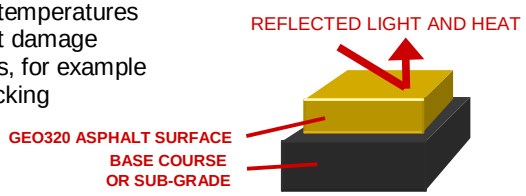
Synthetic Bitumen

GEO320™

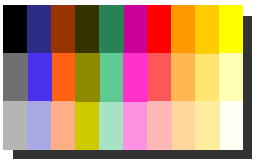
Environmental issues feature increasingly in today's social and commercial world as less harmful and better ways are sought to manufacture and use a wide variety of products.This is why GEO320™ is such an important development, not only is it the first commercial development of a bio adhesive for the manufacture of asphalt that is made from renewable resources, such as Sugar and Molasses (**Innovation 1**) but it also possesses increased mechanical and rheological properties to that of normal road grade bitumen eg, Cl 320. Normal residue bitumen requires hot storage to remain in a viscous suspension until the time of asphalt mixing process. GEO320 on the other hand is stored in granulated form (**Innovation 2**), which is then added to the hot aggregate mix at the time of asphalt manufacture, this not only eliminates wastage (oxidized bitumen) but also saves on fuel costs not having to keep the hot material in a liquid suspension. GEO320 was designed to have higher fatigue and durability performance (**Innovation 3**) than conventional class 320 road grade bitumen, GEO320 asphalt can also be laid at a low 110º C (Warm Mix) (**Innovation 4**). A higher resistance to solvents and lower volatile emissions (**Innovation 5**) was also a careful consideration when designing this product.
One of the most interesting aspects of GEO320 is its low heat absorption qualities, as much as 50% less) compared to normal bitumen asphalt (**Innovation 6**)**,** this extends the life of asphalt by maintaining cooler surface temperatures where the most damage normally occurs, for example rutting and cracking is usually the result when asphalt is exposed to hot and cold conditions during its service life. This constant state of expansion and contraction coupled with traffic loads has an impact on the structural integrity and life of a pavement. the light reflecting ability (**Innovation 7**) of GEO320 asphalt is a very important safety feature, furthermore, asphalt made using GEO320 can be pigmented (**Innovation 8**) to any desirable color, from bright to earthy pastels, this increases the effectiveness in road safety and adds to environmental and architectural aesthetics.
Recyclable materials eg, plastics can also be utilized (**Innovation 9**) in GEO320 binder formulation and also in the hot asphalt aggregate mix, this point in itself is an important eco benefit.



Non Petroleum

Normal road grade bitumen eg, class 320 and 170 is made from the by-products of the petrochemical distillation process. The by-product is further processed by the addition of "oils and cutters" (volatiles) to achieve a desired road-making grade. The fumes that are emitted into the atmosphere during the bitumen manufacturing process, hot storage and at the asphalt manufacturing stage are environmentally damaging and therefore undesirable.Since GEO320™ is a non-petroleum based product it has a measured volatile content (**Innovation 10**) of only 0.5%, it also emits only a fraction of the fumes compared to normal residue bitumen eg, CL 320 or Cl 170.The environment as well as the end-user was a high priority consideration in the twenty years that it took to research and develop GEO320 synthetic bitumen in Melbourne Australia. In view of the global movement towards environmentally friendly products and sustainability, and since GEO320 is made from renewable resources it is well positioned to make a positive contribution to the reduction of harmful greenhouse gas emissions, sustainability and recycling.

GEO320™ Colors



After extensive research, Ecopave Australia™ has also developed a coloring system (**Innovation 11**) specifically for GEO320™ asphalt paving applications, GEO320™ asphalt can be pigmented to any color retaining brightness throughout the service life of the asphalt that resists fading due to wear and weathering.

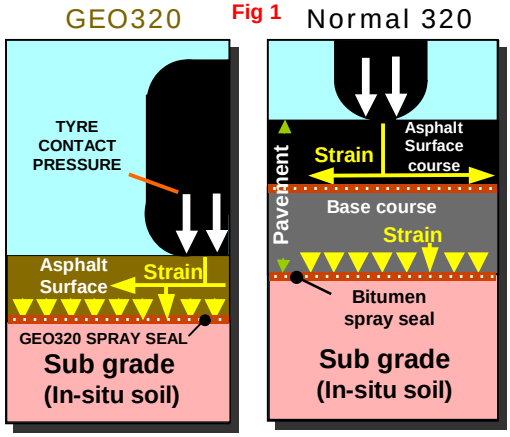
GEO320™ asphalt paver application at Melbourne Deer Park. Note the lack of fumes generated from the asphalt which was laid at 110°C (Warm Mix Asphalt).

The Bitumen story

The surfaces of asphalt roads made from normal bitumen have a tendency of becoming "greasy" in wet road conditions, this is due ironically to the high oil content of residue bitumen,car tyres tend to pick up"binder shift" this oily residue and distribute it from one area to the other and as a consequence contribute to the slipperiness of road surfaces. Normal bitumen asphalt is also subject to softening in the outdoor temperatures experienced in Australia so much so that once the air temperatures become extreme,the black road surfaces absorb so much heat that heavy vehicles have been known to "Lift" the road surface creating road safety hazards for the motoring public, the resulting potholes also causing damage to motor vehicles.

On the other hand,asphalt made withGEO320 having low thermal conductive and infrared absorptive properties resists the build up of damaging temperatures,what this also means is that GEO320 prevents excessive heat from being transferred to the lower "base course" and "sub-course layers" thus giving added protection and increasing the long-term life of the pavement structure. There are two conditions, that cause permanent deformation of an asphalt structure which are determined chiefly by the properties of the upper layers (surface and base course) see **Fig1**. Firstly the load spreading ability of the upper layers reduce the effect of the traffic loading on the bottom layers and second, the effective temperature of the bottom layers is effectively lower, resulting in greater resistance to deformation.

The asphalt industry has adopted a method of lowering the thermal susceptibility (minimizing deformation) of normal road grade bitumen asphalt by adding polymers hence the term PMB's or (polymer modified bitumen) unfortunately this approach has failed to eliminate the so-called "greasy road" problem which is particularly evident on wet road conditions also the use of PMB's is costly and therefore is not as widely used as straight bitumen. Due to the nature of residue bitumen, the manufacturing tolerances for producing asphalt is very narrow, this doesn't allow much room for flexibility in terms of binder content or mix design aggregate loadings, therefore close monitoring is essential for a successful paving outcome. In contrast however, asphalt made with GEO320 has a higher tolerance (margin for error) this allows for greater degree of flexibility by simplifying the procedures associated with asphalt manufacturing, testing and operational quality control.



Comparison between GEO320™ and normal Cl 320 asphalt pavement construction.
GEO320™ asphalt surface course is able to incorporate the base course layer, thereby reducing pavement thickness, simplifying construction and lowering costs. As a general guide, GEO320™ asphalt is applied at **15 - 20 mm** thickness for footpath and light trafficked areas and **30-50 mm** thickness for medium to heavily trafficked roads.

GEO320™ bio-bitumen™ benefits

Road Safety

- Asphalt made with GEO320™ has a non-slip surface, this is especially evident in wet weather conditions, and this increases road safety for pedestrian as well as motor vehicle traffic.
- GEO320 asphalt comes in a wide variety of colors ranging from bright to earthy pastels, colors play an important part in road safety especially where visibility of pedestrian crossings, bends, bicycle paths and intersections are concerned.

Visibility

- Reflected light (Retro-reflectivity) is a very important road safety feature, glass beads have been used in road marking applications for a long time, GEO320 asphalt contains glass spheres to further increase night visibility on the roads. This feature only applies to "colored" asphalt situations, the beads continue working as a thermal aid in black colored asphalt.

Long Life

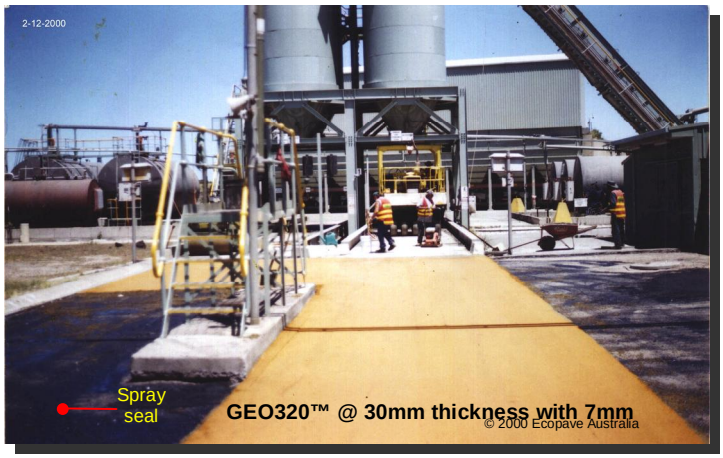
- GEO320™ asphalt can also be made to have zero voids (pores), this is beneficial for roads damaged by salinity, solvents, ice, growth of vegetation etc. Higher void percentage e.g., 30% can be made if increased water drainage is required (drainage asphalt).
- Asphalt pavement made with GEO320 is more durable than conventional road grade bitumen asphalt, the higher resistance to fatigue, heat and oxidative hardening insures against undue cracking from deformation under loads caused by traffic.
- Due to the lower temperature absorption characteristics of GEO320 asphalt, it is able to withstand the effects of "extreme" outdoor conditions "hot or cold" without cracking, rutting or loss of adhesion.
- GEO320 asphalt is designed for footpaths; drive ways, tennis courts, sports areas, car parks, warehouses, intersections, bicycle paths, bus lanes, airfields, roads and highways.

Strength

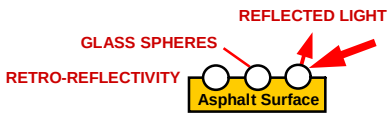
- Due to GEO320 having high resistance to cracking and fatigue, thinner and stronger asphalt constructions are now possible.

Recycling

- GEO320 asphalt is fully recyclable in the same way as normal bitumen asphalt, also the binder composition itself contains recycled raw materials, reclaimed tyre rubber can also be used in the asphalt mix as with normal bitumen asphalt to achieve reductions in traffic noise levels.



GEO320™ asphalt surface was applied to a thickness of **30mm** using a **7mm** dense graded mix design with **0.9%** voids which was chosen in place of a standard 14mm mix design with **5%** voids. The high performance of GEO320 asphalt was demonstrated on a asphalt truck weighing station, the fully loaded asphalt trucks that stop here weigh in excess of 40 tons, the surface has had no change since application in December 2000.



Workability

- The workability and ease of handling of GEO320 is the same as normal bitumen asphalt, all the same cleaning practices and use of equipment also apply. When GEO320 asphalt is being laid either by machine or by hand the asphalt mass settles into its final compaction density (ease of compaction) in less passes with a roller, thus saving time and lowering construction costs.

The Environment

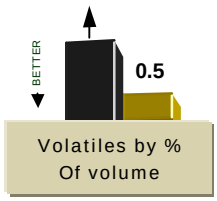
- GEO320 is a safe non-toxic, non-fuming, product and is made from renewable resources. All this and the fact that recyclable raw materials can be used in the asphalt and binder mix rates highly with current and future global environmental objectives towards "zero emissions" and sustainability.

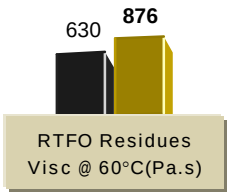
Benchmark testing

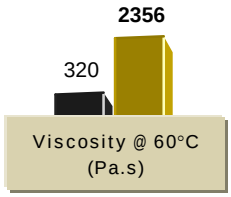
GEO320™ v Shell Class 320

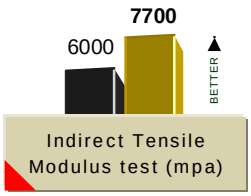
GEO320™ has gone trough vigorous testing since 1987 and presented here are the latest findings *made by ARRB on 16th August 2002*. GEO320 was tested by ARRB Transport Research to compare its performance properties with normal road grade residue bitumen, in this case (Shell Class 320). Standard tests used to characterize bitumen to **Australian Standard AS2008** were applied to both products.

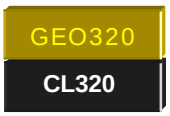
- "GEO320 was less soluble in standard laboratory solvents, the reduced solubility is noted to be advantageous to the end-user".
- "GEO320 behaves like PMBs and lower temperatures were required to overcome the high apparent elasticity"
- "The GEO320 durability is significantly better than typical class 320 bitumen and rarely achieved with softer class 170 grade".
- "Fatigue performance was better than class 320 bitumen, this binder gave fatigue performance similar to a moderately modified PMB, a good result and better than typical CL 320 bitumen".
- "GEO320 handles like a conventional class 320 bitumen".
- "No significant fumes were noted during the high temperature handling phase and a mass loss of only 0.5% was measured which is on the limit (minimum volatile emissions) for an Austroads specified polymer modified binder".
- "GEO320 is not of petrochemical origin".
- "A viscosity decrease was noted during the RTFO treatment, this correlates with the measured rutting performance to that of standard class 320 bitumen".



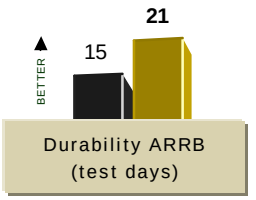


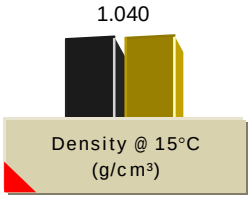


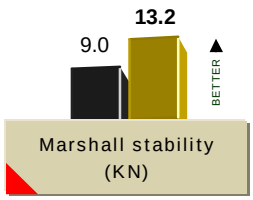


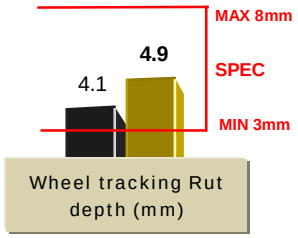


BOTH SAMPLES WERE MADE USING 14mm BORAL MONTROSE MIX

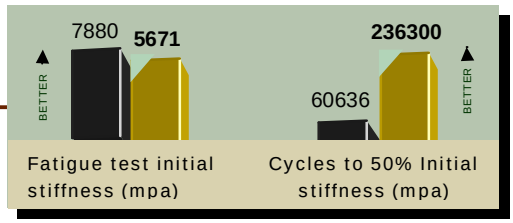








Vicroads tests 1987-1993



The fatigue test is carried out under the Standard reference test conditions of Austroads test method AST 03(1999) giving a fatigue life in cycles to reach 50% of the initial stiffness at a strain of 400ue. GEO320™ recorded 236300 cycles.

Volatiles — **This value relates to the quantity of fumes that bitumen emits**

RTFO Residues — **Rolling Thin Film Oven test (RTFO) gives an indication of The oxidative hardening of bitumen over time.**

Viscosity — **Viscosity relates to the runniness of bitumen at 60°C.**

Indirect Tensile Modulus — **Indirect tensile modulus or (elastic modulus) is a test performed to determine the strength of asphalt under traffic loads.**

Durability — **This test measures the number of day's bitumen reaches critical level of viscosity (oxidative hardening) the more days the better.**

Density — **The Bitumen tested to AS2008 has a density around 1.040 at 15°C.**

Marshall stability — **AS2008 specifies this test as a good indicator how asphalts perform on the road and its ability to withstand stresses.**

Wheel tracking — **By measuring the rut, depth of asphalts at 60°C determines how much it is likely to deform under traffic loads on the road, Austroads Test method AST 01 2001 sets out the tolerance between 3 and 8mm**

Fatigue in Asphalts

Asphalt materials can exhibit fatigue if a given deformation is repeated often enough and the material loses its cohesion and starts to crack. This fatigue behavior is largely dictated by the strain imposed on the asphalt but it is also caused by temperature, the rate of load application and the composition of the asphalt mix design. The effect of these latter variables can be accommodated neatly by relating fatigue behavior to the asphalt modulus. Fatigue behavior is then determined by the imposed strain, the asphalt modulus and mix design quality factor. **Laboratory tests have shown that this mix quality factor is largely a function of the quality of bitumen and its content in an asphalt mix**. The principal criterion for asphalt fatigue (see **Fig 1**) is horizontal strain at the bottom of the asphalt layer, while for sub- grade deformation it is vertical strain at the top of the sub-grade. Using the mechanical properties of the structure's three layers (surface-course, base-course and sub-grade) the strains resulting from traffic load can be calculated. The calculated strain levels are compared with the asphalt fatigue criterion (the number of times that the given strain level can be repeated before cracking occurs) and sub grade strain criterion (the number of times that the given strain level can be repeated before deformation impairs traffic safety), the mix stiffness will affect the liability to permanent deformation of the asphalt layer. A mathematical model is used to convert the repeated traffic load to an equivalent constant load, this in conjunction with the mix stiffness, gives a prediction of permanent deformation. At this stage, the design of asphalt pavements appears to be a procedure, which if meticulously followed, will produce an unequivocal result. In practice, however, it is more complicated. When gathering the data on material properties, which are needed for input to the calculation procedure described above, it becomes obvious that since virtually all construction materials are derived from "natural" raw materials, their properties cannot be known precisely and can vary considerably. These variations imposed by nature must be taken fully into account in designing a road structure, and that demands insight into the nature of the materials used and skill in weighing the possible variations in properties and the resultant variations in the life of the structure. **Numerous tests have demonstrated that the quality of bitumen and its quantity in an asphalt mix is the most important factor.** (Fatigue in Asphalts, from Shell Pavement Design Manual, SPDM 1989).

"Asphalt Bitumen from Renewable Resources™"

Acknowledgment of Organizations involved in the testing and evaluation of GEO320™ in Australia 1982 – 2002.

Vicroads 2003
ARRB Transport Research 2002
Prismo UK - 1999
Department of Transport South Australia 1996 --1998
Road Traffic Authority New South Wales 1995
Potters Industries (Line marking services) -- 1994
Vicroads (Road Traffic Authority) 1987 -- 1993
Mobil Oil (Emoleum) -- 1992
ARRB --1991
CSIRO (polymer division) 1988
Technisearch 1987
Technisearch 1982

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GEO320™ Synthetic Bitumen
Invention, Research and development made in Melbourne Australia
"IN GOD WE TRUST"