Surface Grinding Concrete Pavements

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OVERVIEW CONCRETE GRINDING

- Problems with existing concrete highways
  - Noise reduction
  - Skid resistance
  - Water run off

- Diamond Grinding and Grooving
  - How can the processes help
  - What is it?
  - Benefits

- Grinding Project
  - Trial
  - Results

- Summary
Attitude towards concrete roads

- Concrete roads are considered to be both expensive and noisy
- As an example in the UK no major concrete highways have been constructed in the last 9 years
Issues regarding noise and skid resistance

- Vehicle noise is generated by the interaction of the tyre and road surface.
- Air is compressed and released as the tyre rolls over the surface.
- Passenger cars generate 70-90% of their total noise through tyre pavement interaction.
- The greater the contact area between tyre and road the greater the noise.
  - Methods for improvement or noise mitigation include:
    - Speed reduction, barriers, fences, earth mounds.
    - Overlaying with varying materials, normally so-called porous or low noise asphalts.
Issues regarding noise and skid resistance

- The cause of noise is not the concrete itself but the surface texture of the concrete.
  - Widespread use of transverse tining in Europe and the US has been the norm.
  - Transverse tining can create tonal issues known as “tyre whine.”
  - Human hearing is particularly sensitive to frequencies this process causes.

- The acoustic property of a pavement surface changes over time and that is relevant to any surface.
- As concrete roads age their surface texture deteriorates, the surface becomes polished and noise levels increase.
- Another negative effect of worn or polished surfaces is diminished skid resistance.
issues regarding noise and skid resistance

- Joints can also contribute to the overall noise level and are often the result of inadequate load transfer.
- Uneven expansion and contraction joints between concrete slabs result in poor ride quality.
- The tyres will produce a “joint slap” every time they contact a joint.
How Can Diamond grinding provide solutions

What is Diamond Grinding?

- Grinding is the use of diamond blades to remove and retexture the surface of concrete roads.
- A diamond grinding head consists of around 250 diamond tipped blades generally 450mm diameter.
- We remove between 3 to 8mm from the road to give an even and reconditioned surface.
- Each blade is spaced approx. 2.5mm apart; this can be varied up to 3.5mm for softer aggregates like limestone.
- A typical machine weighs 22 ton and needs a separate water tanker.
- Powered by a 540 hp Cummins engine with a computerised operator interface and a collection and separation system for water and grinding debris.

Machine Length: 8.5m long
Width: 2.1m wide
Grinding and Grooving

PC-4500
- 540hp
- Grooving Width 1250mm
- Blade 400-450mm
  - Length 10m
  - Width 2.6m
  - Weight 22 tons

PC-6000
- 680hp
- Grooving Width 1250mm
- Blade 400-450mm
- Length 16m
- Width 3.2m
- Weight 24 tons
- 34 tons with full water tank.
BENEFITS OF GRINDING

- No remedial works to drains, barriers or bridges
- Grinding can be completed in off-peak hours with short and mobile lane closures
- Diamond grinding can remove any unevenness between joints to restore ride quality
- This flattens the road by evening out undulations and at the same time retextures the surface to improve braking and skid resistance
Benefits of Grinding

- Texture of ground road surface is longitudinal rather than transverse

- Contact area between tyre and road is reduced, so traffic noise is lower than if the road were smooth

- Reductions in noise level are between 3 and 6 dBA

- As a point of comparison, a doubling of traffic density produces an increase in noise level of 3 dBA

- The higher the vehicle speeds the greater the noise reduction
Outline of UK test project

UK Test section

- The first two minor projects were to prove the process
- This led to 125,000 m² (4 lanes 6 Km) and a 4 year testing process
- The concrete road structure was a heavily trafficked 4 lane highway
  - 10 years old built using flint aggregate concrete
  - The test section runs through a populated semi rural location with dwellings in close proximity to the road
- The result of the poor surface meant that it was failing to achieve specification
- The risk relates to increased accident levels and heavy noise pollution
Outline of study

Site Description

Site 1 A12 Chelmsford By-pass

Site 2 A12 Kelvedon

Site 3 A14 Whitehouse to Copdock
Results from grinding trial

- Road noise and the ride quality showed an immediate improvement.
- Tests were conducted on noise levels and skid resistance by the Traffic Research Laboratory.
- Grinding produces a longitudinal texture, much quieter than transverse textures.
- Improvements in noise level at 50-80 Kph were between 4-6 dBA.
- At higher speeds decreases in noise levels were even greater.
A.12 Boreham – Grooving and Grinding Trial
Triton Noise Measurements
Northbound Carriageway at 80kph

NOISE RESULTS GRINDING
Below 0.2 Very poor and dangerous
0.2 to 0.39 Poor to fair
0.4 to 0.5 Generally satisfactory
Up to 0.75 Very Good
Above 0.75 Excellent

➤ On average skid resistance improved by 54%
Conclusions of test results

- Will an increase in low speed skid resistance occur on UK roads?
  - Average low speed skid resistance has improved compared with control surfaces
  - Uplift in Skid Resistance reduces slightly over the first few months and reaches a plateau at relatively high levels

- What are the actual noise characteristics 5 years on?
  - Average values of -4.0 RSI measured on A14 site and an estimated improvement of 6.7 dB from original surface
Summary of Grinding benefits

- Environmentally friendly: A sustainable repair option offering a smaller carbon footprint compared to asphalt overlay.
- Tests by Eupave showed that concrete roads showed a fuel saving of 6% compared to Asphalt roads (EUPAVE 2011)
- Lower noise emissions
- Simple: No need to modify crash barriers, sign, drains, and grinding can be completed in off-peak hours with short and mobile lane closures
- Flexibility: Concrete roads can be ground up to three times with little loss of structural or load carrying capacity
- Cost-Effective: Increasing asphalt prices mean that even initial build costs come close to concrete and whole life costs of concrete roads are considerably lower

Ref data Grinding and Grooving Association and Eupave
**Safer Roads**

- Ride Quality: Diamond grinding retains evenness longer than alternative surfaces.
- Proven: Grinding is an established process and has been used for decades, dating back to its first use in California in 1965.
- A mountain of evidence from the US shows that the advantages of a reground and retextured concrete road surface lasts a minimum of **10 years** (Rao et al. 1999).
- Safe
  - Wisc DOT has shown that a diamond ground surface decreased accident levels by 42% in all conditions and 57% in wet conditions.
  - This data was recorded during a 6 year study comparing ground and unground surfaces.

Ref data Grinding and Grooving Association and Eupave
“Diamond grinding has been adopted as a cost effective and environmentally friendly alternative to Asphalt overlay “
Thank you for your attention!
References

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