RoadPacker Group

Product Information & Technical Manuals

RoadPacker GROUP

If you're interested in our range of chemical soil stablisation products please get in touch.

Email: macd@roadpacker.com
Web: www.roadpacker.com

Canada Office
Phone: +1-403-273-8657

Philippines Office
Phone: +63-046-483-5038
Cell: +63 (0) 017 534 1200 or 1300

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The Company

In many areas around the world, vital road networks are deteriorating, causing concern to governments at federal, state, provincial and local levels. The cost of road construction and maintenance is often the single biggest expenditure item for governments the world over. In any sizeable country, these costs can invariably run to billions of dollars annually. Due to lack of funding in many countries, a more cost-effective construction and maintenance method must be established.

The use of chemical soil stabilisation is now a seriously considered alternative, with many roads being built and evaluated with extremely encouraging results. Chemical soil stabilisers are any chemical which when added to the soil, or road base material alters that material to improve its engineering properties.

This occurs through a variety of mechanisms including increased compaction, density and bearing strength, binding soil particles, reducing the soil's susceptibility to changes from changing moisture content, reducing the amount of water entering the soil and waterproofing the soil. Ionic soil stabilisation offers a low cost alternative to traditional construction methods, and has the advantage of being able to utilise the 'in situ' soil.

Due to these successful results and cost-effective methods the RoadPacker Group has gained credibility among the many government sectors around the world and has manufacturing facilities in Canada. We currently sell to markets in China, Philippines, India, Poland, France, Italy, South Africa, Nigeria, Congo Republic, Ivory Coast, Holland, Brazil, USA, Honduras and many other countries around the world. It is the intention of the RoadPacker Group to target all other countries in the world, as they develop and realise the beneficial financial advantages of this type of technology. RoadPacker Group has developed its own proprietary formulae and continues to invest in and regularly produce new and enhanced chemical products.

After assessment, research and testing to provide construction engineers with information regarding the extent to which chemical stabilisation improves the mechanical properties of their materials,

there has been a major swing to the use and acceptance of chemical stabilisers. This is primarily due to the dramatically reduced cost of initial construction of the roads and the yearly necessity of heavy maintenance as a result of inclement weather. Thus the high annual budgets for maintenance costs dictate that it has been accepted as an alternative method of low-cost road and house construction in many countries.

> "In the USA alone it was estimated that in the 1920s as much as 25 million cubic metres of spent sulphite liquor from paper mills was being dumped in waterways..."

Using RoadPacker Group's products, governments have been assured of annual savings in their maintenance budgets, together with reduced cost of new road construction projects using 'in situ' material. The collateral benefits here, also allow the government to construct more new roads with the same tax dollar budget, and carry out less frequent annual maintenance programmes as the roads last longer and not deteriorate as quickly, if at all.

RoadPacker Group's team of chemists continuously work on product enhancement through the testing of soils from different parts of the world. Their current research involves the study of water and its reactions with regard to chemical soil stabilisation technology, soil mineralogy, and reactions to chemical interaction within clay lattice structures.

RoadPacker Group is the most advanced company in the industry involved in the research of chemical soil stabilisation as an alternative method of low cost road and housing construction, utilising 'in situ' soil as the basic construction material. Chemical stabilisation through the utilisation of Sulphonated Petroleum Products [SPPs] and the ionisation of the 'in situ' soil material which makes a permanent change to the molecular structure of the soil, will continue to keep RoadPacker Group well ahead of the new products emerging into today's market.

This is simply because we have a fundamental knowledge of what is required of the technology to be successful in the field of chemical soil stabilisation.

Chemical soil stabilisation is the use of chemicals to modify the structure or properties of soil to make the soil more

What are Chemical Soil Stabilisers?

dense, or to increase binding of the soil particles, to increase the soil's ability to bear load without deformation, or to reduce surface loss or erosion through wind, rain, or the movement of traffic over it.

The most widely used forms of chemical stabilisation are cement and lime, the latter having been used in ancient Mesopotamia, and forms of cement having been used for centuries. In many civilisations, straw was mixed with mud to increase its strength for building purposes. From the early 1900s particularly with the production of huge volumes of waste chemicals from a range of industrial processes, including paper manufacture, the petrochemical industry, food processing, and the like, ways had to be found of safely disposing of, or utilising these wastes without simply dumping them in waterways, with the inevitable large scale pollution that invariably followed.

In the USA alone it was estimated that in the 1920s as much as 25 million cubic metres of spent sulphite liquor from paper mills was being dumped in waterways. It had been observed that when this waste, which was a mix of sulphuric acid, sulphonic acid, timber resin, wood sugars and other waste extracted from the paper pulp, was applied to roads, it reduced dust. Research was also undertaken in the USA by some universities and the US military, particularly during the Second World War, to ascertain what reactions or processes were occurring in the soil through application of the sulphite liquor. This was to further determine which chemical constituents were proving beneficial in reducing dust and in so doing, having a stabilisation effect on the 'in situ' soil.

It was found that electrostatically charged surface active agents (surfactants), and mineral acids which are also charged, were reacting with clay in the soils and modifying the clay. Exactly how this was occurring was not fully understood because of the complexities of clay chemicals and the minute size of many clay particles (less than 2 microns). The chemicals modify clay through electrochemical or ionic stabilisation.

An American Professor of Chemistry, by the name of Reynold's developed a chemical solution claimed by some to be from waste from the petroleum industry, and by others to be from waste from the paper industry. This product was produced by Zell Chemicals from the 1950s to around 1972 and exported to many countries under the names Reynold's RoadPacker and Reynold's RoadPacker_235. The

product was an effective stabiliser in a significant number of applications but an unacceptably high number of failures also occurred, furthermore, little or no historical data on results were recorded. The failures in both application in the field and in laboratory tests, led to the use of the product being banned in some countries, notably Australia where national and state transport authorities banned its use in 1972. Zell Chemicals stopped producing Reynold's RoadPacker in 1972.

From the early 1970s South Africa became the leader in the development and use of ionic soil stabilisers. It has been claimed that South African interests acquired the rights to Reynold's RoadPacker, and marketed it as ISS 2000 it is now marketed as ISS2500. Chemical laboratory analysis of both Reynold's RoadPacker and ISS 2000 by the Queensland Government chemical laboratory and a leading private laboratory in Queensland on behalf of RoadPacker Australia in 1991 and 1992 revealed that these products were very similar in composition, both being a dilute sulphuric acid solution, with a wide range of elements in trace quantities only. Both laboratories concluded that both ISS 2000 and Reynold's RoadPacker were waste, most likely from the washing of petroleum products. It is also claimed however that the rights to Reynold's RoadPacker were acquired by Conaid in South Africa.

This has long been a point of dispute between Conaid and ISS2500 who also claim to have acquired the original rights. It is likely however that ISS2000 bought the rights, and Conaid came up with their product some years later.

Chemical Laboratory testing of Conaid by the Queensland Government Chemical Laboratory in 1992 revealed it was a dilute solution of alkyl benzene sulphonic acid (ABS), with ABS and water its only ingredients. The company have however

made a slight change to their formulae to decrease the amount of acid that it uses in manufacturing. This we believe has been a mistake by Conaid and time will show this to be true through an increased amount of project failures. Conaid as with ISS2000, and as was previously the case with RoadPacker, all have had problems transporting their products around the world due to the hazardous classification of the product.

The very essence of the formulae for this type of product is the acid compounds contained within it, that's what makes the stuff work. RoadPacker found another way around the problem of hazardous classification restrictions when we opened up additional manufacturing facilities. We will continue to do so where it is a viable solution to product supply.

A similar product to the original Reynold's RoadPacker and ISS 2000 is produced in the USA as Condor ISS, and there

is one known producer of a similar product in Germany. In Australia there are 4 producers of similar products all of whom have copied formulae from other manufacturers. There are also 2 producers of a product that performs in a similar way but use enzymes in conjunction with surface active agents. There is also a manufacturer of a similar enzyme based product in the Philippines. The use of enzymes is copied from the laundry detergent industry, whereby charged enzymes are used to attach to dirt etc. on clothing.

A product using different chemistry is produced in Europe under the name Consolid. The chemistry used by Consolid was researched by RoadPacker Australia in the early 1990s and while it offered potential, it needed further R&D to be viable, its high cost is a major negative factor.

In this industry, it is clear that many of the people producing and marketing ionic soil stabilisers have little knowledge of the processes through which they work and they invariably attempt to apply the same product in all soil types. Very few of the suppliers of chemical soil stabilisers are doing little if any research and it is questionable if many of them would know where to start.

It is the conviction of the RoadPacker Group that if we continue to systematically develop a chemical solution to effectively stabilise each of the major clay types, we will be in a position to tailor a solution for each and every specific application. It is a straight-forward procedure for a soil laboratory or University to identify the clay types and amounts of mineral components, by conducting an XRay diffraction analysis. With solutions specifically tailored to the clay chemistry of each soil, we will be in a position to apply a product that will work far better than existing solutions and with a far greater degree of certainty and consistency.

The Market for Chemical Soil Stabilisers

Road transport network: The most obvious market is the road transport network worldwide. Road construction and road maintenance is one of the biggest expenditure items of governments and in countries like Australia, Canada and the United States, is often the biggest expenditure item of local Government accounting for up to 50% of the total budget. Methods of constructing roads have changed in that sophisticated stabilisation machinery is used in developed countries, yet the majority of roads are still constructed using a grader, water tanker and roller (compactor) as they have been for many decades now. Irrespective of how roads are constructed road failures still occur at unacceptable levels. The increasing pressure on the available tax dollar is currently making road engineers in most countries, look more closely at how they build and maintain roads, and the pressure is on to find an alternative low cost method of construction.

The tried and proven methods of using crushed aggregate and/or cement or simply lime, are not applicable or available in many locations. Every kilometre a truck load of road base/ crushed aggregate has to be hauled, adds to the cost. In many third world developing countries and remote areas, the hauling of road materials is not an option because of cost. This means that roads must be made from the available 'in situ' material which often has a high clay content. In colder areas of the Northern Hemisphere, the use of

cement stabilisation is severely limited because of the problems of frost heave. Once a cement bond is broken it cannot reform. Repair of a cement stabilised road in these circumstances is a major problem and increases the expense of road maintenance. The major cost in the northern hemisphere of new road construction while very high, is not as debilitating as the recurring maintenance costs that recur annually.

"Once a cement bond is broken it cannot reform. Repair of a cement stabilised road in these circumstances is a major problem and increases the expense of road maintenance."

In road construction there are several market segments:

Road Base Stabilisation: The stabilisation of the actual layer of road material from which the road is constructed.

Yards: There is also a very big market for stabilisation of yards, e.g. timber yards, Council yards, machinery yards, transport / Freight Company's yards, etc. These frequently have forklifts or loaders turning as well as heavy trucks, so stabilisation and surface abrasion (dust) are major factors

Sub Grade Stabilisation: The 'in situ' ground on which the road is built, for example in much of the prairie country of Canada the soil when wet has very low bearing capacity (CBR of <2) which necessitates the roads being designed with extra layers or thicker layers of sub base and road base at great expense. City of Calgary engineers have advised us that if we can double the CBR of the 'in situ' soil to at least 4, it would save millions of dollars in Alberta alone (and hence be worth huge sums of money).

Surface dust control: Bitumen/asphalt seal is the most common form of surface seal. On many roads sealing is not affordable. Also if a road is sealed and it is not properly stabilised or it is built on an unstable sub grade, sealing is often of little benefit as the road soon breaks up. Oil is widely used in Canada in particular, but it is not environmentally acceptable, and the push is building for a more acceptable alternative. In many countries the cost of maintaining sealed roads in remote areas is proving to be too high and they are being returned to unsealed gravel roads as with Saskatchewan. This is increasing the market potential for a cost effective, environmentally friendly dust control product.

Private Roads: Apart from the government highways and municipal roads, there are many mining and timber haul roads, farm roads and driveways.

Airports & Runways: Sub grade stabilisation as well as surface stabilisation on both commercial and private air strips.

Car Parks, Dam Walls & Embankments

Building and Construction: Stabilisation of building sites, loading bays and parking and access areas is a huge market segment.

Mud Bricks, Rammed Earth Wall, Adobe Style Buildings: Throughout the world, the advantage of earth as a construction material is becoming more widely accepted, particularly in respect of its insulating properties. In third world developing countries, the 2 resources which are readily available are soil/clay and labour. There is a great opportunity to develop a low cost housing system by the use of our Clay Brick Stabiliser chemical that can be used in conjunction with the 'in situ' soil/clay. Now that HydraForm International has developed their extensive and inexpensive range of compaction machines with force necessary to deliver the pressure required to compact the bricks, we are in the unique position to exploit this market also. Previously, there had been was a company in South Africa who tried this using a very expensive brick making machine from Germany back in the 1970s but it never came to anything.

The requirement of structural strength can easily be met, but the stumbling block in the tropics to date has been waterproofing of the outer walls to prevent erosion of the walls in torrential downpours in tropical

storms or typhoons. RoadPacker Australia was informed by the Indian Government in 1992/3 that if a suitable housing system could be provided, they would immediately contract for 4,000 houses. It has therefore been the major thrust of RoadPacker Group over the years to push ahead with a research programme to fully investigate the use of Ionic Soil Stabilisation [ISS]. We started from the strong basis of being able to use our existing RoadPacker Plus formulae as a base for the development of a new product that would allow us to fully embrace and exploit the enormous potential of this low-cost housing market. As previously stated, our Clay Brick Stabiliser does just that and we are now servicing the low cost housing markets in India, Africa, The Philippines and several other countries around the world.

Our Research and Development Program

We Believe We Are at the Forefront of Research and Development in the Field of Chemical Soil Stabilisation.

As mentioned earlier, virtually every supplier in this field world-wide is producing and marketing products based on out-dated formulations that are successful only in limited applications.

Our research is aimed towards several different outcomes. Clay Stabilisation: Most clays when wet become very soft and some can become very sticky. This is because of the amazing ability of clays to attract water (and ions) to sites of charge imbalance on the surface and interlayers of the lattice molecular structure of clays. Clays are referred to as layer silicates and they are made up of octahedra and tetrahedra, joined in layers in 1:1 or 2:1 layers.

Modern scientific research methods are unlocking the complexities of clay chemistry. To date, little research has been done on each of the major clay types in terms of the exact nature and extent of the charge imbalances and matching ions to precisely fit the spaces in the clay lattice to neutralise the charge imbalances. Alternatively it may be more appropriate to use these charged sites, to provide a binding site and provide a molecular bridge from one clay particle to another.

Research into clays is being done at Universities in many countries and some of the mining companies are funding research into drilling muds. The RoadPacker Group's plan is to use the best experts in the field to help us engineer specific research into the effects of various electrolytic solutions on the major clay types. Some of the research would be done by our consultant clay experts but some would be done in collaboration with University researchers, probably as PhD research projects. Funding would be sought from Government Agencies where appropriate, to subsidise this research.

Initial research would focus on the smectite and illite clays, two of the predominant clay groups and the principal clays found in the Northern Hemisphere, including much of Canada. Once the most appropriate electrolyte solutions have been identified, a systematic series of soil laboratory tests would need to be undertaken to determine the best concentrations and mix of the solutions to achieve the optimum results.

Soil Binding: Neutralising the charge imbalance sites on clay particles does not necessarily lead to chemical binding of the particles. Several different types of chemical bonds are possible and research is required to determine the most appropriate binding agents.

Soil Water Proofing: As well as chemical binding, our research has been under way on waterproofing of soil. This has major implications in respect of frost heave in the Northern Hemisphere, for dam wall construction and for mud brick/ earth wall construction. RoadPacker Group has after an extensive accelerated research programme, come up with a solution to enable us to completely waterproof soil. This has resulted in the government of China using our product in the construction of the country's many irrigation canals which require the product to be constantly under water.

The Research Program: Our research programme is now considered to be in 'permanent session'. The initial research we undertook we estimated would take 3 to 6 years and would deliver an ionic stabilisation product tailored to suit the chemistry of individual soils. We believe what we've actually delivered

to be significantly better than any other ionic stabiliser currently on the market. In December 1998, our chemists confirmed that they had completed their research into the total water-proofing of RoadPacker Plus & Clay Brick Stabiliser. This research will be ongoing as will the research into binding and water proofing agents being introduced into our RoadBond product. Our goal is to continue to improve our products and be the first to make our own products obsolete thereby remaining the world leader in this field.

Marketing: The RoadPacker Group will eventually appoint exclusive distributors in all countries of the world. It is our intention to utilise the power of the internet to establish a global network of exclusive distributors second to none. Initially these distributorships will be secured by the purchase of a minimum quantity of stock, one (1) full container load each of 80 x 205 litre drums. Obviously, in most cases, it will take some time for the new distributor to become comfortable and satisfied that the product works, however, with each new success, the accompanying testimonials will assist in smoothing the way. (We have some twenty (20+) distributors around the world at various stages of development).

Our products made from our existing formulae are selling at the moment and are measurably superior to those of our competitors. However, we still believe that when our research develops new products, the results of our testing program will prove to engineers that soils treated with our products will meet their engineering requirements and thus be specified for major contracts. Marketing of the products in these circumstances becomes a far easier exercise [i.e. they sell themselves].

Future Plans

Now that we have developed our new products and proven them in both the soils testing laboratory procedures and field trials, the potential to develop new building systems is enormous. With the world's best soil stabilisation products at our disposal we have the potential to set up world-wide subsidiaries in the building and construction/ contracting fields. There is also great potential to take on other new complementary products as a world distributor.

The earning potential in each of the market segments for soil stabilisation products is calculated in billions of dollars. We are firmly establishing ourselves as the undisputed world leaders in this field.

RoadPacker Plus

In both the public and private sectors of governments and municipalities the world over, great concern has been expressed for some considerable time regarding the deteriorating condition of vital road networks due to the lack of funding availability.

Each year the declining situation accelerates due to costly preventative maintenance not being carried out. Various interest groups (including special government appointed committees) are presently examining new or alternative road construction technology in order to identify more cost-effective construction and maintenance methods that will halt and reverse this trend. The use of chemical soil stabilisation is now seriously under consideration and many roads have been built and evaluated during the last ten years, with extremely encouraging results.

Governments world-wide have instructed their bureau of standards to conduct research into new testing procedures that would provide provincial and private road construction engineers and consultants, with an effective means of assessing, in advance, the extent to which chemical stabilisation will improve the mechanical properties of their materials. These new testing procedures have been identified and published. Undoubtedly, a major swing toward the use of chemical stabilisation will create the huge benefits inherent in using 'in situ' soils that would otherwise be unsuitable and require transporting away to waste.

Simultaneously, the need to import expensive, better gravels to replace unsuitable materials would be minimised. IONIC SOIL STABILISATION has been promoted in many third world countries for many years using SULPHONATED PETROLEUM PRODUCTS (SPPs) with documented levels of success. It was originally introduced from America to South Africa in the early 1970s. It was also introduced into South America and many other countries over the next twenty years. Originally it was used on a small number of secondary roads where little or no money was available for concrete or asphalt. However, during the past twenty years and in particular the last ten years, ionic soil stabilisation has become accepted as an alternative method of low-cost road construction in many countries.

To date, thousands of kilometres of roads world-wide, have been successfully stabilised using SPPs, some for private-end-users, but mostly for provincial, regional and municipal bodies where the engineers concerned, have monitored and kept effective records on its performance.

This is a new airstrip in Big River Saskatchewan Canada being prepared for treatment with RoadPacker Plus

This is the same airstrip after it has been treated and packed with RoadPacker Plus

RoadPacker Group has been working closely with Government departments, Federal, Provincial and City, world-wide and in particular, throughout Canada, dealing with the problems of the Canadian road construction industry. The main thrust of the programme, has been to highlight the benefits and proven savings of using soil stabilisers to construct/maintain their roads. The maintenance of Canadian roads, which suffer from the debilitating effects of the recurring sub-zero winter temperatures in Canada, is a constant drain on the nation's tax dollar. By using RoadPacker Group products RoadPacker Plus and RoadBond and RoadPacker Clay Brick Stabiliser, the government has been assured of annual savings in the maintenance budget, together with the reduced cost of new road construction projects using 'in situ' materials.

"RoadPacker Plus is completely environmentally friendly in its diluted form when added to water."

RoadPacker Plus in Road Construction

By the addition of RoadPacker Plus, the compaction process working on the ionised water vigorously exchanges its ions with the soil particles so that the pellicular water [i.e. ground water suspended above the water table in films that adhere to the surface of solid particles or the walls of cavities] breaks its electrochemical bond in an irreversible process converting to free water which then runs off and is compacted away. The ionic exchange process allows for a better orientation of the soil particles, reduces moisture and compaction energy and permits the gaining of maximum density. Due to this effect, the design California Bearing Ratio [CBR] penetration test is taken at the value corresponding to the maximum dry density. Soil stabilised with RoadPacker Plus loses between 30% and 90% of its moisture with respect to the Optimum Moisture Content [OMC].

The maximum dry density of the treated soil rises by up to 15%. The reduction of the porous - capillary structure and the

Completed runway after two days work.

permeability, enable the body of the road to conserve its density and bearing strength. The result of this effect is an improvement in the bearing capacity of the foundation of the road, which can be translated in important reductions to the box depth of each structural element.

RoadPacker Plus works in soils which contain clay particles; gravel and fines mixes containing per volume around 20% at 0.075 mm fines; in sand and fines, mixes containing 30% fines by volume. The amount of gravels embedded in the road achieves an increase in the density and bearing strength, a minimisation of capillary effect, a reduction in maintenance and lengthening of the life of the road.

The use of RoadPacker Plus on main highways and expressways is effective and its cost is more than covered by reduction in the structural elements of the pavement. With electrochemical stabilisation, local materials are made more useable, producing obvious savings in transportation and material costs. Comparing the cost of RoadPacker Plus stabilised roads with other conventional methods of construction and/or stabilisation, savings of 40 to 70% can be achieved.

RoadPacker Plus Soil Stabiliser How it Works and Testing Procedures

How RoadPacker Plus Works

An understanding of the properties of clay and of water, and the forces of attraction between water and clay resulting in the "diffuse double layer" of water surrounding clay particles, is essential to fully understand how RoadPacker Plus works to stabilise clay or soils and gravels which contain clay.

Water molecules are dipolar, i.e. they have a net negative charge at one end where the oxygen is located and a net positive charge at the other end where the hydrogen is located, so that each water molecule acts as a "bar magnet" which can align itself with electromagnetic forces or fields. It is this property which gives water its surface tension. It is also this property of water which enables it to be electrostatically attracted to the charges on the surface of clay particles. In some clays the forces involved in the electrostatic attraction between water and clay can result in forces up to 10,000 atmospheres. This is why the swelling of some clays can lift buildings off their foundations and why normal wetting and drying cycles of the road base, sub-base or sub-grade frequently cause road failure.

RoadPacker Plus is a very powerful ionising agent which ionises water and induces ionic exchange at the surface of clay particles. It contains powerful surface active agents (surfactants) which greatly reduce the surface tension of water, which greatly increases the ability of the ionised

water to penetrate soil. The initial action of RoadPacker Plus is as a dispersant. The ionised solution initially acts as a super plasticiser to increase the plasticity of the treated soil. This greatly increases the compactability of soil treated with RoadPacker Plus as the clay particles are able to be moved within the gravel more easily.

In soils treated with RoadPacker Plus the ionised solution penetrates the "diffuse double layer" of water surrounding clay particles. This brings more ions close to the surface of the clay particles, replacing the previously electrostatically held water, which causes much of the previously bound water to be released as free water.

Through the powerful ionising action of RoadPacker Plus, ionic exchange is induced at the surface of clay particles. This means that much of the water which is normally bound up can, after application of RoadPacker Plus, be drained away as free water. RoadPacker Plus therefore acts as a de-watering agent. In releasing previously bound water, RoadPacker Plus enables clay particles to be moved much closer together on compaction. After treatment, the "cushion" of electrostatically bound water which normally surrounds clay particles and prevents optimum compaction, is now expelled by physical compaction, enabling realignment of clay particles. RoadPacker Plus therefore acts as an extremely efficient compaction aid.

RoadPacker Plus enables optimum compaction to be achieved which reduces void space, and reduces the amount of water in the clay. Maximisation of compaction achieved by RoadPacker Plus increases clay particle interlock which results from the particles being realigned and pushed closer together. The process of ionic exchange induced by RoadPacker Plus is a permanent process, which permanently reduces the attraction between water and clay, and therefore reduces permanently the swell and shrinkage. It permanently reduces the Plasticity Index of the clay.

RoadPacker Plus also contains flocculating and coagulating agents, which over time increase agglomeration of clay particles. For instance RoadPacker Plus contains

Sulphuric Acid which reacts in the soil to create Sulphates. Aluminium Sulphate, Ferrous Sulphate and Ferric Sulphate are coagulating agents that neutralise the charge on the surface of colloidal (suspended in water) clay particles. Alum (a double sulphate of aluminium) is used world-wide as a water purifying agent as it takes clay (or mud) particles suspended in water out of suspension.

Some binding action takes place (cementing) in soils treated with RoadPacker Plus but this action is not immediate, taking place over several weeks, as does agglomeration which continues for several months.

Because the initial action of RoadPacker Plus is as a super plasticiser and dispersant any unconfined sample of soil will disperse in an "unconfined compressive strength test" (placing a block of compacted soil in water and after it has soaked, measuring its compressive strength). In reality gravel in a road is never "unconfined" as any part of the road is always "confined" by the surrounding gravel or soil. The Unconfined Compressive Strength test is only suitable for setting agents like cement, and engineers increasingly question whether this test has any validity.

RoadPacker Plus – How it Works

Testing of Soils for Suitability for Treatment with RoadPacker Plus

RoadPacker Plus alters only the clay in soil because only clay has the lattice molecular structure with an electrostatic charge on the surface (sand, silt and rock do not possess this characteristic). Therefore determining whether a soil will respond to treatment with RoadPacker Plus is a matter of determining the amount of clay, and the nature of the clay, in the soil. Determination of the percentage of soil passing the 75 micron sieve, and the Plasticity Index of the soil will give an indication of the amount and type of clay in the soil. Ideally at least 18% of the soils should pass the 75 micron sieve and the P.I. should be at least 3.

There is however one test which provides the best measure to determine whether a soil will respond to treatment with RoadPacker Plus and this is the Linear Shrinkage of the soil. If the 'Linear Shrinkage" is 2.5 or more, the soil is suitable for treatment with RoadPacker Plus.

The other test which should be done on any soil to be treated is soil pH. The normal formulation of improved RoadPacker Plus is acidic and is suitable for soils with acid or neutral pH. The acidic product will most likely have reduced effect in any soil with a pH over >8 as the alkali in such soil will neutralise the acidic RoadPacker Plus solution. A pH neutral version of RoadPacker Plus is available for soils with pH of greater than >8.

Procedures for Testing the Results of Treatment with RoadPacker Plus

In testing of the results achieved in enhancing the performance of road-bases, sub-bases and sub-grades by treatment with RoadPacker Plus soil stabiliser there is often a lack of understanding of how it works to stabilise soils and therefore there is often a lack of appropriate testing procedures. Many of the standard tests are designed around cement stabilisation and are applicable to setting agents like cement. It is therefore necessary to understand the difference between cement stabilisation and ionic or electrochemical stabilisation achieved with RoadPacker Plus.

Cement Stablisation and Testing

Firstly it must be understood that RoadPacker Plus is not a setting agent like cement. As a setting agent cement forms bonds which are rigid when set. Once the cement bonds have been broken they cannot reset, as evidenced when a crack occurs in a concrete slab. In cement stabilised clay/soil normally 2-5 % cement is used which provides sufficient bonds to increase the bearing capacity and cohesive strength of the treated soil. Up to 5 % cement is, however, insufficient to fully waterproof the gravel so that variations in the moisture content of the cement stabilised soil will still occur (wetting and drying will still occur). If cement stabilised soils contain expansive clays i.e. clays with high swell and shrinkage, the variation in moisture will still cause swell and shrinkage of the clay in the gravel and lead to progressive fracturing of the cement bonds.

A number of soil tests are designed specifically to measure the effect of setting agents like cement. One such test is the Unconfined Compressive Strength test. This test will only show an increase in unconfined compressive strength with

"setting agents" which form chemical bonds in the process of setting. (THIS IS NOT APPROPRIATE FOR SOIL TREATED WITH ROADPACKER PLUS).

Testing of Soils Treated with RoadPacker Plus

RoadPacker Plus increases compaction, increases soil density and increases bearing strength so testing should be to measure these. Tests of bearing strength or compressive strength (provided it is not an unconfined sample of soil) are appropriate for gravels treated with RoadPacker Plus. California Bearing Ratio (CBR) tests are appropriate to show the increase in bearing strength of gravels when treated compared with the same gravel untreated.

A 4 day soaked CBR test comparing the CBR in the same soil treated with RoadPacker Plus and untreated will indicate the increase in CBR (bearing capacity) achieved with RoadPacker Plus.

A note of caution should be sounded with regards to CBR results as with some good quality gravels, small changes in moisture content around the Optimum Moisture Content (OMC) can significantly change the CBR, so that a CBR by itself may be misleading. Ideally a series of CBRs should be done with moisture content varied from under OMC up to 2% over OMC, and plotted against moisture content, i.e. prepare a bearing strength/moisture graph. Apart from the soaked CBR test penetrometer testing of compacted soil when it has dried, whether in the laboratory or 'in situ' in the field is appropriate. Shear strength tests are also applicable.

RoadBond

RoadBond is Both a Binding Agent and Ionic Soil Stabiliser. It reacts with the surface of clay particles to modify the clay and reduce its susceptibility to water. As an "ionic Stabiliser" RoadBond relies on ionic exchange reactions to perform its expected functions satisfactorily. The active "ingredients" are calcium lignosulphonate and other ionic exchange agents. Sulphonate is derived from mineral oils (hydrocarbon chains) modified with sulphuric acid to form sulphonate. The sulphonate in RoadBond is in the form of a lignosulphonate, combining lignin, the natural polymer which binds the fibres in trees. RoadBond is a "surface active agent" (surfactant). Surfactants have the ability to form micelles in solution, which gives them their soap-like or detergent action.

RoadBond also binds the fine particles and increases compaction of the surface layer to prevent dust in roads, driveways, yards, construction sites and car parks. RoadBond is manufactured from a powerful natural organic binding agent. In its capacity as a compaction aid and soil stabilisation agent, it will increase soil density and bearing strength, while reducing voids plasticity.

In effect, it binds and compacts to create a hard, durable surface and prevent surface abrasion loss. RoadBond is a liquid concentrate that mixes in water for ease of application.

RoadBond is environmentally safe and is effective irrespective of soil type. RoadBond has been used since 1996 to treat roads in Canada, and was found to be impervious to the sub-zero temperatures of the frozen north, where recent winters were recorded as the worst ever in over 100 years.

The Problems of Unsealed Roads

Many unsealed roads do not have the ideal range and distribution of particle sizes to give a good load bearing capacity when wet (coarser particles) or sufficient plastic capability (clay) when dry to prevent material from breaking loose. All gravel roads, when dry, suffer some surface

abrasion loss resulting in dust because the adhesion between the particles is reduced.

Loose material on the road causes dust that blows away or washes away under heavy rain. Over time, the amount of 'fines' [i.e. smallest soil particles important for binding the soil together] in the road is reduced and gradually more and larger particles break away.

The loose surface becomes prone to increased dust, pot holing and corrugation, making the road uncomfortable and dangerous to drive upon. Ongoing maintenance is expensive and in time the fine binding soil is lost and the road deteriorates faster requiring more regular maintenance.

Calcium compounds have a binding action in soil (whereas sodium is dispersive), and the major chemical stabiliser used worldwide, e.g., cement, lime and calcium chloride is calcium based.

RoadBond thus stabilises and binds the soil by combining the strong, effective binding actions of calcium and lignin.

RoadBond also acts as a compaction aid to increase compaction of soil. It incorporates sulphonated hydrocarbons that have a high level of surface activity and imparts an electrical charge that induces ionic exchange in clays with high cation exchange capacity (the less stable clays). This modifies the clay, reducing its electrostatic attraction to water thereby enabling greater particle realignment to increase compaction and stabilise the clay.

While it acts as an Ionic Soil Stabiliser, the principal stabilising action of RoadBond is through its powerful binding action, so that unlike ionic stabilisers, it still performs on soils that do not respond to ionic exchange agents.

The 'fines' and aggregates are bound together in roads treated with RoadBond. However, the bonds are not as rigid as cement bonds. Trees, in which the fibres are bound by lignin will flex and return to their original shape whereas concrete is prone to cracking when flexing occurs. RoadBond treated roads, therefore, display the best characteristics both of a bound pavement and a flexible pavement.

RoadBond is compatible with cement and lime stabilisation and effectively enhances their performance. Calcium lignosulphonate (on which RoadBond is based) is used in the refractory, ceramics and concrete products industries to provide increased compaction and adhesion.

This sub-grade will be covered with 12 inches of pitrun and then crushed gravel, before the asphalt paving is applied.

RoadBond is easy to apply by simply adding to water at the required dosage rate. Standard machinery such as water truck, roller and grader, is all that is required.

Ideal results are achieved with stabilisation machines. For surface dust control only water spraying equipment is required.

Soils Suitable for Treatment with RoadBond

RoadBond can be used on all soil types but best results are achieved in soil with near to ideal Particle Size Distribution with 12 -15% clay, although RoadBond is effective in soils with much higher clay content. If soil is mainly silt or sand, lacking clay, and prone to corrugation, higher dosages are required to provide additional binding. RoadBond is effective irrespective of soil pH.

This picture shows 52nd Street S.E., Calgary, Alberta, Canada, paved after sub-grade stabilisation using RoadBond.

RoadBond stabilised roads will remain maintenance free for a minimum of 12 months and in many instances several years longer. All unsealed roads however, will suffer some surface abrasion loss which contributes to dust. The surface of roads containing less than 12% clay will normally break up and dust faster because binding soil is lacking.

RoadBond and the Environment

As it is based on natural binding agents, RoadBond is non-toxic and environmentally safe. The base ingredient, calcium lignosulphonate, is used as binder in animal foods. Furthermore, some 800 drums of RoadBond have been successfully applied to roads throughout Canada for government and private sector projects.

RoadBond – How it Works

A Definitive Report on RoadBond and its use as an Ionic Soil Stabiliser/ Dust Suppressant.

How RoadBond Plus Works
In the final analysis, use of RoadBond as a surface treatment is ideal because of its dust control properties. This however, does not make it any less effective as a sub-base or sub-grade treatment. The binding and ionic exchange properties apply equally well in all applications provided the soil falls within certain parameters [i.e. in terms of particle size distribution and specifically some clay content].

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RoadBond reacts with the surface of clay particles to modify the clay and reduce its susceptibility to water. As an "Ionic Stabiliser" relies on ionic exchange reactions to perform its expected functions satisfactorily.
The active "ingredients" are calcium lignosulphonate and other ionic exchange agents. Sulphonate is derived from mineral oils (hydrocarbon chains) modified with sulphuric acid to form sulphonate. The sulphonate in is in the form of a lignosulphonate, combining lignin, the natural polymer which binds the fibres in trees.

RoadBond is a "surface active agent" (surfactant). Surfactants have the ability to form micelles in solution, which gives them their soap-like or detergent action.

The lignosulphonate molecules can be described as consisting of a sulphonic moiety which is soluble in water (and is hydrophilic) attached to an aromatic hydrocarbon ring and aliphatic hydrocarbon chain. The hydrocarbon component can be considered as a hydrophobic tail attached to the sulphonic acid head. This type of structure is typical of many surfactants, with the sulphonic acid derivative being recognized as one of the strongest cation exchangers.

Three specific properties theoretically make RoadBond extremely useful for soil Stabilisation:

1. Its ability to fix, displace or replace exchange cations in clays.

2. Its ability to waterproof soil materials (particularly clay but not necessarily clays only) by displacing adsorbed water and water of hydration and preventing re-adsorption of this water.

3. Its ability to bind clay and granular particles.

As our knowledge of clays and the complexities of the clay water relationship has increased and improved ionic soil stabilisers such as RoadBond have been developed.

Carbon Exchange
RoadBond can be considered as an anionic surface active agent. It is highly susceptible to ion exchange reactions in which appropriate inorganic ions present on mineral surfaces (particularly clays)

and in clay interlayers are replaced by, or attached to, the organic molecules. This reduces the mobility of the ions and effectively reduces the plasticity of the material. The bonding of the sulphonic molecule may be through a number of mechanisms, such as direct chemical bonds (between the SO_3 anionic head and a metal cation at the surface), inductive bonds (between an uncharged oxygen ion in the sulphonic group and a metal cation), occupation of a vacant ionic site in the mineral structure by the lignosulphonate or dissolution of the head in the diffuse double layer of water surrounding the clay particles.

These processes are given in a generally decreasing order of bond strength. Various chemical factors, such as the valence, hydration state and ionic radius of the incumbent cations and the pH of the solution, affect the tendency for the various exchange reactions and bonding processes to take place.

The lignosulphonate in RoadBond is a particularly active ion exchanger because of its surfactant properties and large molecular size and can displace most inorganic cations.

Waterproofing Capability

Once an ion exchange reaction has occurred and the lignosulphonate moiety has attached to a mineral particle, the so-called hydrophobic tails of the lignosulphonate are directed away from the particle and form an oily protective layer around it. In theory, this has the effect of reducing the thickness of the electrical double layer or hydration layer and of preventing water from gaining access to the mineral particle. With this reduced double layer thickness, it now becomes theoretically possible to achieve a greater degree of compaction in the material and also to reduce the possible water adsorption of the material in the long term.

Surfactant Properties

Sulphonic acids and sulphonates are described as surfactants with the property of being able to reduce the surface tension of the solution in which they are emulsified. It is clear that when using RoadBond, the surface tension of water is significantly reduced.

General

For effective compaction of soils with high fines contents, the process of breaking down soil clods, is a major energy consumer. Any chemical which assists with this process would result in either a higher density for a given compactive effort or the same density for a lower effort. This reduction of clod strength can be achieved either by reduced surface tension, by increased dispersion or both mechanisms. RoadBond greatly increases compactability by both mechanisms. For a compaction aid to be effective it should reduce the strength of the material in some way. However, this reduction should be temporary in order to render the long term strength adequate. If the loss of strength is temporary and this effect is lost through biological activity, oxidation or adsorption onto clay particles, the compaction aid can be considered to be of limited benefit. (Through the ionic exchange reactions and the binding properties of lignin in the soil, RoadBond has a lasting effect in binding

soil particles).

Action of Iconic Stabilisers RoadBond
In the context of soil stabilisation with RoadBond, the material to be treated should have an adequate quantity of a suitable clay mineral (not necessarily clay-sized fractions). This clay will have an appropriate cation exchange capacity and the cations should be capable of being exchanged (some clays, particularly micas and illites, "fix" potassium, which is then not easily displaced or removed). It should be noted that it is the clay minerals with their unique plasticity and water adsorption characteristics which tend to render many materials inappropriate for road construction and that neutralization of their water susceptibility is probably the main priority.

However, recent investigations in South Africa have shown that apart from the actions of sulphonated oils or sulphonates on clay minerals described above, a number of other reactions may take place. This means that certain materials which are inherently weak, not necessarily as a result of their clay content, could also be improved by the use of ionic stabilisers.

Soils Containing Hydrous Iron and Aluminium Oxides
The amphoteric nature of these metal oxides (i.e. variation of charge with pH) results in the potential for ionic exchange to occur. There is a very good possibility of some lignosulphonate being adsorbed onto them. Although iron and aluminium oxides in themselves do not contribute to plasticity as defined, they do have the susceptibility to hydrate by adsorbing water. This results in a reduction in their shear strength (although compaction efforts are reduced). It is also suspected that drying of iron and aluminium oxides treated with RoadBond would result in higher surface tension effects, resulting in an effective strengthening of the materials

One of the strongest bonds affecting the attachment of the lignosulphonate molecules to soil particles is the direct ionic bond between the anionic SO_3 head of the molecule and metal cations at the surface of the soil particle.

RoadPacker Clay Brick Stabiliser

Stabilised Earth Brick (SEB) technology
The primary purpose of the RoadPacker Stabilised Earth Brick (SEB) technology is to produce low cost housing for the poor of any country where there is a distinct lack of conventional housing. Its biggest advantage is that it is immediate. Not only can this procedure be used in creating new communities of a permanent nature, it can be used in the event of a disaster being declared due to typhoons, flooding, earthquakes and any other disaster that renders people homeless.

The benefits of this system of house building is that a disaster rescue unit does not need many raw materials to immediately move into a declared disaster area and begin to provide the rudimentary requirements for a community to return to a position of normalcy.

By the simple movement of several mobile SEB making machines into a disaster area, the local government response unit can immediately begin to produce homes, schools and even hospitals to accommodate the homeless population.

All that is required, is a SEB machine, some RoadPacker Clay Brick Stabiliser (C.B.S.) and the local soil from the side of the road or near-by fields. If there is already a machine in place and an adequate supply of C.B.S., then reconstruction of the homes can begin immediately.

Should the equipment not be in place, then the SEB machine and the RoadPacker C.B.S. can be brought into the area as emergency relief equipment and supplies. Another option is to move in the finished bricks from an off-site location.

SEB Machine Specifications
The SEB machine is easily transported to a construction site and can immediately produce high quality, interlocking bricks made from the 'in situ' (local) soil, by using the unique interlocking features.

The LCH Technology allows "dry construction" [i.e. no mortar is required to hold the bricks together]. Made from soil treated with the RoadPacker C.B.S. product, the RoadPacker Stabilised Earth Bricks [SEBs] can be used almost immediately, after curing. The fast, reliable and easy to handle, SEB machine, will allow for low cost construction of high quality houses with unskilled labour.

The construction of a 50 square metre house requiring 5,000 Stabilised Earth Bricks [SEBs], can be achieved in three or four (3 or 4) days and will be of the highest standard. The home will also be heat resistant, sound proof and completely stable.

Made of 'in situ' soil plus RoadPacker Clay Brick Stabiliser (C.B.S.) and compressed at over 6000 lbs PSI, the block size is consistently +/- 200 mm (length) x 200 mm (width) x 100mm (height) weight +/_12kg and the MPA is > 8 mpa.

RoadPacker SEB technology, the following procedures must be adhered to:

- A soil that contains 15%> percentage of clay, must be used (pure sand will not work nor will lahar). If inferior soil/ clay/lahar is to be used, then a clayee material will have to be imported and properly mixed with the 'in situ' material.
- Mix the soil with 0.2 of a litre of RoadPacker Clay Brick Stabiliser per Cubic Metre (m3) of material/soil. (for foundations, 0.3 of a litre per Cubic Metre (m3) of material/soil is recommended).
- Adjust the hydraulic pressure then the treated material is placed into the machine and compaction begins.
- The lever that activates compaction is then operated and the process begins. The technology involved in this process is of the simplest type requiring no highly specialised labour to operate the equipment.

The application for this type of technology is endless, not only is suitable for the emergency disaster low cost housing projects, it can also be used to construct quality type homes for the middle to upper cost bracket. The unique isothermic features of the RoadPacker Clay Brick Stabilised home allows for whole villages and sub-divisions to be constructed.

An interlocking clay block

RoadPacker Stabilised Earth Bricks [SEBs] are firmly interlocked on the top, bottom and sides. A wall built with SEBs is extremely strong and highly isothermic. Each block is perfectly extruded and all blocks are of the highest quality. There is no available technology that will allow you to build as fast, as with SEBs at such a competitive price.

Reasons why this Technology Should be used

SEBs allow you to use the most abundant raw material on earth, namely soil! The SEB uses only 0.2 litres of RoadPacker Clay Brick Stabiliser per m3 to be mixed with the soil to stabilise it. The blocks being strong and highly compacted, are of the highest resistance (>8mpa) nd do not require the use of any reinforcing bars to build a completely strong durable dwelling of up to 2 floors.

SEBs can be produced on the construction site, which negates the need for transporting the blocks and thereby reduces the risk of damaging the already "paid for" blocks. This technology utilises unskilled labour to manufacture the blocks, therefore, employment is provided for the indigenous population and costs are kept to a minimum. These houses require a minimum of skilled labour to build. A professional bricklayer supervising the job will be sufficient; all other workers can be unskilled from the surrounding area.

SEBs are of a quality so high and a finish so good, that most of the builders do not plaster or paint the external walls. Furthermore, because of the high standard and finish, the majority of the low cost housing units built can be left with the internal walls not painted.

A RoadPacker SEB house is totally isothermic to the extent that neither

the heat nor the cold will affect the comfort of the occupants. Should the occupant decide that they wish to install air conditioning, then their electricity bill will be minimal due to this constant temperature effect.