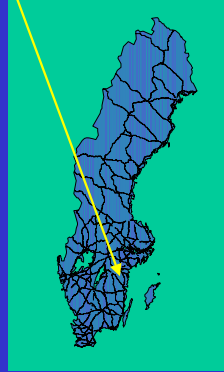


Cold and Semi-Hot Recycling of Asphalt Pavement in Sweden

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Asphalt pavements in Sweden



Asphalt production:

- 7 million tons of hot mix
- 1 million tons of cold or semi-hot mix
- 1 million tons of recycled asphalt

Wearing course:

- Surface dressing (30%)
- Cold and semi-hot mix (20%)
- Hot mix (50%)

Recycling of Asphalt Pavement



- Cold recycling: 40%
- Semi-hot recycling: 35%
- Hot recycling: 25%
- Mix in plant
- Mix in place

Reclaimed Asphalt Pavement (Asphalt Granulate)



Asphalt granulate

- Crushed or milled and sorted asphalt pavements
- 0-16 mm for wearing course
- 0-22 mm for road base
- Binder content: 3,0-6,0%

Cold Recycling in Plant



- Bitumen emulsion: 2,0-4,0%
- Aggregate: 10-20%
- Asphalt granulate: 80-100%
- Optimal water content: 6-7%
- Total binder content: 4,5-7,5%

Cold Recycling in Plant



- Easy to move
- Close location to the job site
- Continuous or batch mixer
- Modern control systems
- 100-150 ton per hour

Cold Recycling in Plant - new binder



Standard

- BE60M/1500
- BE60M/6000
- BE60M/12000
- BE 60M/160/220

Special

- Nyrec 240/pen.330/430
- Nyrec 630/pen.160/220

Semi-Hot Recycling in Plant



- Temperature: 50-80°C
- Batch mixing: 100-150 ton per hour
- Soft bitumen: 1,2-1,8%
- Asphalt granulate: 80-100%
- Aggregate: 0-20%

Semi-Hot Recycling - new binder



- Soft bitumen
- 0,8-1,4 % adhesion agent (amin)
- V1500
- V3000
- V6000
- V12000

Laying and Compaction



- Cold mix is relatively slow to lay
- Compaction with both steel and rubber tyre roller
- Newly laid pavements can be sensitive to mechanical stresses

Laying and Compaction



Cold Recycling - Mix in Place



- **Bitumen emulsion**
 - BE60M/160/220 and 330/430
 - 1,5-4,0% emulsion
- **Foamed bitumen**
 - 1,0-2,5% bitumen
 - adhesion agent (1%)
- **1-2% cement** improve water sensitivity and stability

Semi-Hot Recycling - Mix in Place

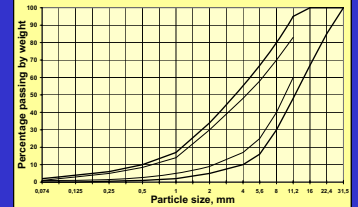


- Temperature: 50-80°C
- For soft bitumen asphalt pavement
- New binder, mix or aggregate is added
- Depth: 0-8 cm

Laboratory tests - step 1

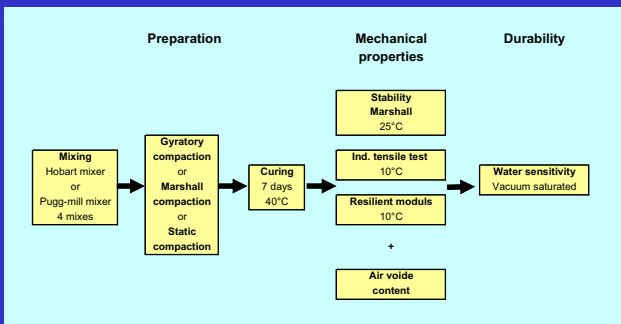
- Sampling
- Characterising old pavement material
 - Binder content, grading of extracted material
 - Compaction curve
 - Grading and moisture content of granulate
 - Penetration, softening point or viscosity of recycled binder

- Suitable particle grading for granulate:



Laboratory tests - step 2

Mix design system for cold or semi-hot asphalt:



Laboratory tests - step 2

Mix design

- Preparation of specimens
 - Mixing, compaction, curing
- Mechanical properties
 - Stability, Ind. Tensile test, Resilient modulus + air void content
- Durability
 - Water sensitivity

Preparation of test specimen



Laboratory tests - step 3

Quality control

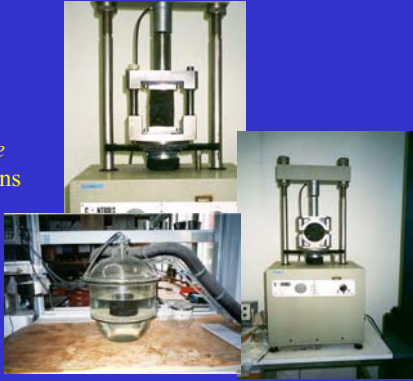
With low traffic volume

- Binder content and grading of mix

With higher traffic volume

- Preparation of specimens from mix, then:
- Mechanical properties
- Durability

Test equipment



Laboratory test - requirements for Cold Mix

Method	Road base	Wearing course
Void content, volume %:	6-14	4-12
Marshall stability, 25°C, kN:	>7	>5
Stiffness modulus 1), 10°C, MPa:	>2000	-
Ind. tensile strength, 10°C, kPa:	-	>300
Water sensitivity, %:	>50	>60

Laboratory test - requirements for Semi-Hot Mix

Method	Road base	Wearing course
Void content, volume %:	5-10	3-8
Marshall stability, 25°C, kN:	>10	>8
Stiffness modulus, 10°C, MPa:	2000-5000	-
Ind. tensile strength, 10°C, kPa:	-	>500
Water sensitivity, %:	>60	>70

