



Admixtures

– An Overview

ARMCON
CERTAINTY: IN CONCRETE

In regards to concrete, what is Admixture?

Often referred to as the 5th ingredient, admixtures are formulated from various chemicals - generally in liquid form - but can be powders - and are added to concrete to improve the physical properties in the wet / plastic & hardened state.

POTENTIAL IMPROVEMENTS

(Depending on admixture type)_

In the plastic (workable) state

- Better mix workability
- Easier to place
- Easier to compact
- Improved cohesion
- Reduced segregation
- Bleed water reduced

In the hardened state

- Denser concrete
- Increased strength
- Improved durability
- Better frost resistance
- Volume stability
- Reduced permeability
- Reduced efflorescence
- Brighter colours

- Plasticisers / water reducers (simple view - makes water WETTER)

ARMPLAS 3000 - a high performance, low dose polymer based plasticiser / water reducer. (Dual function - above dose rate 250 ml / 100 kg cement - acts also as a set retarder)

a). Used as a plasticiser - i.e. to increase mix workability:-
(typical dose 150 to 200 ml / 100 kg cem.)

- mix is much easier to place & compact } faster placing & finishing
- easier to float / finish surface }
- good workability retention - longer open time for mix
- gives much better, more uniform finish } fewer rejects
- reduces surface blemishes / blowholes } less making good
- brighter colours where pigments in use } reduction in pigment possible
- stronger concrete via better cement dispersion

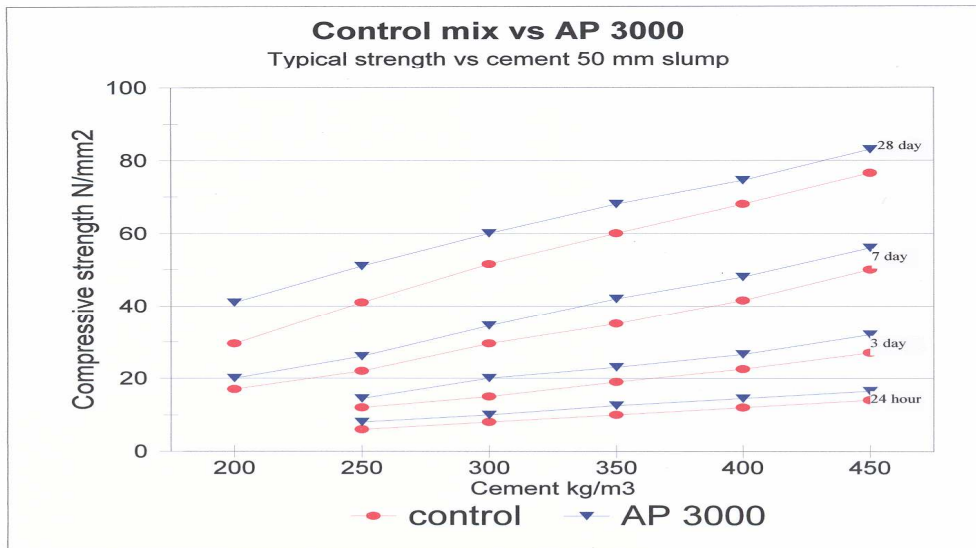
b). Used as a water reducer - i.e. same workability, lower water content (10 to 20% less) :-
(typical dose 200 ml to 300 ml / 100 kg cem.)

- mix is still easier to place & compact
- gives much better, more uniform finish
- reduces surface blemishes / blowholes
- higher strength at all ages (+10 to 25%) - reduced breakage levels
- economies possible via cement reduction (1 litre of admixture saves a significant amount of cement)
- brighter colours where pigments in use } reduction in pigment possible

See Diagrams below and on the next page for effect on strength and workability.

Figure 5

Cement kg/m ³	Compressive strength - N / mm ²							
	24 hr		3day		7day		28day	
	control	AP 3000	control	AP 3000	control	AP 3000	control	AP 3000
200	6	8	12	14.5	17	20	29.5	41
250	8	10	15	20	22	26	41	51
300	10	12.5	19	23	35	42	60	68
350	12	14.5	22.5	26.5	41.5	48	68	74.5
400	14	16.5	27	32	50	56	76.5	83

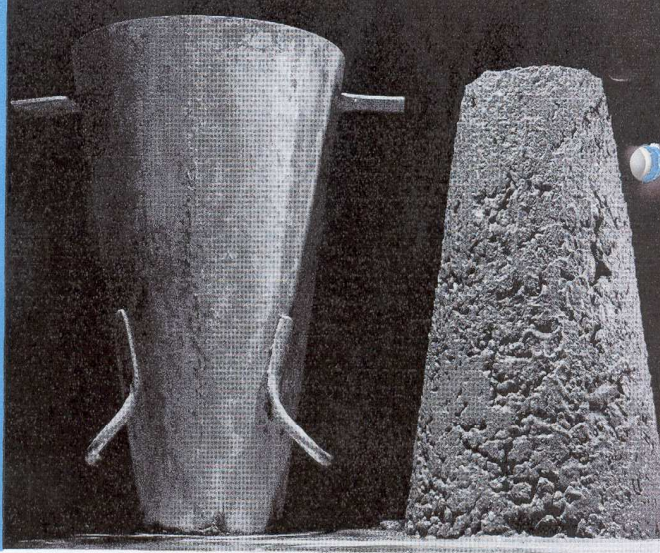


CONTROL

300kg
Cement/m³

w/c
0.57

slump
15mm

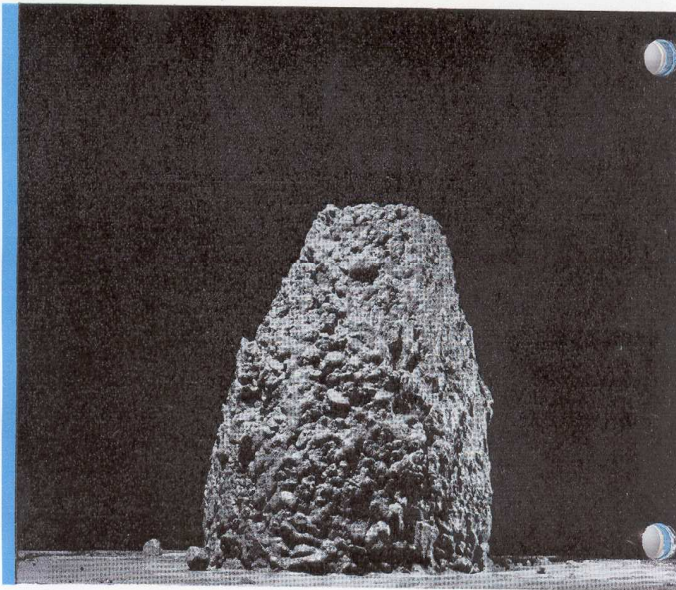


15mm slump

SAME
MIX

AP 3000
150 ml
per 100kg
Cement

Slump
75mm

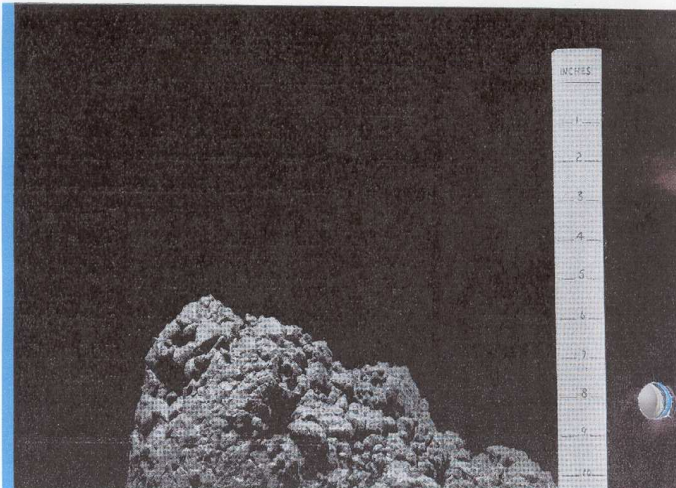


75mm
slump

SAME
MIX

AP 3000
300 ml
per 100 kg
Cement

slump
150mm.



ARMCON
CERTAINTY: IN CONCRETE

- Superplasticisers / High Range Water Reducers (simple view - makes water **EXTREMELY WET**)

ARMPLAS Superplasticiser XWR. This is a completely different chemical range to 'ordinary' plasticisers. Use at the same dose as **ARMPLAS 3000** & you will see no effect at all. This type of material is capable of much higher workability increase or water reduction effects - but is used at **5x to 10x** the dosage rate of normal plasticisers to achieve these dramatic effects without adversely affecting the set time.

SEE FIGURE below for comparison of plain mix & superplasticised mix being laid.

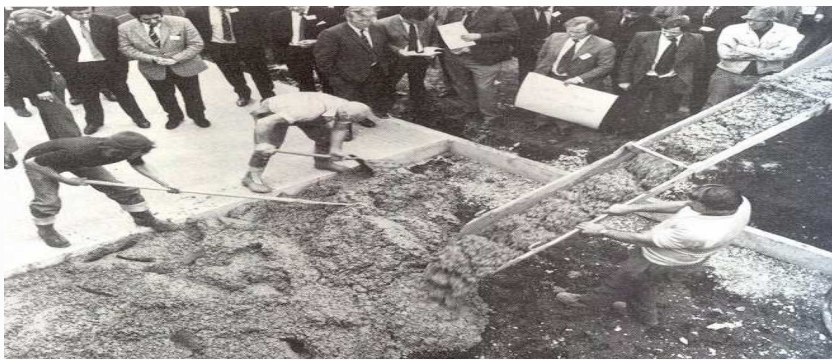
Ordinary plasticisers are incapable of achieving these workability effects - even if used at very high dose - the result would be a mix that did not set for days - 11 days being the worst effect I have seen personally.

a). Used to increase mix workability:- (typical dose 750 to 2000 ml / 100 kg cem.)

- minimal effort to place / compact } faster placing & finishing
- easier to float / finish surface }
- gives much better, more uniform finish } fewer rejects
- reduces surface blemishes / blowholes } less making good
- brighter colours where pigments in use } reduction in pigment possible
- stronger concrete via better cement dispersion

b). Used as a High Range Water Reducer - i.e. same workability, lower water content (20 to 40% less) :- (typical dose 1000 ml to 3000 ml / 100 kg cem.)

- mix is still easier to place & compact
- gives much better, more uniform finish
- reduces surface blemishes / blowholes
- much higher strength at all ages (+20 to 40%) - reduced breakage levels
- economies possible via cement reduction (3 litre of admixture/m³ saves a lot of cement)
- brighter colours where pigments in use } reduction in pigment possible



Photos showing the difference between concrete with and without plasticiser

- Accelerators

Various types / grades available. Generally required to be of chloride-free type, since chlorides promote rapid corrosion of steel reinforcement in concrete.

Types:

- i). Set accelerators with some early strength effects
- ii). Strength accelerators
- iii). Strength accelerators combined with plasticisers

ARMSET - is of the first type, and is an effective chloride free set accelerator, low dose, the effect depending on dosage rate used. **See Armset Diagram on next page for effect on set time vs control mix.**

a). Used as a set accelerator

(Typical dose 0.5 to 2.5% liquid vol. on cement wt. - i.e. 0.5 to 2.5 litres / 100 kg cem. - effective limit - 4%)

- mix sets faster allowing earlier trowel finishing
- allows work to continue in cold weather (< 5°C)
- permits earlier formwork removal, faster mould re-use
- speeds up production
- increased early strength lowers breakage rates, enables earlier handling and any subsequent production processes

b). Special uses

(Typical dose 3 to 6% liquid vol. on cement wt. - i.e. 3 to 6 litres / 100 kg cem.)

- Sprayed concretes such as gunite & shotcrete mixes to give rapid set to improve build up of successive spray layers & reduce material loss
- Fast set of foamed concrete / foamed mortar mixes used in trenchfill & emergency utility hole repair situations. Enables trench reinstatement / blacktopping in 4 hours @ 20°C. (In this application used in conjunction with **ARMFOAM**).

c). Drawbacks

1. Rapid set / stiffening may need changes to work practice (e.g. reduced mix size in precast) to utilise effects & may not always be possible
2. Can cause lime bloom on pigmented mixes - water proofer needed

ARMSET set time vs control mix

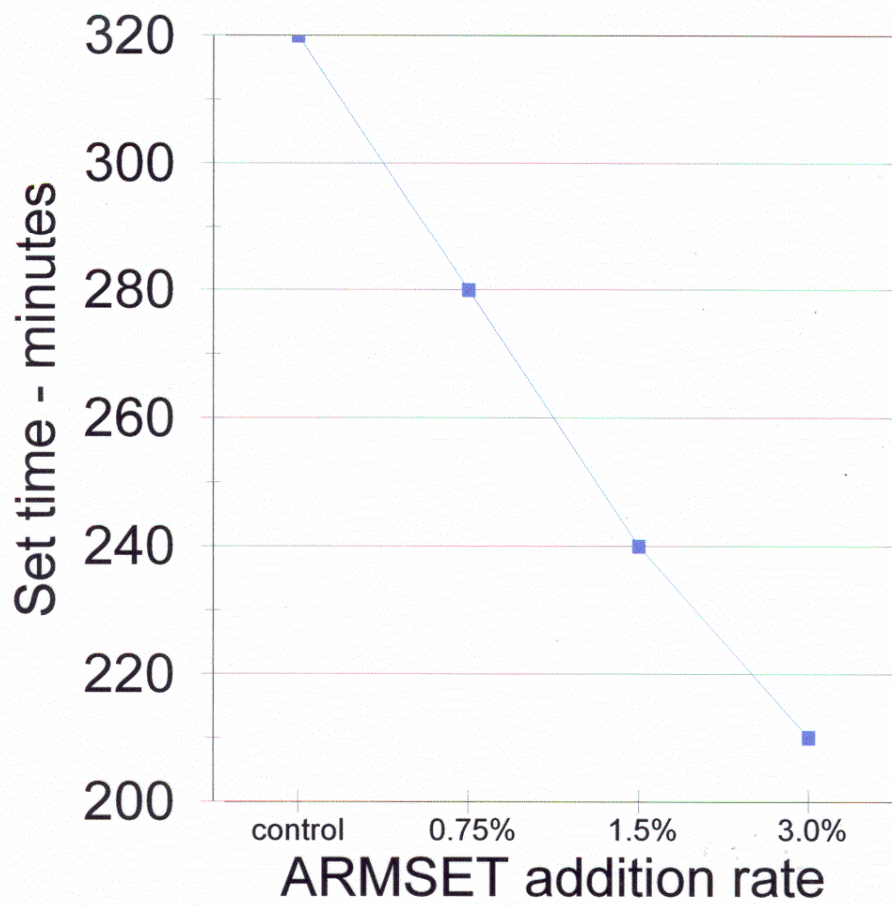
10°C mix / ambient conditions

w/c ratio 0.62

Cement content 260 kgs / m³

	set time (mins)
control	320
0.75%	280
1.5%	240
3.0%	210

ARMSET effect on set time



- Permeability reducers (preferred term to waterproofers for legal reasons)

ARMPROOF - a high performance, low dose permeability reducer / compaction aid. This literally is the Rolls Royce in this product area.

(Typical dose range 250 ml - 2000 ml / 100 kg cement - depending on application needs).

(See Picture on next page for use in cast stone to beat CAT requirements and graph below for Tarmac own test w/p & strength results vs SIKAL L1)

Designed for use in semi-dry mix instant demould applications - such as :-

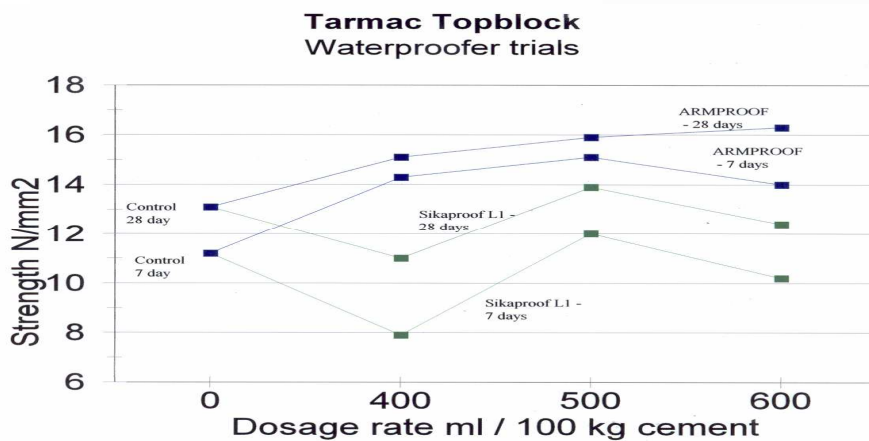
- concrete bricks,
- concrete blocks
- concrete paving blocks,
- cast stone,
- split stone
- ornamental garden units production
(in wet cast mixes it will cause air entrainment effects - strength loss effect).

ARMPROOF is designed to greatly improve mix response to mould filling and densification from the vibro-compaction methods employed in this type of product area production. Whilst also considerably improving the unit density of such products, this is accompanied by a disproportionately high increase in compressive and tensile strength - extremely useful in concrete paving block production where new British Standard introduced requires tensile strength testing that will need higher strengths than those currently obtained by most producers who will struggle to meet new Standard requirements. **ARMPROOF** also has excellent permeability / 'waterproof' properties.

Benefits :-

- Denser, stronger concrete - potential to meet new strength Standard in CPB production - or permit cement reduction
- Reduced permeability & efflorescence with brighter colours
- Faster mould filling - increases production output
- Liquid product - disperses more thoroughly in dry mixes than powders and no balling up effects
- More user friendly & safer to use - no dust nuisance as with powder grades

For areas where the waterproofing / efflorescence reduction effect is not required, there is another version called **ARMPLAS DRY** available for use in semi-dry mix work such as concrete block, brick production





ARMCON
CERTAINTY: IN CONCRETE

- Air entrainers

ARMAIR - this is a traditional wood resin based air-entraining agent - dosage level designed specifically for use with the Cementech continuous mixer rig.
(As a guide to trial work, the normal dosage range is 400 ml. to 800 ml/100 kg. cement).

This type of material produces the optimum bubble size and bubble spacing deemed to be necessary for negating the damaging effects of ice-caused freeze / thaw degradation of concrete occasioned by repeat freeze / thaw cycles. Ice causes the surface spalling of wet cast concrete if air entrainers have not been incorporated in the mix. (See picture below for comparative effect of frost attack between plain concrete & air entrained mix)

Target air content in an air-entrained concrete mix is $4.5\% \pm 1.5\%$ to be effective.

Entrainment of air causes a loss of compressive strength. If **ARMAIR** is to be used in a designated characteristic strength mix (e.g. - 30 N/mm^2 @ 28 days), then the following mix design adjustment needs to be considered :-

Mix design adjustment

A normal non air-entrained concrete has a nominal 1% air content.

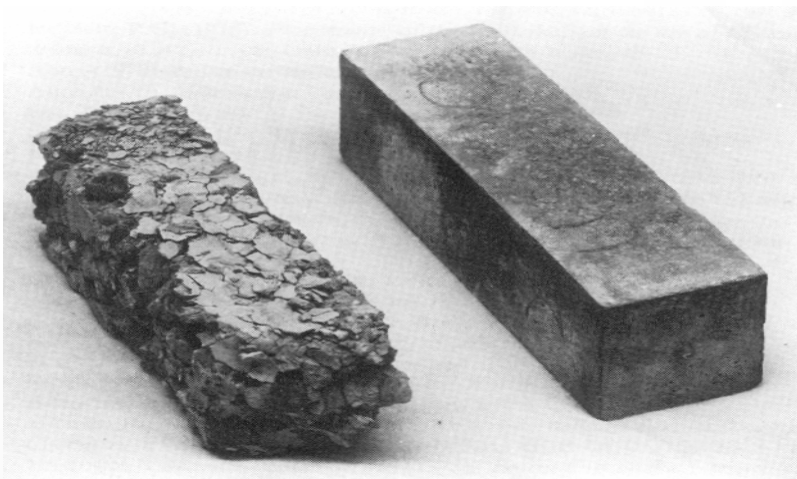
For every 1% air content above this, a loss of strength of 5% compressive strength occurs.

For say a 5% target air content mix - this is 4% higher than a 'normal' mix - so a 20% strength reduction (4x 5%) will occur - unless the mix is redesigned by increasing the cement content to offset this.

6 kgs of cement per $\text{m}^3 \equiv 1 \text{ N/mm}^2$ change in compressive strength. So in say a 30 N/mm^2 mix design - 20% strength reduction (6 N/mm^2) has at least a requirement to increase the cement content by 36 kgs / m^3 to maintain compressive strength. Reduce sand content by same weight to maintain volume yield.

If the concrete mix to be air entrained is a prescribed mix (i.e. fixed cement content – such as 300 kgs of cement per m^3) - then there is no need to adjust cement content, since no strength is specified.

ARMAIR can also be used as a mortar plasticiser at the above dosage rate.



The Effect of 300 freeze thaw cycles on air entrained concrete (right) and non treated (right)

- Foam agents

ARMFOAM - this is a foam agent concentrate - ideally suited to the augur type mixers such as the ARMCON supplied Cementech type to produce lightweight foamed concrete, but also usable in conventional mixers of the rmc, drum or pan type as found in all manner of concrete production units. The payload using an augur type mixer is 2x that of an rmc truck - so production / delivery costs are much cheaper.

Typical addition rate is 1 litre per m³ for use in lightweight concrete foam mix suppliers for trench reinstatement mixes for the utilities sector e.g. cable companies, gas companies, water companies, electricity companies. HAUC spec. for these mixes is either 2 N/mm² or 4 N/mm² @ 28 days. Foamed concrete / mortar is also used for cheap mass fill of culverts, tanks, embankments and pipes.

There are 2 methods of foam agent addition:-

a). by straight addition to the mix as a neat liquid via continuous pump (or can be pre-added to the mix water supply via inlet or main tank). This limits the final density achievable to the amount of energy imparted to create foam by the mixing action alone and would normally be in the range 1800 to 2000 kg/m³ vs normal 2350 to 2500 kg/m³.

b). by addition to the mix as shaving type pre-foam via continuous pump into a foam generator (also requires a continuous compressed air feed). This method is for the more serious foam concrete supplier - allowing greater control over the final density achievable and would normally be in the range 1400 to 2000 kg/m³ vs normal 2350 to 2500 kg/m³. Leads to even greater payloads and reduced mix costs. **See Diagram below for picture of 'shaving foam' consistency via foam generator.**

Advantages :-

- Foamed concrete trench reinstatement does not require the customary revisit to the site / road / pavement area after 3 months to make good the effects of fill settlement. It's done once which means minimal cost and disruption.
- If further trench work is required, the foamed concrete mix is relatively easy to break out which makes it perfect for road filling
- Recycled aggregates (such as crushed concrete & brick) can be very successfully
- used in foamed trench reinstatement mixes to reduce costs even further – maximising profits and meeting green energy / recycling requirements. *We have also successfully foamed mixes reusing the screened trench excavation material (in worst case, this needs use of a special plasticiser compatible with foam).*
- As stated earlier, **ARMSET** is also usable with **ARMFOAM** to produce fast set foamed mixes to enable same day reinstatement of trench / emergency excavations including blacktopping. The augur type Cementech mixers are much more suited to this area of operation, since unlike an drum mixer (rmc truck), they mix what is required when it is required - so high dose levels of accelerator are able to be used to obtain fast set times. An rmc truck is limited in this aspect, since accelerator of sufficient power to do this effect can set the whole drum contents - clunk ! (One continuous mixer operator type made a video (in conjunction with Transco) of a job done in Scotland at 0°C with horizontal sleet s howing a 'steaming' foam mix (**hot** water used) pouring into a ½ m³ emergency hole and being black topped in 15 minutes).



ARMCON
CERTAINTY: IN CONCRETE