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The New Test Technology for Evaluating the Anti-cracking Performance of Concrete Runway of the Airport under Construction

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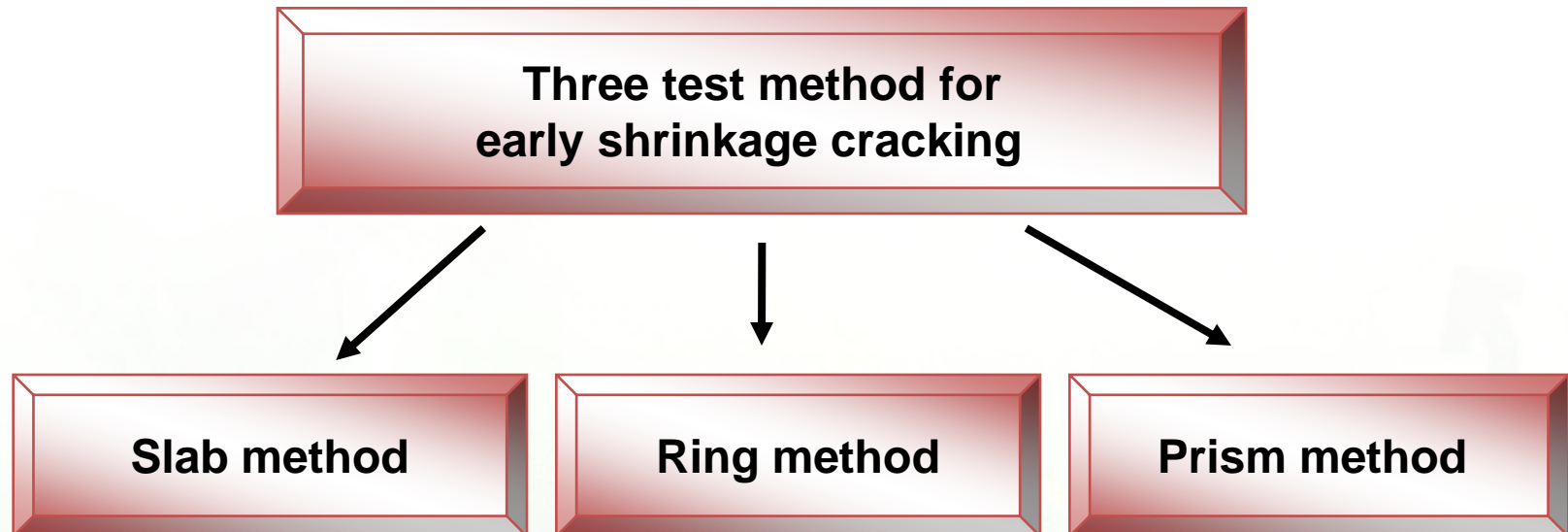


Introduction

This presentation introduces one new test technology for evaluating the anti-cracking performance of concrete runway of the airport under construction.

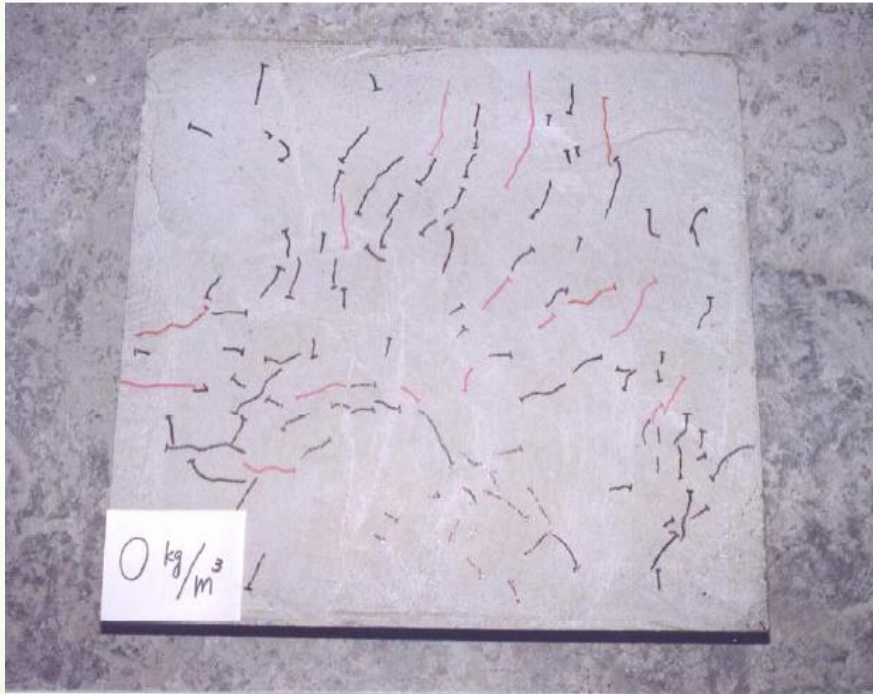
The cracking performance of concrete testing under constraint condition is more close to the condition of concrete at job site.

The lack of a standard test for early shrinkage cracking resistance has prompted several methods.



1、 Slab Method 1

**Introduce by Karri in 1985
ACI 544.2R for
testing Fiber Reinforced Concrete**

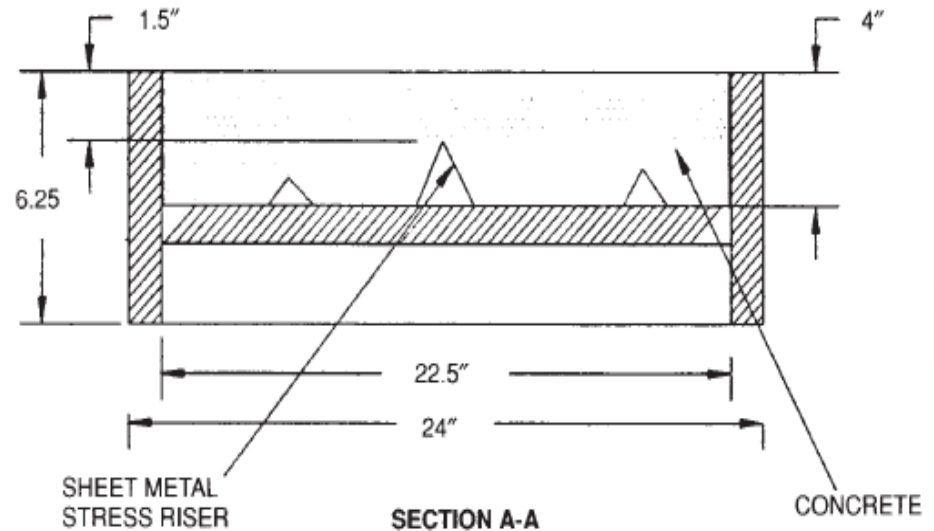
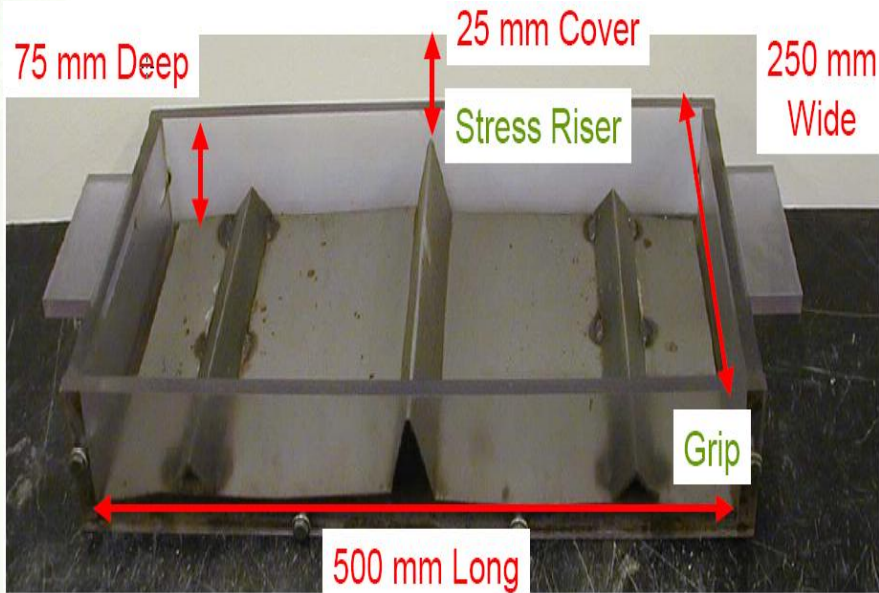


**wire mesh or steel bar
provide constraint**

**limitation : crack is irregular and disorder
couldn't provide quick and accurate evaluation**

1、 Slab Method 2

Recommended by ICBO and RILEM

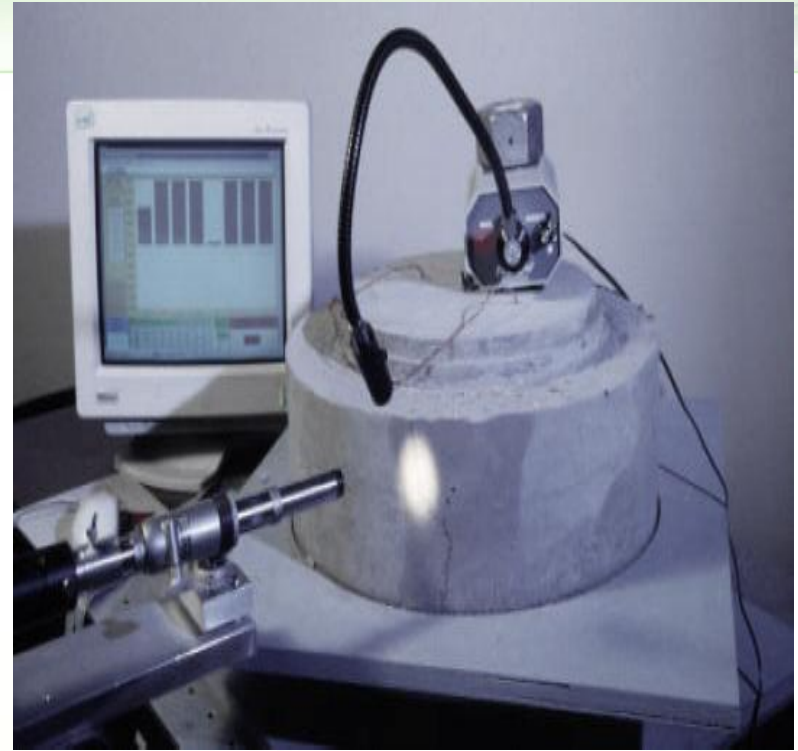


limitation : coarse aggregate in concrete falling down after vibration
The key test part may be mortar ,not concrete

2、 Ring Method



Ring method picture



Observe and measure the crack

Introduced by Roy Carlson from MIT in 1942.

limitation : need long time (several days) to wait the crack appear and its poor sensitivity.

3、 Prism Method



**Introduced by Springenschmid from Germany in 1960's.
limitation : inconvenient to use at job site and
instruments require high sensitivity and expensive.**

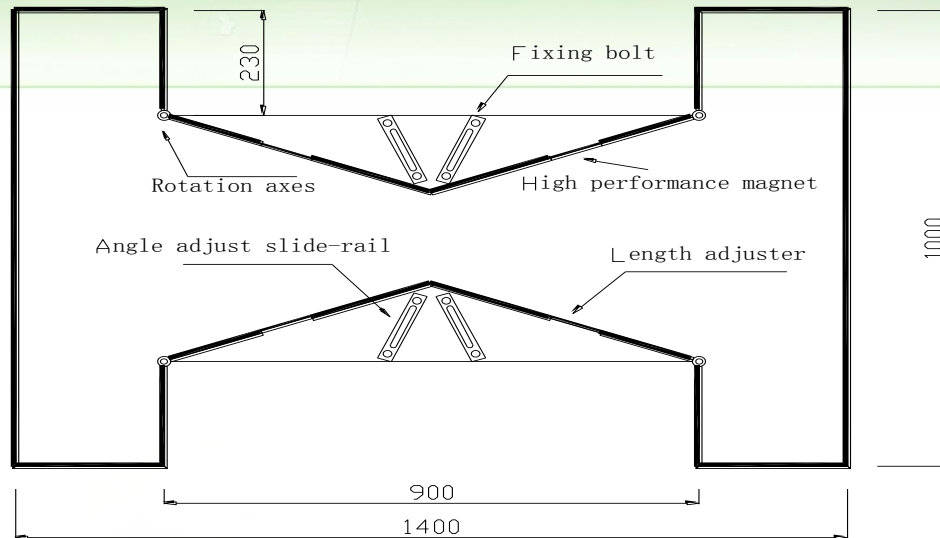
Aim for the new method

providing a method to evaluate
concrete crack performance with:

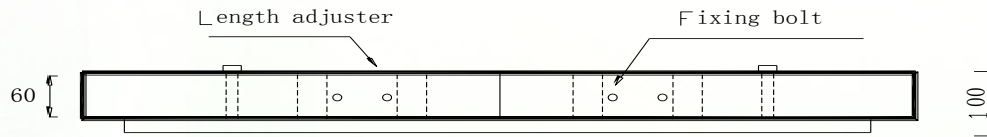
- 1、 quickly testing
- 2、 convenient measurement
- 3、 can perform test at job site



New method- Dumbbell Method



planview (mm)



Section (mm)

Dumbbell device

Dumbbell method with stress risers is invented.



New method- Dumbbell Method



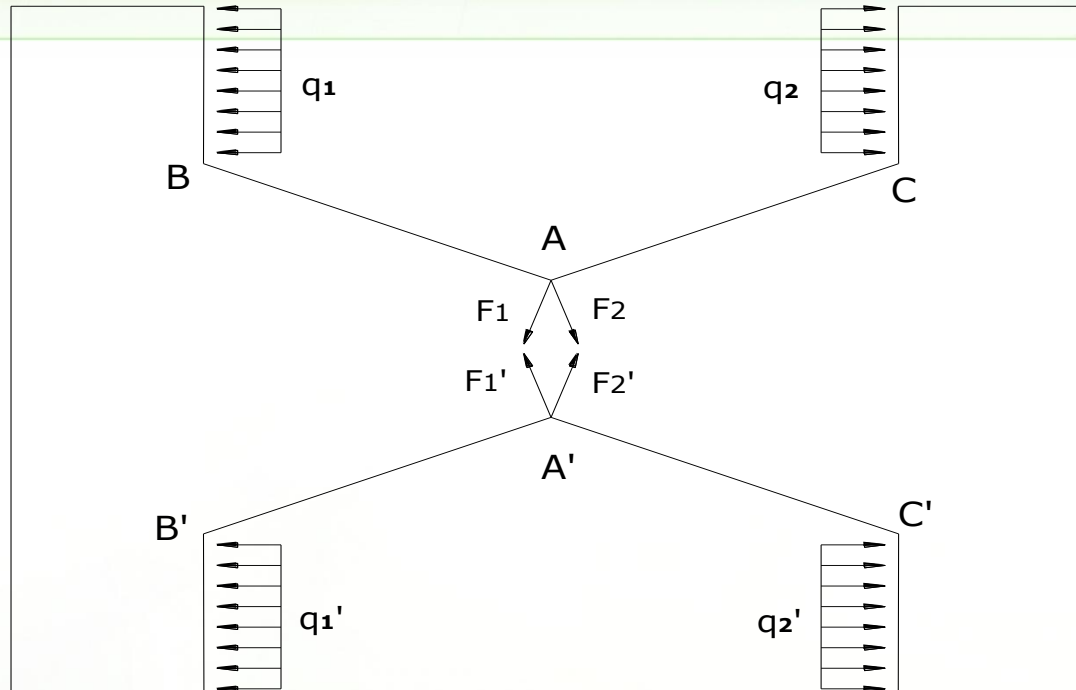
Dumbbell device

The device is made by steel material, which included the fixed-end and adjustable stress risers in the middle which can induce the crack of the concrete specimen. The ends of the device can provide the constraint which makes concrete crack.

This method proves to be more effective for the quick crack testing.



Mechanism Analysis of dumbbell method



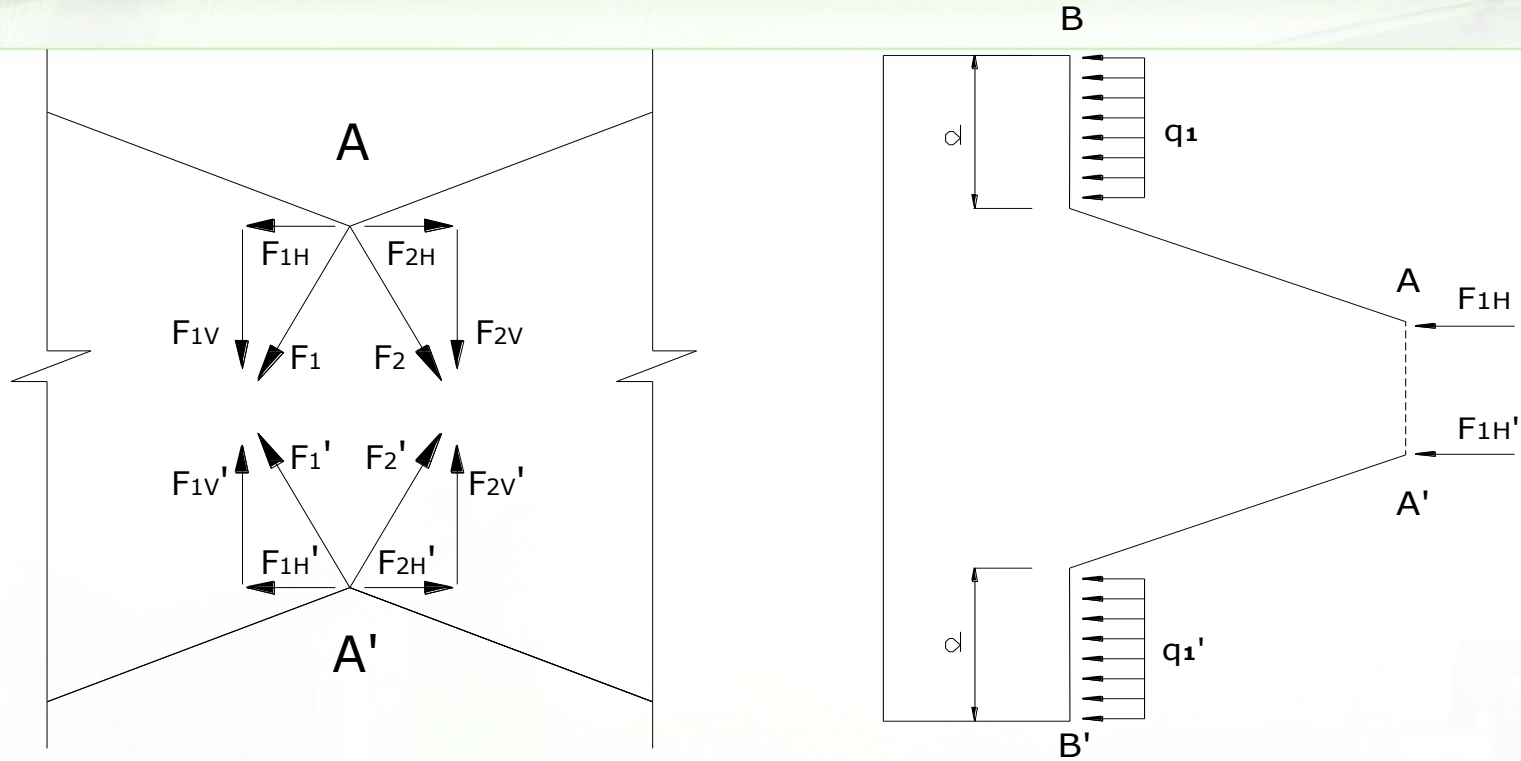
Mechanism Analysis

Under the induction of stress riser and the constraint of the ends of mold, the crack shape is close to a single line, (the line of A-A').

So the crack observation and measurement is more convenient and faster.



Mechanism Analysis of new test method



Mechanical analysis of A point and A' point



Evaluation Index

1、 ACW (average crack width within 24h)



microscope

The only crack are divided into six equal portions by five line segments. Record the crack width at the five crossing of crack and line.

The average of the five widths is ACW .

2、 ICT (Initial crack time)

ICT is another important index of concrete cracking performance. The later the concrete crack, the better the anti-cracking performance.



Comparative study of three evaluating methods



Concrete mix proportion

There are 3 mix proportions and each will be tested by three methods under the same test condition. The fiber reinforced concrete is designed to compare sensitivity of three test method.

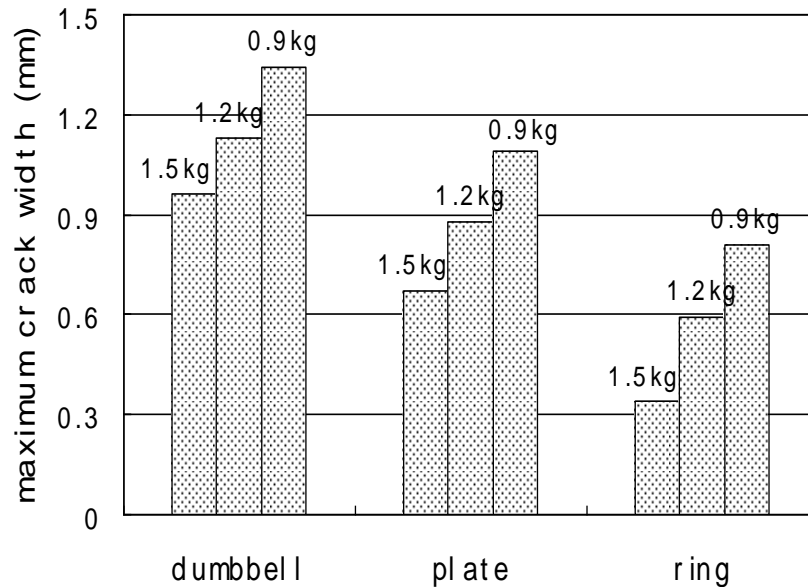
Fiber dosage is 0.9kg/m³, 1.2kg/m³, 1.5kg/m³. Tests temperature is maintained at 30 ± 2 °C, relative humidity is maintained at 50 ± 5 %.

Concrete mix proportion

Material (kg/m ³)					Slump (mm)	Slump Flow (mm)
Cement	Sand	Gravel	Water	Fiber		
360	796	1099	145	0.9	210	400/400
360	796	1099	145	1.2	200	460/460
360	796	1099	145	1.5	205	440/460



Test results



maximum crack width(24h)

		Dumbbell	Slab	Ring
1.5kg/m ³	Initial crack time	2h:15min	2h:30min	6d
	Maximum crack width	1.07mm	0.64mm	0.52mm
1.2kg/m ³	Initial crack time	1h:50min	2h:10min	4.5d
	Maximum crack width	1.13mm	0.88mm	0.59 mm
0.9kg/m ³	Initial crack time	1h:25min	1h:50min	4d
	Maximum crack width	1.34mm	1.09mm	0.81mm

From the test results, for concrete with dosage for 1.5kg/m³,

concrete crack first by dumbbell method which is superior to slab and ring method. dumbbell method need 2h:15min. Ring method need 6d;

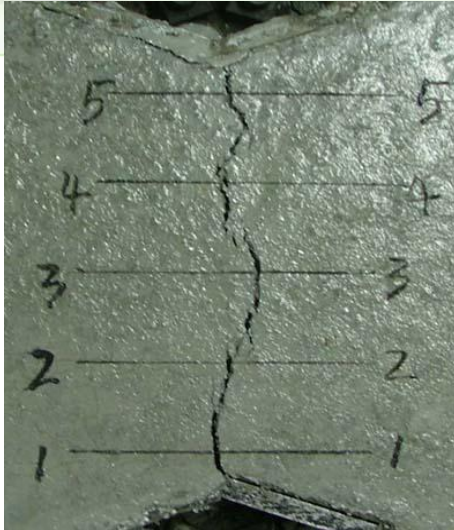
From view of the maximum crack width, it is 1.07mm by using dumbbell method which much larger than the other two methods.

The concrete cracking performance can be reflected more obviously with larger Maximum crack width which make the crack be measured more easily and can reduce measurement error.

concrete with dosage of 0.9kg/m³ and 1.2kg/m³ also shows the same trend.



Overall comparisons of the three test method



dumbbell



slab



ring

	dumbbell	slab	ring
sensitivity	good	above average	average
testing cycle	short	short	long
operability	good	average	above average
application on job site	good	above average	average



construction



Concrete finishing



Runway (Tianjin, China)



Runway test for A320 (China, May, 2009)



A320 test successful (China, May ,2009)



Conclusion

To sum up, from the view of sensitivity, test cycle, operability, application under airport construction,

Dumbbell method is suitable for evaluating the early age concrete cracking performance with the following advantages:

- 1、 stronger sensitivity
- 2、 quickly testing
- 3、 more accurate
- 4、 easy measurement
- 5、 convenient application under airport construction



Thank you

