Construction Trial and Implementation of 10G Cement Treated Base (CTB) at Singapore Changi Airport

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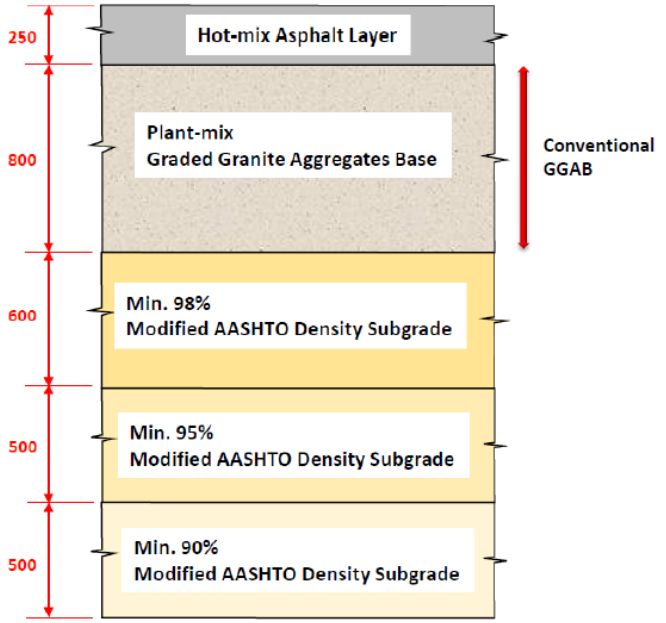
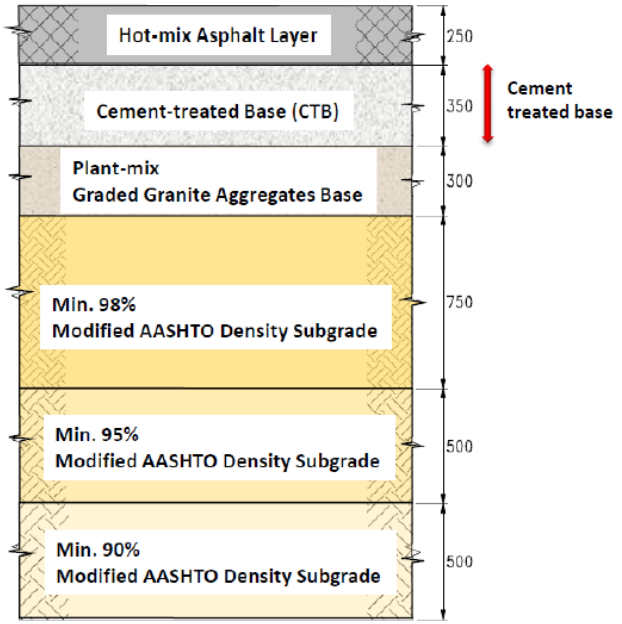
Agenda

- Typical Airport Flexible Pavement
- FAA Cement Treated Base Specifications
- Research Collaboration between CAG & NUS
- Field Trial Panels
- Results of field Trials
- Large scale implementation of 10G CTB in Taxiways
- Additional QA/QC Measures
- Productivity Improvement on adoption of 10G CTB
- Way Forward

Typical Airport Flexible Pavement



Traditional pavement without CTB

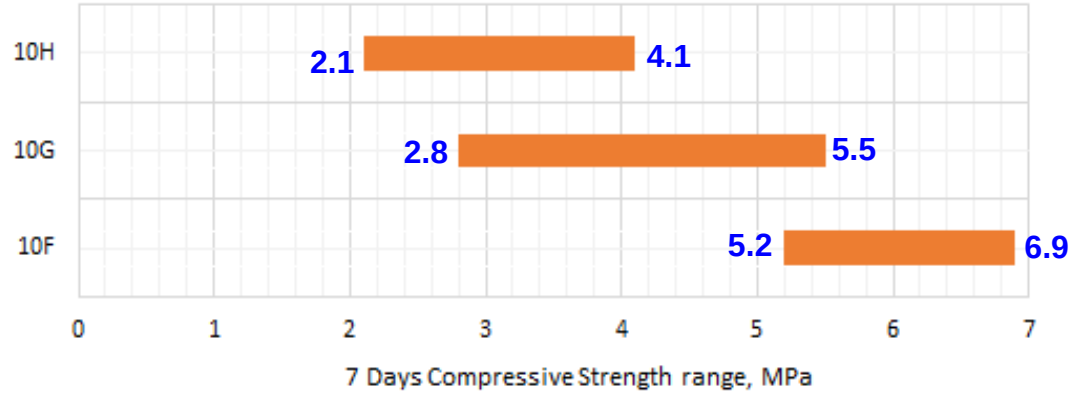


Changi East pavement design with CTB

- The Cement Treated Base (CTB) is a type of base course material used in the construction of roads, highways, and airport pavements.
- The CTB provides a stable platform that enables the pavement to behave flexible and distribute the load to the subgrade effectively & efficiently.

FAA Cement Treated Base Specifications

FAA Advisory	7 Days Compressive Strength (MPa)	28 Days Compressive Strength (MPa)	Pre-cracking
10F	5.2 – 6.9	-	-
10G	2.8 – 5.5	Max 6.9	-
10H	2.1 – 4.1	-	-
Modified 10F	Min 5.2	-	Yes



Ref: Federal Aviation Administration Standards for Specifying Construction of Airports

Research Collaboration between CAG & NUS

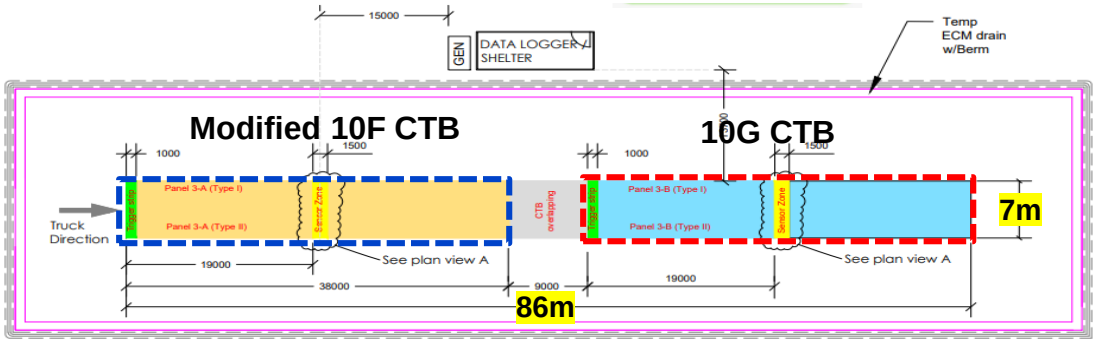
Optimising the design for long term performance of Cement Treated Base (CTB)

Objective:

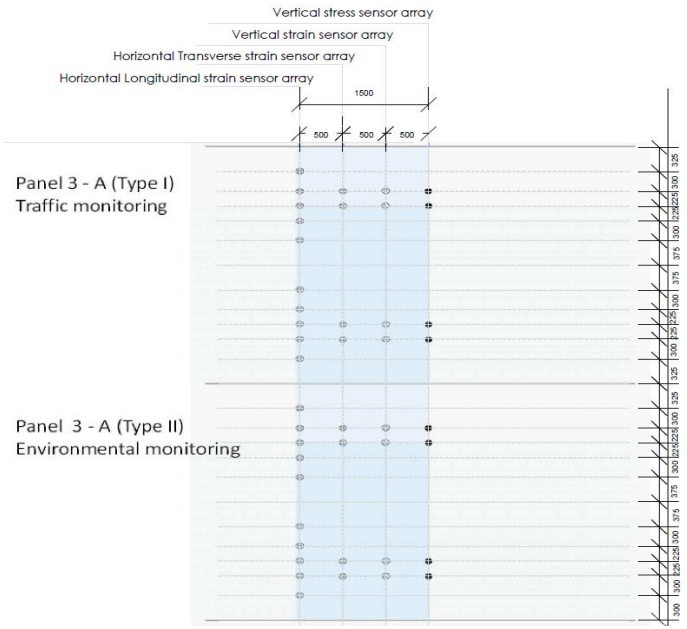
To study and explore the long-term mechanistic and strength characteristics of CTB design and estimate the potential design lifespan of airfield pavement structure.

- To monitor the long-term performance of CTB layer, instruments were installed along a stretch of Haul roads at Changi East Construction site, with 2 different CTB mix (10F and 10G).
- Install instrumentation to measure and monitor the key characteristics of different layers of the pavement with 10F and 10G CTB mix.
- The instruments register readings from the heavy traffic (trucks) along the haul roads.
- The results from the instrumentation are extrapolated to aircraft loadings.

Field Trial Panels at Changi East



Overall Plan View for NUS Research Pavement Panel 3 (86.0m x 7.0m)
SCALE:1:200



Instrument type	Layer found
Stress	HMAC CTB GGAB, SG
Strain	HMAC, CTB GGAB, SG
Temperature	HMAC CTB
Moisture	SG

Data from traffic loads were collected for 12 months

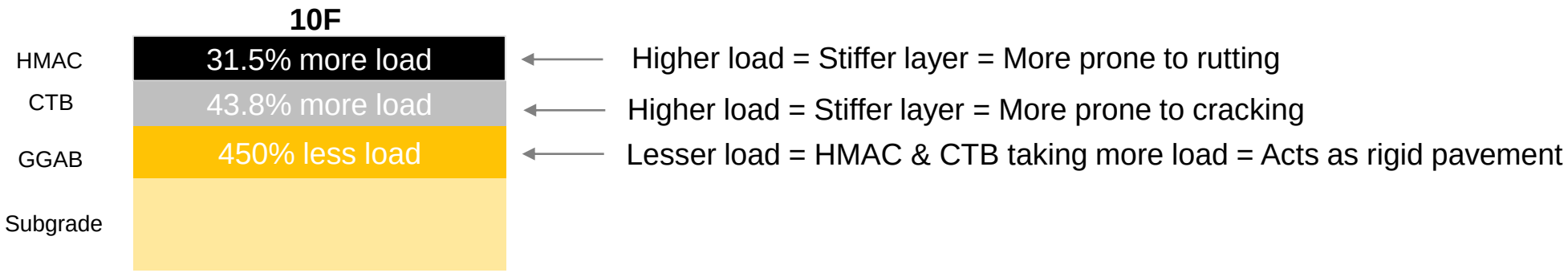
CHANGI airport group

NUS National University of Singapore

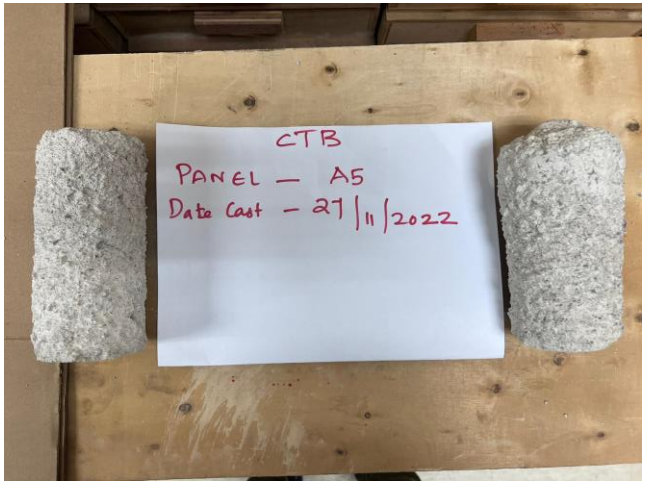
Results of field Trials

Preliminary analysis suggest that CTB (10G) is likely to have better long-term performance

Property	Panel A (10F)	Panel B (10G)	Findings
Average horizontal tensile strain **(CTB)**	9.26 x 10^{-6}	6.44 x 10^{-6}	10F CTB is stiffer. Hence the tensile strain is 43.8% higher than 10G and is more prone to cracking
Average vertical compressive strain **(HMAC)**	2.25	1.71	As 10F CTB is stiffer, the HMAC has 31.5% higher vertical strain than 10G and is more prone to rutting
Average vertical compression **(GGAB)**	4.25 x 10^{-3}	23.7 x 10^{-3}	As the CTB & HMAC take higher load, the GGAB in 10F has 450% less vertical compression than 10G and behaves more like rigid pavement

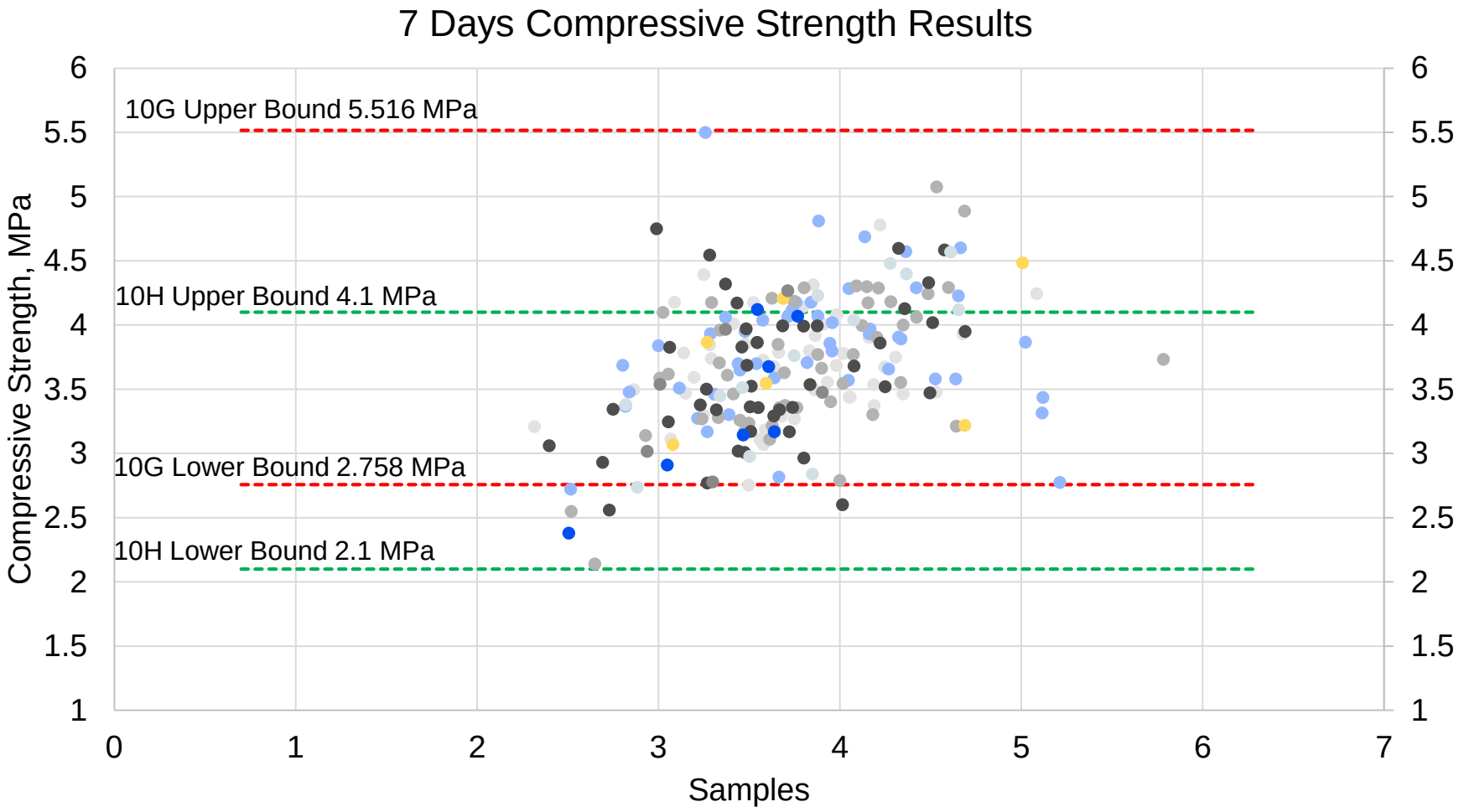


Implementation of 10G CTB in Permanent Taxiways



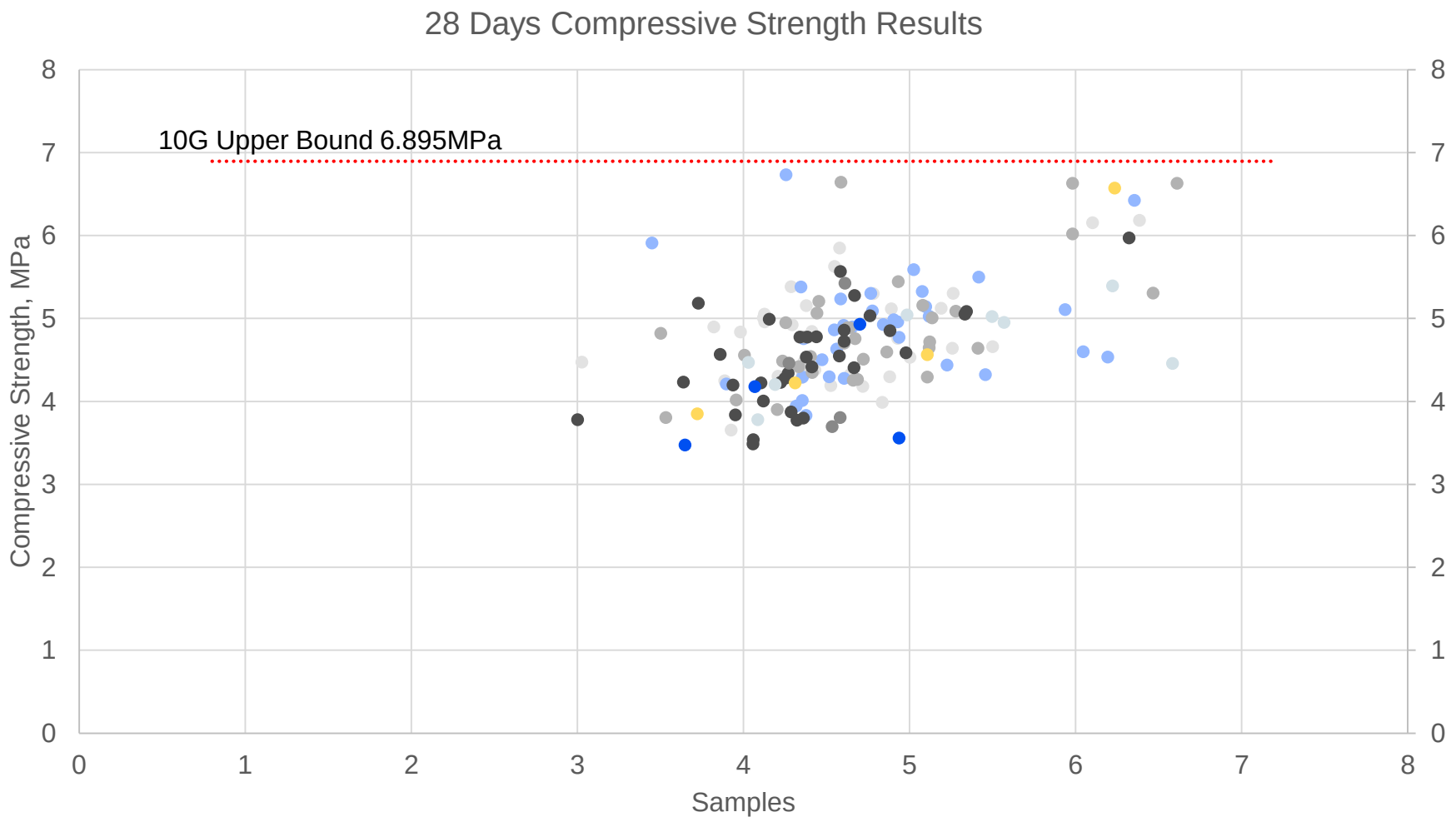
In addition to the field trials, the 10G CTB was also implemented at Permanent Taxiways (Area > 100,000m2)

7 Days compressive strength comply with 10G requirements



About 70% of the compressive strength results also comply with FAA 10H Advisory as well

28 Days compressive strength comply with 10G requirements



Additional QA/QC Measures

- **Batching**

1. Frequent check of moisture content of raw materials and CTB.
2. Control CTB moisture tolerance during production at +/-1% (FAA specs allow +/-2%)
3. Extract the sample from mold after 3 days age (10F - extract sample after 1 day age)
4. Extra care during sample extraction and handling (due to low strength design)

- **Laying**

1. Ensure timely laying of CTB layer to prevent loss of moisture content
2. Additional curing with plastic sheets over the entire CTB layer/
3. Plan/Design for pre-cutting at designated locations to avoid hairline cracking

Productivity Improvement on adoption of 10G CTB

10F CTB with pre-cracking at 3.5m x 3.5m grid

Average Productivity – 63m2 per man-day

10G CTB with no pre-cracking

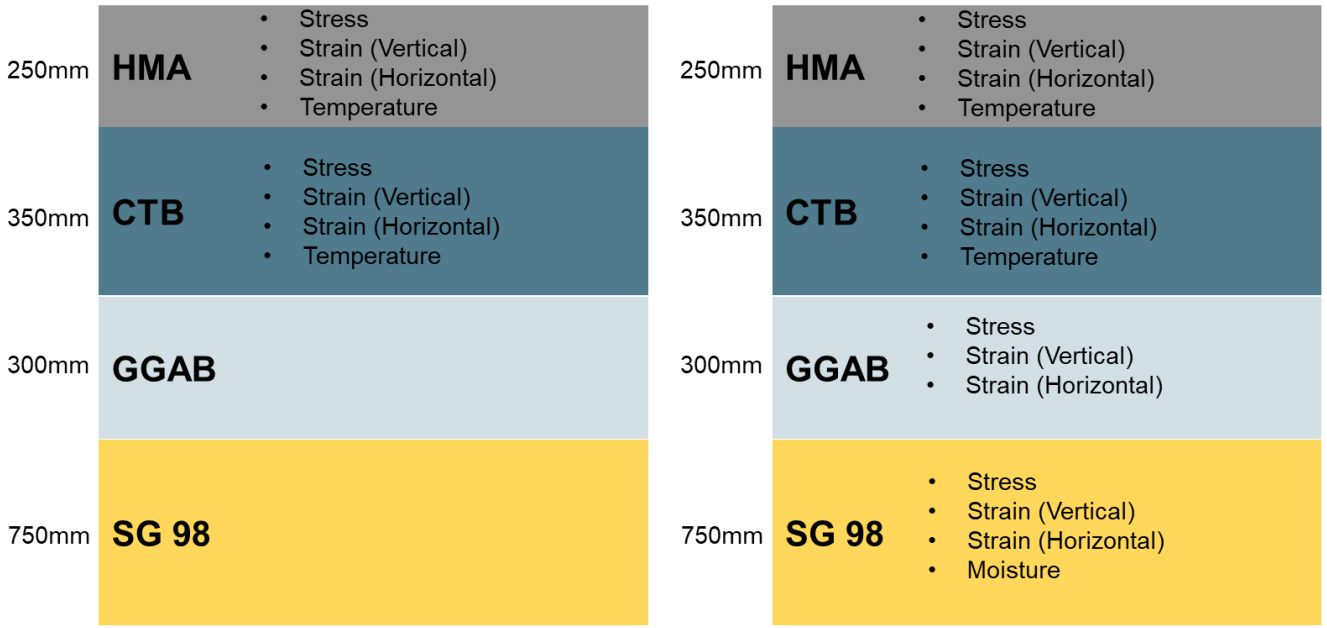
Average Productivity – 83m2 per man-day

33% more productive
Lesser dust pollution without pre-cracking

Way Forward

Instruments are installed in permanent taxiways to complete study on long-term influence of CTB stiffness on pavements

a) Construction vehicle loads are not sufficiently high enough to induce fatigue response in the trial pavement during the monitoring duration
   - Cracks have not formed, and no rutting after few months
   - Stress and strains have not increased significantly since the trial began



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