A MIX TOO FAR? - A story of concrete in China

by Pete Male, Concrete Technical Consultant & Trouble-shooter.

Ring ring, ring ring……

"We need some help with some concrete in China", said the man at the end of the phone in Singapore,
"We're doing another job for Tesco, this time in China".
Knowing Chinese cements and how things work in China, "you must be mad" was my first response,
"you'll never get the concrete you lot need in China!"
"It's too late for that" said the contracts director, "we've got the job and we're doing it!" (Well, he is American)
"And we want you to sort out the concrete!"

So, never being one to resist a challenge, or perhaps just naive, I was heading for a week or 2, or so I thought, in Jiashan, a minor Chinese 2 horse town of some 300,000 souls, about 1 hour from Shanghai, that doesn't even have a swimming pool. Not good for a Jaishan summer in the high 30s.

I was familiar with what they needed from previous experiences when were sorting out a little delamination problem in Malaysia, hence my entitlement to make my initial comment.

The specification for the superflat floor is quite simple:
Strength requirement same as a RC35
Max W/C ratio 0.5
Max agg. size 20mm
Overall agg. grading must fit within their specified limits
40kg/m³ of 60mm cut hooked-end wire steel fibre
Abrasion resistance AR2
Retain initial workability for 5-6 hours, required for wide bay construction to ensure that each row that the Laserscreed pulls meshes with the next row.
Start to set in 12-14 hours
Must stand up under the Laserscreed and not flow away as the surface is levelled, essential for flatness.
No more than 200mm slump at batching and 140-160 at discharge, after the fibres have been added.
Set in a controlled, consistent pattern with no patch setting – this is an absolute no-no as the power trowels cannot get at the later setting patches without ruining the flatness of earlier setting areas.
And: "Must bleed sufficiently to wet out the dry-shake topping (used at a surface fibre suppressant), but not too much to retard the surface, affect finishing, contribute to delamination or weaken surface"

So not too difficult so far…….

"What choice of aggregates have I got?"
"Whatever the plant's using, it may be 16,000m³ but it's not enough to get the plant to change and they haven't enough storage space or bins for another agg".
"Oh".
"But we're assured that it's a good quality crushed rock and a dredged river sand from the Yangzi".
"Oh".
"Cement?"
"The ready-mix company produces its own so we'll have to use that".
"Oh".
"Isn't it what they call a Class II which has 15% of 'filler', which can be pfa, slag, burnt rice husks, processed cow dung, limestone, Feng shui or whatever - and they don't have to tell us how much of whatever?"
"Yes".
"Oh".

You realise what the Chinese rmc suppliers think of their cements when you notice that all rmc plants have their own full cement testing labs.

"Admixture?"
"They make their own".
"What, at the rmc plant?" As it turned out, this wasn't such a daft question.
"No, don't be silly, the CHINESE make their own".
"Oh, that's all right then"……..Little did I know at the time that it may not be all right then!

The "good quality crushed rock" turns out to be the shards from hell and the Yangzi sand varies from Zone 1 to Zone 3 - older readers will remember, younger ones will get my drift. The sand is generally quite good quality but its grading can vary from barge to barge depending on where in the river it happens to come from, and the Yangzi is a very big river. They just don't seem to understand basic quality control to provide a consistent grading "they don't see the need for it", said my translator, "EVERYONE knows that Yangzi sand is good for concrete!"
"But don't worry they have another fine sand at the plant that can be mixed in in varying amounts to get the grading right".
"Oh".
"Well at least it's straight discharge, not pumped".
"Ah, yes, we were coming to that" said the site manager, "as the floor is pile supported the sub-base is not strong enough to support the trucks, it's supposed to be, but this is China, so we'll have to pump"
"Oh".
"Not with the shards from hell, steel fibres and being at the W/C ratio limit you won't"
"Well, we'll have to".

2 weeks later after many, many trials and trying many, many different pumps we faced defeat.
Did I mention the 40°C ambient and 98% rh and that we had inside a well protected crinkly-tin shed?
"Don't want any nasty cooling breezes mucking up MY finish on MY concrete", said Bob, the finishing supervisor. Ownership is a good thing, so we always let him believe that it's his concrete.

Or the 'mains' water?
"But you're pumping it out of the canal?"
"Yes, that's mains water" said the translator.
"But we test it regularly"
"Oh."
"But sometimes it's green and sometimes it's brown, depending on the silt or algae".
"Well we can't use that" said I, in a naïve sort of way.
"But everyone uses it around here and there isn't anything else".
"Oh dear. How is it at the moment?"
"Brown".
"Oh."

"Are you absolutely sure we cannot use another supplier? Another agg. Another cement? Another anything?"
"No, all other options are too expensive".
"Oh".
So I asked the rmc supplier "anything we can do to reduce costs to give us some flexibility with materials?"
"How about dark concrete?" says my translator.
"You what?" I said in my best Worzel accent.
"Dark concrete?" can the reply, again.
Well, I really believed that I'd been around, seen most that concrete could throw at me, but this was a new one on me. Had it anything to do with that Feng shui option?
"Concrete delivered in the dark", my translator eventually came up with after I had seriously though I was past it and should have retired last year after all.
"It's cheaper at night because we are not so busy".
"Oh".
"And we can put more concrete on the trucks at night".
"How much concrete can you put on these trucks then, aren't they 6m³ trucks?"
"Depends on how well you know the police", said my translator.
"Oh".

But I did notice that with 8m³ on you could at least see the concrete in the drum, with 6m³ on it was very difficult due a strange perforated tube arrangement at the opening.
We were saved from the pump by a man with a lorry load of large steel plates that were used to support the trucks to stop them sinking into the subgrade, it required a major logistics operation with many forklifts buzzing all over the place to move the plates around, but it worked, and it was our only option.

Fortunately, by utilising dark concrete and plates I could use any admixture within reason; BASF's boys and their chemicals came to the rescue. And we did use the Chinese variety, after all.

After trials, trials and more trials (and many plates) we eventually started and everything seemed to be going OK until the plant rang "we can't get any aggregates for a while the government has shut the Yangzi to barge traffic during the Shanghai EXPO opening ceremonies, they say barges look untidy on the river".
"Can you ring your government and tell them how important this job is and get them to open the river ", I said to my translator.
"No".
"Oh".

The difficulty in designing a suitable concrete for this application is the conflicting requirements and the constraints of the imposed materials. If we could use best Trent Valley ball bearings, a nice, consistent sand and a pure OPC, then life would be a lot easier. When you have your back against the wall with the W/C due to the high water demand of the aggs. and cement, and the temperature and you are at the limit of what current admixture technology can do, it makes life very difficult. We also had to build in safety margins for unknown future changes in the performance of the concrete due to the 15% unknowns in the cement. Whatever you change to try to improve the mix changes something else.
Change the water content it affects bleed. Change the sand content to make it pump easier, it also affects bleed. We were already doing morning gradings to decide the fine sand percentage for that day due to variation in the main sand grading.

The admixture and rmc supplier are very helpful and involved, but what we're doing is outside of anyone's experience locally, so we are on our own. The cement supplier has no idea, it's just a manufacturing plant.

"Usual 4am start tomorrow?" I asked.
"Ah, no, China is short of electricity so they're rationing it, it's our turn tomorrow".
"Oh".
So things bubble along for a few more weeks and Bob's reasonably happy so we know we can't be doing that bad.

"DELAMINATION!" The cry goes out. The scourge of the floor layer.

Well, some of the slabs had to come out, but paranoia creates good watchdogs, so it was noticed early, so not too much of a problem. But the job stops yet again while we sort it out. I won't bore you with the details but after many sleepless days and nights of trials we established that the cement chemistry of the OPC bit of the cement had changed and the PCE admixture was reacting with it to entrain even more air.
"More defoamer please Mr BASF"
"Oh, er, um, well it could be a few days before we can make any more admixture for you, and what will you do with what you already have?"
"Just sell us some defoamer then, we'll mix it in the stuff we already have".
"Oh, er, um, we've never done that before, we'll have to check with the Germans"
"No time for that, they're still in bed (that'll be due to time zones, not laziness) I'll just ring Sika".
"Oh, er, um, um, um, OK then".

So begins the operations of FCAM (Flooring Contractor Admixture Manufacturers Co.Ltd),
Another few weeks of relative peace ensues as we spend all our spare time tapping the concrete with 2 Yuan coins, checking for delamination.

Just when we think we've got it cracked (accidental pun), the plant rings "we'll have to stop supplying after this week, China's short of coal so it's being rationed and it's the cement company's turn next week".
"Oh".
"I don't care WHAT it takes we cannot stop pouring again" says the Contracts Director (well, he is American).

So begins the operations of FCCS (Flooring Contractor Cement Storage Co. Ltd), as they hire a number of cement river barges and buy enough cement for a few weeks' pours to get them through the rationing period.

These sort of things may be the norm for a major contractor on a large site, but this is a only a humble floor layer and only 16,000$m^3$of concrete

China may be a country where everything is impossible but it's also a place where anything is possible.

A few more weeks of relative peace ensues.
"Pete, yesterday's concrete hasn't gone off yet and Bob can't finish it and he's not very happy!"
"Oh."
"We've checked everything we can think of and nothing has apparently changed, it must be the cement has changed again".

So the lads of FCAM are galvanised into action, BASF supply some retarder and yet more trials ensue to try to match the retarder content of the admixture to the changed cement.
By now, in the rmc plant cement lab, FCAM are doing daily foaming tests, solid contents, setting times, flow table test, gradings and tests to check how much air the cement/PCE reaction generates, as well as all the concrete tests.

All routine stuff for a floor layer!

Of course, by 'trials' on this job, I don't mean those little ones we play at in the lab, these are all big manly ones, on site, with lots of concrete, laid and placed as on the finished job, but then cut up and sold to the local farmers in slabs to build roads. It's the only way with a Laserscreed, dryshake and very flat floors.

So then ensues a period a daily admixture production by FCAM, whereby the formulation for the following day is based on today's setting performance and the weather. It's now August, times of heavy rain showers (don't ask about control of agg. moisture content, that was another whole can of worms). Problem is, the temperature can drop from 40 to 25 when it rains, and this can have quite an effect on a heavily retarded concrete. BASF looked on with support and relief, I don't think they would have got the concept of daily formulation changes past the Germans.

The situation stimulated unusual conversation at dinner. It's not very often the finishing supervisor has a say in how much retarder is to be included in the admixture for the next day! But then it was Bob's own concrete, after all.

Anyway, it all settles down again and FCAM are wound up and BASF are back as the admixture producer.

"The cement plant has run out of clinker and has bought some in to keep them going, it that OK?"

Amazing! A major breakthrough! We are actually being told about something changing!

Of course, joy does not last very long with this type of question in the world of concrete floors.
I'm not sure whether 'punch drunk' translates into Mandarin, but we certainly felt it.
Well, to cut an even longer story short, coupled with, what I can only describe as 'pity' from the rmc producer, they managed to change to an OK cement that enabled us to finish the job.

So, are they mad, or very clever? Sometimes these extremes can be very close in a man's brain.
But despite all the odds, they succeeded, and that's the main thing.
The trouble is, they'll now be even more confident about doing the next one. And I can't wait!