≤ 20)	GR3	GR4

- Cement-bound material :
  - Technical guide CFTR n°10


Comité français pour les techniques routières

N° 10
Janvier 2005

Cftr - info

AIDE AU CHOIX DES GRANULATS
POUR CHAUSSEES
BASEE SUR LES NORMES EUROPEENNES

La présente note d'information a pour objet d'aider les maîtres d'ouvrage à choisir les granulats dont ils ont besoin pour leurs usages routiers, en appliquant les normes européennes.

Depuis le 1er juin 2004, les normes européennes granulats sont les seules normes granulats dont la référence dans les marchés publics est obligatoire. Conséquemment, à partir de cette même date, le marquage CE des granulats entrant dans le champ de ces normes européennes granulats devient aussi obligatoire.

Les nouvelles dispositions

- Les normes européennes

Trois normes européennes d'août 2003 intéressent plus particulièrement le domaine des granulats pour chaussées : NF EN 13242 (granulats pour graves traitées aux liants hydrauliques et graves non traitées), NF EN 13043 (granulats pour enrobés bitumineux et enduits superficiels), NF EN 12620 (granulats pour béton de ciment, y compris les chaussées en béton).

Elles définissent des catégories européennes de granulats, déterminées à partir d'essais européens normalisés. Plusieurs nouveautés modifient sensiblement les habitudes, mais s'avèrent sans incidence technique notable sur les matériaux routiers :

➤ le changement des tamis à toile tissée en tamis à tôle perforée à trous carrés pour les dimensions supérieures ou égales à 4 mm,

In situ recycling for sub-base and road base layers

In situ recycling with bituminous binders

Classification according to SETRA Guide (2003)

Recycling nature / Characteristics	Bitumen emulsion recycling			Hydraulic binder recycling	Mixed binder recycling
	Class I	Class II	Class III	Class IV	Class V
Aim	Structural reinforcement	Rehabilitation of the surface layers		Structural reinforcement	Structural reinforcement or correction of a surface courses defects
Principle	Improvement of mechanical and geometrical characteristics of the road with more or less old base and possible regeneration of bitumen in the class II		Recycling of bituminous coverage with regeneration of bitumen	Creation of a new base or a new surfacing (class V) : -With or without new material - With or without removal of surface courses	
Material from the old pavement to recycle	30 to 40 mm bituminous coverage + road base or treated with hydraulic binders	40 to 80 mm bituminous coverage + road base untreated or treated with hydraulic binders	Only bituminous materials by integrating the interface	All or a part of bituminous top layer. All or a part of base. Possibly part of the substrate	All or a part of bituminous top layer and all or part of base
Binder	Bitumen emulsion	Pure bitumen emulsion or regenerating	Bitumen emulsion regenerating	Cement or hydraulic binder	A mixture cement or hydraulic binder + bitumen emulsion
Current content of added binder	3 to 5% of residual bitumen	1to 3% of residual bitumen	up to 2% of residual bitumen	3 to 6% of hydraulic binder	3 to 7% of mixed binder
Thickness of the recycled layer	100 to 150 mm	50 to 120 mm	50 to 120 mm	200 to 300 mm	100 to 300 mm

Specification for the material

- The quality of the material is defined as follows:
  - M1 = material with a grading curve in the grading envelope of the Standard NF P 98-129 (EN 13 285) and Soil Methylene blue value < 0.8
  - M2 = Grading curve is outside or Soil Methylene blue value $\geq$ 0.8

Technical Guide Setra "Cold in situ recycling of all pavement" July 2003

In situ recycling for sub-base and road base layers

Specification for the Equipment

- Criteria for the spreader

	Critères	NOTE		
		3	2	1
L	Homogénéité longitudinale d'épandage du liant (en %)	$C_{VL} \leq 5$	$5 < C_{VL} \leq 10$	$C_{VL} > 10$
T	Homogénéité transversale d'épandage du liant (en %)	$C_{VT} \leq 10$	$10 < C_{VT} \leq 20$	$C_{VT} > 20$
V	Possibilité de faire varier la largeur d'épandage	OUI	NON	NON

Technical Guide Setra "Cold in situ recycling of all pavement" July 2003

Specification for the equipment

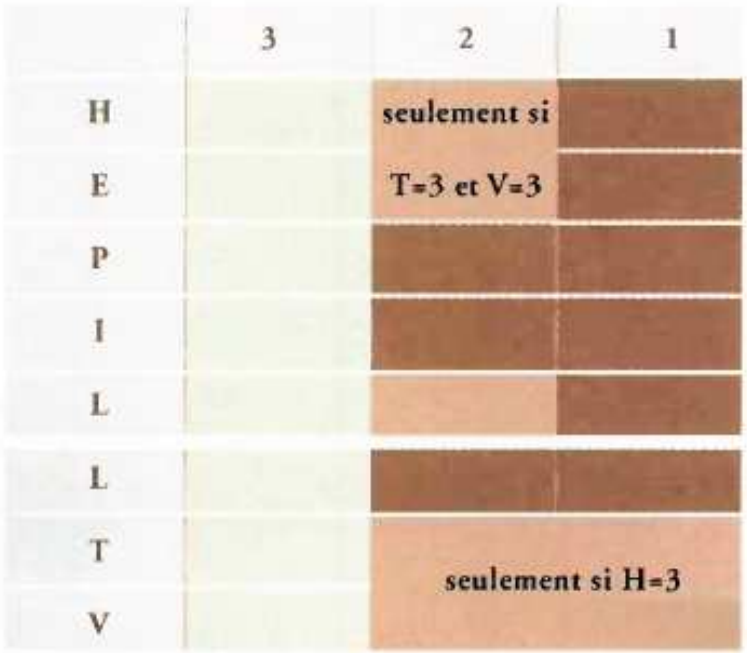
- Equipment of fragmentation and mixing

Critères		NOTE		
		3	2	1
H	Homogénéisation du matériau avec le ou les liants	Homogénéisation verticale et transversale (malaxeur associé)	Homogénéisation verticale uniquement	Homogénéisation limitée
E	Maîtrise de l'épaisseur traitée	Réglage et contrôle de l'épaisseur avec fonction supplémentaire de maintien à la profondeur(1)	Réglage et contrôle de l'épaisseur	Réglage de l'épaisseur
P	Puissance disponible par mètre linéaire de rotor de fraisage	> 70 kW	35 < P ≤ 70 kW	≤ 35 kW
I	Possibilité d'injecter l'eau dans la chambre de malaxage ou de fragmentation	Pompe à débit variable asservi à la translation et rampe de largeur variable	Pompe à débit variable asservi à la translation	pas d'asservissement
L	Dosage du liant sous forme de liquide (eau + liant hydraulique)	Pompe à débit variable asservi à la vitesse de translation ou au poids de matériau retraité + débitmètre (eau) et pesée (ciment)	Pompe à débit variable asservi à la vitesse de translation ou au poids de matériau à retraiter + compteur volumétrique	Pompe à débit variable non asservi

Technical Guide Setra "Cold in situ recycling of all pavement" July 2003

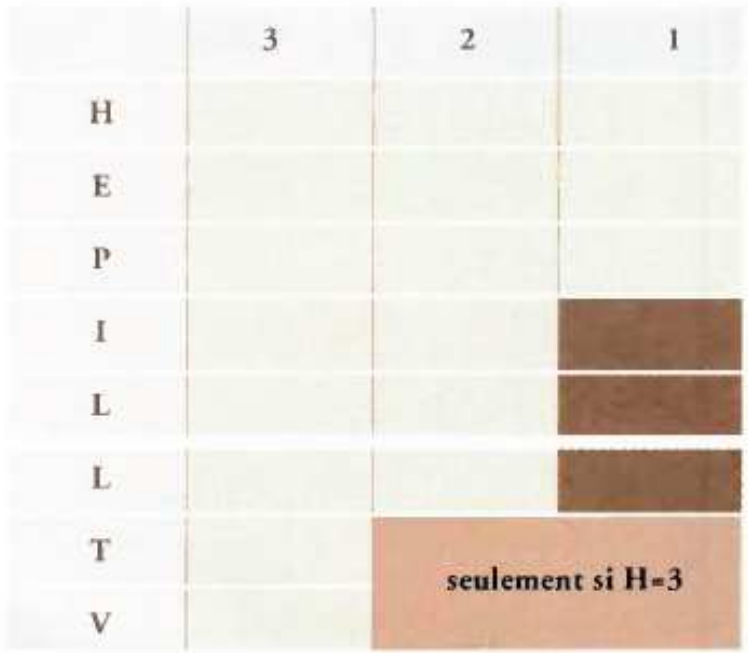
In situ recycling for sub-base and road base layers

Specification for the equipment



Compactage : qualité q1 si > T3 ou q2 si ≤ T3
Emploi de compacteurs V5 ou V4 et P2
(voir V3 suivant l'épaisseur compactée)

Tableau 11 : Matériels nécessaires pour obtenir : le niveau de qualité R1 du retraitement.



Compactage : qualité q2
Emploi de compacteurs V3 ou V4 ou V5
et P2

Tableau 12 : Matériels nécessaires pour obtenir : le niveau de qualité R2 du retraitement.

Accepté Accepté sous conditions Refusé

In situ recycling for sub-base and road base layers

- Parameters used for pavement design according to LCPC Alizé Software

Cas de chantier	Qualité de retraitement R1		Qualité de retraitement R2	
Caractéristiques obtenues après abattement	Matériau M1	Matériau M2	Matériau M1	Matériau M2
Module E (MPa)	20 000	18 000	18 000	13 000
σ6 (MPa) contrainte à 10^6 cycles	0,70	0,55	0,55	0,35

Technical Guide Setra "Cold in situ recycling of all pavement" July 2003

In situ recycling for sub-base and road base layers

- In situ treatments

In situ recycling for sub-base and road base layers

- In situ treatments

In situ recycling for sub-base and road base layers

- In situ treatments

In situ recycling for sub-base and road base layers

- Cold recycling process in plant

In situ recycling for sub-base and road base layers

- Cold recycling process in plant

EUROVIA

VINCI

HRVATSKO ASFALTERSKO DRUŠTVO

HAD

Recycled household-waste bottom ashes

Recycled household-waste bottom ashes

- Definition :
  - It is incinerator ashes screened, with :
    - A sieving : 0/D
    - A suppression of non ferous particles and unburned materials
    - Blowing of unburned materials, papers, plastics
    - A maturation (> 3months) :
      - ✓ Oxidation
      - ✓ Carbonation
      - ✓ Stabilization of metals

Recycled household-waste bottom ashes

Before

After

Recycled household-waste bottom ashes

Conditions of use :

- Environmental characterization of level 1:
  - Objectives :
    - Provide informations on the variability of the materials
    - Justify the acceptability in road techniques

Thanks to leaching test

(NF EN 12457-2 or NF EN 12457-4)

Paramètre	Quantité relarguée à L/S = 10 l/kg (essai de lixiviation NF EN 12457-2 ou NF EN 12457-4)		
	Ensemble de valeurs à respecter par au moins 80% des échantillons (mg/kg de matière sèche)	Ensemble de valeurs à respecter par au moins 95% des échantillons (mg/kg de matière sèche)	Ensemble de valeurs à respecter par 100% des échantillons (mg/kg de matière sèche)
As	0,5	1	1,5
Ba	20	40	60
Cd	0,04	0,08	0,12
Cr total	0,5	1	1,5
Cu	2	4	6
Hg	0,01	0,02	0,03
Mo	0,5	1	1,5
Ni	0,4	0,8	1,2
Pb	0,5	1	1,5
Sb	0,06	0,12	0,18
Se	0,1	0,2	0,3
Zn	4	8	12
Fluorures	10	20	30
Chlorures[c]	800	1 600	2 400
Sulfates[c]	1 000	2 000	3 000
Fraction soluble[c]	4 000	8 000	12 000

Recycled household-waste bottom ashes

Conditions of use :

- Geotechnical characteristics
  - Grading curve
    - Often 0/20 mm
    - Dry screened fraction at 2mm ≤ 70%
    - Dry screened fraction at 0.08mm ≤ 12 %
  - Los Angeles test value ≤ 45
  - Sand equivalent test > 55
  - Content of unburned materials ≤ 3%

Recycled household-waste bottom ashes

Conditions of use :

- Fill and capping layer (technical guide from Setra/LCPC)
  - Category F 61
  - Used as a D21 material
  - All traffics
- Untreated material type A 0/20, complying with the specification envelop specified in the standard NF EN 13285
- Sub-base
  - Traffic under 50 trucks/day
- Layers between 150 to 350mm thick

Recycled household-waste bottom ashes

Requirements concerning job site :

- Environmental characteristics
  - According to the circular, bottom-ashes can't be used:
    - In areas liable to flooding and in the protection areas surrounding drinkable water catchments,
    - Less than 30 meters from any waterway,
    - Under the level of the « highest known waters »,
    - In filling trenches with metallic pipes,
    - In draining systems,
    - In porous pavements or « chaussée réservoir »,
    - In fills higher than 3 m and not covered by at least 500mm of topsoil.
  - Moreover, Eurovia prohibits their use under a concrete slab in buildings and recommends the laying of at least 120mm of bituminous materials on top of them.