



ABILITY CONSTRUCTION NOTE FOR *SPECIFIERS*
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DURABLE, INTEGRALLY COLOURED, CAST-IN-PLACE CONCRETE

PIGMENT PERMANENCY OF THE MINERAL (METAL) OXIDE TYPE - THE BEST TYPE OF ALL?

QUESTION: Is the *permanency* related to UV light resistance of all 55 odd brands of colouring mineral oxide powder pigments available throughout the world which are used to make barrel mixed integrally coloured concrete the same? Example: brand 'X' versus 'abilox®' from Ability.

With our day-to-day problems, stress and the competitiveness of current industrial commercial and economic life particularly in the building, coating, plastics and allied industries it's easy to forget that, provided they have a similar chemical specification and are compared by testing in the same binder/medium/vehicle which has demonstrated the same degree of integrity and durability, the light-fastness and *permanency* of virtually all brands of inorganic mineral oxide type pigments are the **same** - no more, no less! They are absolute.

The chemically inorganic, absolutely light-fast mineral (or metal) oxide colouring pigment type includes iron, titanium and chromium oxides, cobalt blue and manganese dioxide powder. Most of these pigment powder colourants have been used from antiquity and are incorporated daily by adding and thoroughly mixing them into many grades and classes of pre-mixed concrete, mortars, grouts, asphalt, baked clay products, coatings, sealants, plastics, rubbers and other bound composite materials and building products - to make them permanently coloured.

One of the many benefits of mineral oxide pigments are their exceptionally high UV light absorbency, dissipation and overall resistance to degradation characteristics. They therefore feature exceptionally long-lasting qualities. Also when properly mixed and encapsulated into paints, inks, caulks, adhesives, plastics, rubbers and other composite materials they substantially protect chemically organic rosins, resins and polymers when used as binding media in these products/materials from UV degradation and spoilage over time - thereby markedly enhancing their total durability.

Concrete is a composite material and with the large range of grades and classes of chemically inorganic, pre-mixed concrete available, the incorporation of ultra-fine grain, insoluble colouring pigments of this mineral oxide type such as those in Ability's 'abilox®' range, generally neither detract from or substantially add to the quality and durability of their hydrated cement binders. The pigment 'holding' or 'locking-in' of these micro size/high surface area particulate colourants and their overall colour longevity in concrete is directly related to the adhesive binding quality and durability of these cement binders - the hardened 'glues' of pre-mixed concrete, mortars or concrete products. The degree of quality and durability of the concrete itself is also directly related to the quality of this cementitious 'glue' and is brought about by factors discussed overleaf.

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COST vs EFFICIENCY PER TIME:

Today, cost 'consciousness' is usually an important consideration in most industries. Therefore it may be well worth users or specifiers of these colourants in a particular usage system considering the degree of, or the intensity of colouration (tinctorial colour strength) per mixing and dispersing time, of different brands of mineral oxide dry colourants *at the same dose rate by weight. It is this colouring strength factor of oxide powder pigments for a given dose which can vary considerably from brand to brand.*

GENERAL USE - HIGH EFFICIENCY OF DISPERSION TO OBTAIN MAXIMUM INTENSITY OF COLOURATION PER UNIT DOSE FROM THE USE OF PIGMENTS:

Although other factors such as:

- the colourants' cleanliness of tone, (relative colour brilliance)
- the colourants' low or nil tendency for its pigment particles to severely 'cake' and/or stick together when transporting, storing and handling - particularly when it's used for colouration in pre-mixed concrete, concrete products, or other coloured composite product production processes to achieve, if required, an efficient free-flowing powder pigment dispensing/transport system
- lowest degrees of pigment dusting so that operator comfort is not jeopardised and that the work-place environment is kept as clean as possible and essentially dust-free
- the need to pigment or colour the product or material uniformly from batch to batch

are all important, it is virtually the single factor of *intensity of colouration* achieved with a given pigment by means of the degree of pigment dispersion per dose amount and the resulting amount of dollars spent, that is today, pre-eminent in most people's minds and is, more than ever, of significant economic importance.

PIGMENT PARTICLES - SOLID, SUB MICRON SIZE GRAINS WHICH REQUIRE THOROUGH MIXING:

Being exceptionally fine, **non-soluble** solid particles in the form of a coloured powder, or powder processed into granules, neither of which dissolve in the material's binding vehicle, medium or carrier, 'abilox[®]' and other brands of mineral oxide pigments - in fact *all* types of pigments - are required, for satisfactory results, to be uniformly and thoroughly mixed, dispersed and de-agglomerated in the initially liquid binder.

Coloured material and product formulations, are therefore being updated and production managers, specifiers and users with initiative constantly, monitor the degrees of dispersion (and their relative ease of achievement) per unit dose

and time in the binding liquid and the resultant degree of the resulting colour development, colouring intensity and colouring efficiency of mineral oxide, as well as other types of pigment colourants, actually achieved in their various production or building/construction processes. As you may realise this monitoring is particularly important with very expensive pigments.

The true, effective dispersion process of all types of particulate, insoluble pigments (as opposed to soluble dyes) involves, by means of efficient mixing, the uniform distribution of their discrete, solid but ultra-fine particles in the binder of the material being coloured. For effective dispersion, pigment grains require to be almost completely de-agglomerated/de-flocculated by an efficient mixing (dispersion) shearing process - within the mass of the binder material being coloured so that they are 'broken up' - preferably into discrete separate particles and homogeneously spread throughout it.

Therefore, it can be regarded as a significant benefit for production/specifying personnel to use or specify a pigment which has been especially treated and processed to result in relatively easy ultimate dispersion in the shortest mixing and lowest mixer shearing time schedules.

'abilox[®]' powder pigment colourants are especially processed to result in this feature of easy, rapid and efficient dispersion. As a result, the 'abilox[®]' range gives the benefits of maximum colouration and opacity at conservative and *less costly* dose rates (which for uniformity and repeatability of results should be measured by weight - not volume and for easy comparison based as a percentage of the composite materials' binder weight).

For pre-mixed concrete the recommended mixing time when pigments have been incorporated is **10** minutes at the fastest barrel speed of a stationary transit truck mixer.

Incidentally, each 'abilox[®]' and similar brands of colouring pigment is different - one to the other not only in colour but price, colouring strength, particle size and shape and bulk density. Therefore, the ideal degree of dispersion and the time this takes may vary slightly for each specific pigment in the supplier's range.

IMPORTANT FACTORS TO BE CONSIDERED FOR THE EFFECTIVE USE OF CEMENT PIGMENTS IN CONCRETE - RELATED TO THE CORRECT PROCESSING OF THE CONCRETE ITSELF:

The visual colouration effect of tiny dispersed, permanent oxide pigment grains in hardened concrete, at any particular time of its strength development and maturity after it sets is not only based on the pigment dose rate, weight for weight of the cement or cementitious binding

material and the pigment's degree of dispersion within it per mixing time, but particularly on the qualities, distinctive characteristics, idiosyncrasies and properties - particularly the mechanical strengths - of the coloured *hardened* cement paste 'glue' or binder of the concrete itself.

In the case of Portland cement-bound concrete - pigmented or not - the quality, hardness, strength and durability of its hardened cement paste binder *is essentially based on the water-to-cementitious binder material (w/c) ratio* of that concrete in its wet plastic form. The lower it is - the better and more durable it will be.

Relatively *low* w/c's in concrete, its densification by compaction from the use of adequate vibration techniques to remove air voids from it following placement which are counter productive to its strength gain after it sets together with the adoption of *the procedure* of satisfactory moist curing will result in quality, durable concrete with the formation of very hard, strong and durable inorganic metal silicate binders (formed from completely hydrated cement) which effectively bind the aggregates together by a chemical process called concrescence and which have excellent long-term pigment particle holding qualities.

COLOURED WITH PIGMENTS OR AW CONCRETE THAT POTENTIALLY LASTS:

For good, effective and durable integrally coloured cast-in-place concrete of a particular strength grade or class, such as floors and pavements, factory made architectural precast coloured concrete units, structures and coloured concrete or mortar products and materials, it is therefore more important to ***'get the w/c, slump or degree of consistency, handling, casting, selection and use of a suitable procedure of curing and other site processing procedures of the actual concrete right'***. In particular to have a relatively low cement paste content per unit volume (by means of a low w/c ratio) and to use and/or specify the recommended grade or class of pre-mixed concrete such as that stated below together with the proper site procedures for its successful processing after its supply to the site in its plastic state by the pre-mixed concrete supplier.

FOR PAVEMENTS, WALLS & FLOORS IT WILL BE WISE TO ENSURE:

1. THE SPECIFICATION AND USE OF A DURABLE GRADE OF PRE-MIXED CONCRETE WHICH IS CAPABLE OF PERFORMING IN SERVICE TO EXPECTATIONS:

For general work we strongly suggest that the N32 (32 MPa compressive strength at 28 days) grade or *higher* of *non-bleeding* pre-mixed plastic concrete be specified and placed/site processed according to Australian Standard AS 3600-2001 'Concrete Structures' - compared with weaker grades such as N25 and N20.

This '32' grade should typically contain 300Kg. of fresh Portland cement Type GP - General Purpose (old Type 'A') binder (either normal grey, off-white or imported white shades) per cubic metre (m³) or an optimum weight of Type GB - Blended cement or a blended cementitious binder suitable for attaining this concrete strength grade.

It is worth noting that modern N32 (normal) or S32 (special) grade pre-mixed concrete is basically the old volumetric ratio mix design of 4:2:1 which has proven its durability for over 150 years. This volume batched grade consisted of:

4 parts by volume (pbv) of suitably sized coarse aggregate (C/A) usually 20mm - made from suitable crushed stone or the use of natural pebbles in that size

plus

2 parts by volume of fine aggregate (F/A)
- usually a *suitable* particle sized grade of washed concrete sand

plus

1 part by volume of FRESH Portland Cement.

PLEASE NOTE:

As stated the fine aggregate in this simple volume concrete mix design above is usually sand which should to assist in providing good workability preferably have essentially *spherical* particles, be clean and free from organic matter (washed) and in particular be of a coarse gradation rather than a fine one - an aspect which helps to keep the W/C ratio LOW for a given 'fluid' consistency/workability (slump).

2. NO ADDED WATER:

It is important *without* further water addition to ensure that:

proper discharge and placement of the low w/c ratio plastic concrete (without the occurrence of water bleeding to the surface or the segregation of the coarse aggregate) into a properly formed, excavated area for casting slabs or pavements into which has been added a sub-grade consisting of a suitable, very coarse bedding sand or crushed rock which is adequately dampened prior to placement [or for precast concrete products into suitable mould(s)/form(s)].

3. THE IMPORTANCE OF USING A MOISTURE BARRIER FOR FLOORS/PAVEMENTS AND THE INCORPORATION OF SUITABLE STEEL REINFORCEMENT FOR VIRTUALLY ALL CONCRETE STRUCTURES:

For floors and pavements the prior installation of the correct grade of plastic sheet moisture barrier underlayment and the correct grade of steel reinforcing mesh/rods/bars in place supported correctly on bar-chairs, prior to placement and site processing for all concrete is also important.

4. ADEQUATE COMPACTION OF PLACED CONCRETE:

Satisfactory compaction by vibration with the use of an immersion (poker) vibrator, vibrating screed bar or in thin sections with a spiked roller and for some types of pre-cast concrete – form/mould vibrators or other suitable vibrating method/equipment to densify the plastic concrete by *removing all air bubbles*, [10% of which for example on a volumetric basis in any hardened concrete are adverse and will reduce its compressive strength, load bearing capacity as well as its abrasion/wear resistance by the substantial amount of about 50%] is an important procedure!

5. SKILFUL UNIFORM FINISHING AND JOINTING:

Proper finishing at exactly the right time during the setting period - which is essentially related to the concrete grade, *concrete* temperature and the prevailing weather - with the proper equipment to achieve the specified type of surface texture or smoothness, pattern imprinting etc. - such as a low-slip, low-skid broom finish, 'open' slightly textured wood float or smooth, semi-glazed steel float finish - *uniformly*, which with an adequate and long-term CURING procedure (a suitable moisture retention method of preventing the evaporation of the original mix water during the concrete's long hardening period to be commenced *immediately* after setting), will ultimately result in a very hard, uniformly coloured/textured and durable surface having high weathering, impact, abrasion and wear resistance.

In addition the provision of an adequate amount of, and satisfactorily deep, cut and tooled crack control jointing carried out with bolster tools during the site processing of the placed plastic concrete will minimise unsightly cracking appearing elsewhere in the slab or unit. Alternatively, the saw cutting of joints into and at preferably 1m centres to 1/3 of the concrete depth *within* 12 hours of placement (depending on the concrete's temperature and its grade/class) is an excellent alternative.

For the lowest possible occurrence of visible cracking in pavements why not consider specifying the incorporation of 1 or maximum 2 metre square, cut and tooled or sawn jointing? This together with the provision of isolation jointing at all walls, piers, fences etc.

should ensure that NO visible cracking appears anywhere and the concrete is therefore aesthetically pleasing to the eye - especially for attractive integrally coloured concrete pavements, floors and suspended slabs, precast concrete panels etc.

6. ADEQUATE LONG-TERM CURING:

A satisfactory curing procedure adopted to prevent the concrete's mix water (which should be as stated - as *low* as possible) from evaporating - preferably over a twenty eight (28) day period and longer, commencing *immediately* after final finishing/setting, is also *most* important. Efficient moist curing together with the previous items 1 to 5 ensures that the characteristic (*f/c*) design strength, (the 'N' or 'S' strength grade ordered from the pre-mixed concrete supplier) abrasion/weathering and concrete 'cancer' (steel reinforcement corrosion) resistance of the ultimately hardened concrete in place *will* actually be achieved.

Effective curing means the preferably complete retention of the water used to mix the concrete - especially under highly evaporative weather conditions. This procedure enables virtually all of the preferably *low* quantity of mix water to hydrate (chemically and permanently combine with the cement component) to, as a result make the strongest, hardest cementitious 'glue' or binder to bind the aggregates together into one composite mass. This water content should be, as stated, as low as possible compared with the cementitious content (ie the lowest w/c ratio). On a weight for weight basis for example the water content should be certainly no more than 55 litres (= 55kg) per 100kg cementitious material, ie a w/c ratio of 0.55.

NOTE WELL:

The lower the w/c ratio the lower the cementitious paste content per unit volume of concrete and with a given dose of pigment, properly dispersed the *stronger* the colour (ie the intensity of the coloured concrete result).

The 'criminal' practice of adding extra water to a transit truck load of pre-mixed concrete on arrival at the site or pre-casting yard (thereby increasing the w/c ratio to avoid the use of the mandatory process of vibration and compaction and to make placement and finishing easier) to result in weaker, higher shrinkage - and therefore, poorer crack resistance, poorer quality, non-wear and non-weathering resistant, non-durable and weakly coloured concrete, can be avoided by specifying/using Ability's '**Cosmotron®**' DPU-AC.

This is an instantly dissolving, high purity, water reducing, *super plasticising* high range powder admixture for concrete. Alternatively the multifunctional and super plasticising chemical admixture, 'Efflorein®' Mark 2 powder may be used. Either product* or to achieve ideal results in un-admixed concrete, preferably **both** - added separately and well mixed in at the recommended dose, may be added to the plastic concrete preferably during official constant architectural/engineering inspection and *supervision*, to (say) grade N32 plastic concrete ordered at a 40mm slump. The addition of both of these Ability admixtures at optimum dose rates and with adequate *additional* mixing, should with thorough prior testing ensure that this plastic concrete has a semi-flowing consistency and can be placed at a typically normal, paving contractor - acceptable, 80mm-100mm slump **without** the addition of extra water.

PLEASE NOTE:

Comprehensive testing and evaluation of these admixtures prior to actual use is essential.

One of the best ways from a convenience point of view of preventing the evaporation of the concrete's mix water is to apply to it's finished surface *immediately* after the final set has occurred, a single coat or layer of a good quality liquid film-forming curing compound (curing 'membrane') such as Ability's '**Duro-Seel**'. **THIS MUST OCCUR ON THE SAME DAY AS CONCRETE PLACEMENT - AS SOON AS THE FRESHLY FINISHED CONCRETE HAS SET TO THE DEGREE THAT THE COATING APPLICATION WILL NOT AFFECT, MAR OR DISTURB THE IN-PLACE CONCRETE SURFACE.**

* Further printed information for Ability's high purity powder grade rapidly dispersing super plasticiser (high range water reducer) '**Cosmotron®**' DPU-AC and the efflorescence (white salt bloom) controlling and multi-functional '**Efflorein®**' Mark 2 powder admixtures for concrete is available upon request.

For an optimum curing job, with the use of an approved curing compound coating (having a low moisture vapour transmission rate, thus helping considerably to prevent most of the mix water from escaping from the concrete as vapour during the long hardening period of 28 days and longer) and also to completely and very effectively coat, seal and protect the concrete in the long term, a *second* coat of 'Duro-Seel', in a colour grade if required or clear may be applied as early as possible as a protective 'sealer' coat - usually if the weather is 'kind' in allowing the initial application to dry *completely*, on the day following the initial curing application.

'Duro-Seel' is available as a transparent clear product and in 20 standard colours including 'white' and 'concrete grey' as well as custom

colours which may be made available, with a minimum quantity of 200 litres by prior arrangement on firm advance order.

There are now numerous in situ concrete paving projects in Melbourne and elsewhere in Australia where two (2) coat decorative coloured 'Duro-Seel' sealer coated concrete pavement jobs which constantly experience light to medium foot traffic have successfully endured over 12 years, are still in excellent condition and performing extremely well today.

Even if these special 'Duro-Seel' curing/coating compound applications are not maintained over the years by re-coating with the same product and therefore gradually disappear by natural weathering and abrasive forces (*without* unsightly 'flaking' or 'peeling'), the coated concrete and particularly its surface, under the coatings, is most hard, durable, wear and crack-resistant - and the integrity of original through colouration with suitable colourants is maintained.

The maintenance of a 'Duro-Seel' coating application on concrete may be effected at virtually any time quickly and easily by re-coating with fresh 'Duro-Seel' (after simple mop cleaning with a suitable detergent solution followed by adequate rinsing with clean water and drying only). No sanding or roughening to obtain inter-coat adhesion of the new application onto the old is required.

Incidentally, 'Weather-o-meter' artificial weathering performance tests conducted at the CSIRO, Division of Construction and Engineering at Highett, Victoria in 1984 indicated that the weathering resistance of two (2) coats of pigmented 'Duro-Seel' applied 24 hours apart to properly prepared, sound, surface-strong existing hardened concrete surfaces, to be typically in excess of 15 years before a single maintenance coat of the same 'Duro-Seel' is required to restore the original application to pristine condition.

CONCLUSION

Good integrally 'through' coloured, barrel mixed cast-in-place pre-mixed concrete compared with similar good, plain, *unpigmented* concrete can result in permanently attractive, elegant and decorative effects. 'Through-coloured' concrete can, with the use of suitable pigments that result in intense, pale but bright as well as pale pastel colours increase light reflectance. This assists safety of use, particularly for elderly people in low light conditions and at night with less lighting energy required and as a consequence therefore, may save energy and may save lives.

Alternatively the use of light-absorbing deep dark colour shades in concrete, reduces glare in people's eyes which could in some cases be dangerous as well as in certain cases can, together with the use of certain Ability concrete admixtures such as 'Efflorein[®]' Mark 2 powder and 'Cosmotron[®]' DPU-AC decrease its shrinkage and increase its water tightness, hardness, wear and weathering resistance, overall durability as well as impermeability to staining and or corrosive liquids.

PRINTED INFORMATION ABOUT ABILITY'S 'COSMOTRON[®]' DPU-AC AND 'EFFLOREIN[®]' MARK 2 ADMIXTURE POWDERS AS WELL AS 'DURO-SEEL' LIQUID COATING FORMULA AND FURTHER SENSIBLE RECOMMENDATIONS FOR SPECIFYING THE DETAILS OF SITE HANDLING PROCEDURES AND PROCESSING OF CAST-IN-PLACE INTEGRALLY COLOURED PRE-MIXED CONCRETE USED FOR FLOORS, PAVEMENTS, THROUGH-COLOURED ARCHITECTURAL IN SITU, TILT-UP OR FACTORY PROCESSED PRECAST CONCRETE AND ALL 'COLOUR-THROUGH' CONCRETE PRODUCTS IS AVAILABLE BY CONTACTING:

ABILITY BUILDING CHEMICALS CO
SUBSIDIARY OF AUSTRALIAN OXIDES PTY LTD

ABILITY ARE MANUFACTURES OF FINE, UV RESISTING 'abilox[®]' MINERAL OXIDE COLOURING PIGMENTS, ADDITIVES ETC FOR INDUSTRY: HIGH PURITY CHEMICAL ADMIXTURES TO MODIFY, PROTECT, DECORATE AND IMPROVE THE PERFORMANCE OF ALL GRADES AND CLASSES OF PRE-MIXED CONCRETE, MORTARS AND GROUTS TOGETHER WITH A RANGE OF SPECIALISED, LONG-LIFE HIGH PERFORMANCE, PROTECTIVE, DECORATIVE SURFACE TREATMENTS, STAINS AND COATINGS FOR CONCRETE AND OTHER BUILDING SURFACES AS WELL AS STRONG, LIGHTWEIGHT (SG:1.47) ADVANCED *LIGHTWEIGHT* COMPOSITE MOULDING/APPLIED FINISH MATERIALS SUCH AS THE EASY-TO-USE, MIX-WITH-WATER POWDER INVENTION CALLED 'cemlite[®]' HE.



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