Application of SMA in Chinese Airports

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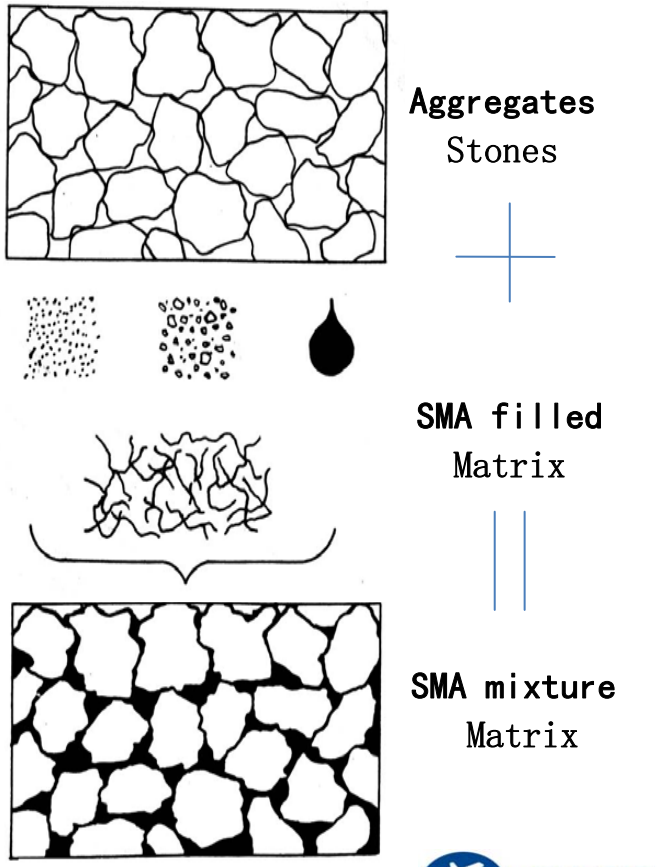
Production and development of SMA

- **Originated in Germany in 1960s.**
- **Evolved in the USA in 1990s.**
- **Introduced into China in 1992, included in CAAC's specifications in 1997.**
- **Applied in highways, airports and bridge pavements construction all over China.**

Filler/sand/asphalt/fiber



SMA's applicability in airports

Adaptable to high stress fatigue load

- **Automobile: 50 tons, tire ground pressure 0.7MPa（heavy truck）**
- **Aircraft: 400 tons, tire ground pressure 1.4MPa（747-400）**
- **Highway: Lower stress and more cycles – fatigue failure.**
- **Airport: Higher stress and less cycles – fatigue failure.**

High shear strength

- **Pavements get huge shear stress during aircrafts' taking off and landing.**
- **What if overlay pavements' shear strength is insufficient:**
  - ✓ **Instability ruts (W deformation）**
  - ✓ **Slipping cracks (nearly 45° angle)**

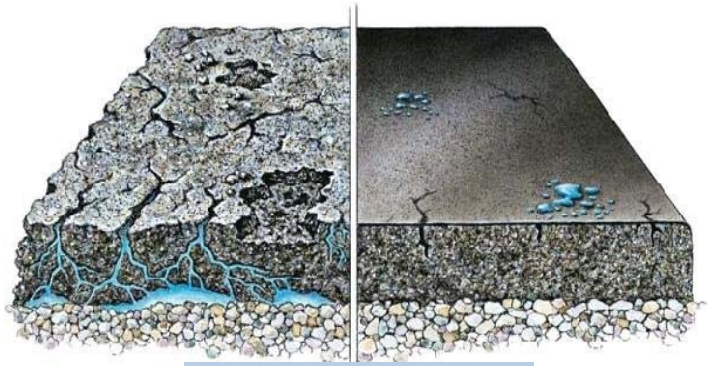
Ruts

Slipping Cracks

Rut profile

Compact, skid resistant, smooth surface

- **Compact: Aggregates embed closely, asphalt fills sufficiently**
  - ✓ **High strength (prevents ruts, cracks)**
  - ✓ **Aggregates hard to loose (prevents FOD)**
  - ✓ **Water resistant (prevent water damage)**
  - ✓ **Skid resistance: rough surface, plentiful structure**
  - ✓ **Safety requirement**
- **Smoothness: cross slope, elevation, IRI**
  - ✓ **Serviceability, safety requirement**



Water damage

Insufficient skid resistance

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Application of SMA in Chinese airports

- **Ray Brown(NCAT): “China is the leader in the use of SMA on airfields.”-AAPTP 04-04 ,NCAT**
- **Applied to the Eastern Runway of Beijing INT’L Airport successfully in 1996**
- **More than 35 airports (Beijing, Harbin, Shenyang, Qingdao, Dalian, Xiamen, Changsha, Kunming, Lhasa, etc.)**
- **SMA has become main trend of asphalt pavements.**

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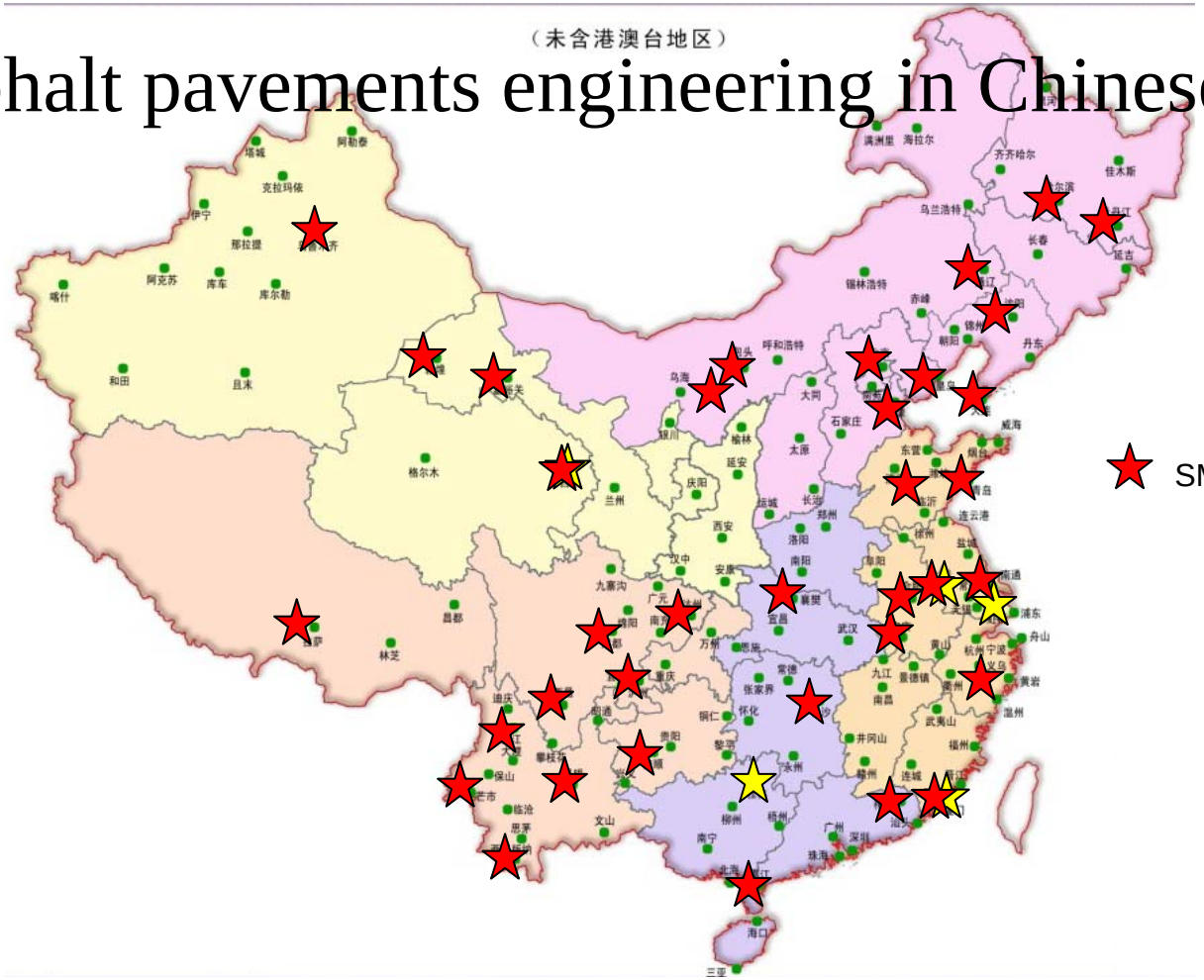
Asphalt pavements engineering in Chinese airports



SMA Pavement

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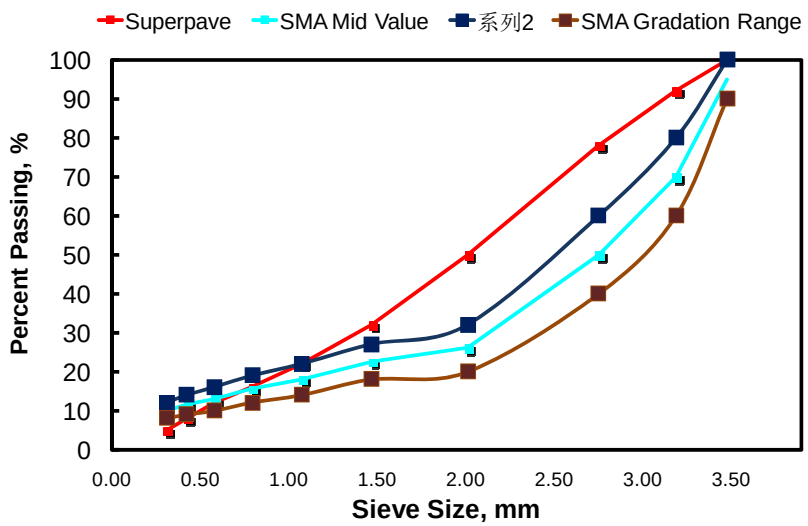
Technical requirements -- Gradation

SMA Gradation Requirements for Airfield in China

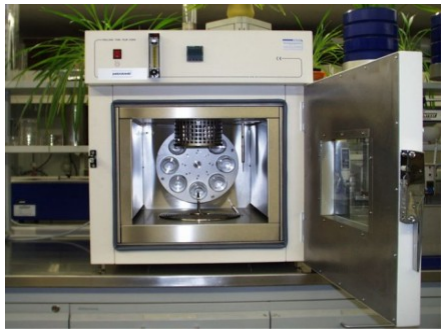
Sieve Size, mm	Percent Passing	
	SMA-16	SMA-13
19	100	
16	90 – 100	100
13.2	60 – 80	90 – 100
9.5	40 – 60	45 – 65
4.75	20 – 32	22 – 34
2.36	18 – 27	18 – 27
1.18	14 – 22	14 – 22
0.6	12 – 19	12 – 19
0.3	10 – 16	10 – 16
0.15	9 – 14	9 – 14
0.075	8 - 12	8 - 12



Technical requirements -- Performance

SMA Mix Properties Requirements for Airfield in China

Index	Criteria
Marshall Blows	75 on each face
Stability, Min (KN)	6.0
Flow, 0.1mm (0.01 in)	20-50 (8-20)
Design Air Voids, %	3-5
Minimum VMA, %	17
Minimum Asphalt Content, %	5.5
Minimum Dynamic Rutting Stability Index[1]	When using modified asphalt: 3000; When using unmodified asphalt: 1500
Retained Marshall Stability[2] after submerged in water, %, Min	80
Minimum TSR, %	75
Draindown (170 °C, 1h), %, no greater than	0.15
Cantabro Abrasion Test [3] (-10 °C), %, not greater than	20



Typical application 1– Beijing Capital International Airport eastern runway

- **Background**
  - ✓ **Built in 1954**
  - ✓ **3800m×60m**
  - ✓ **Asphalt overlaid in 1996**
  - ✓ **Performs well under heavy load**

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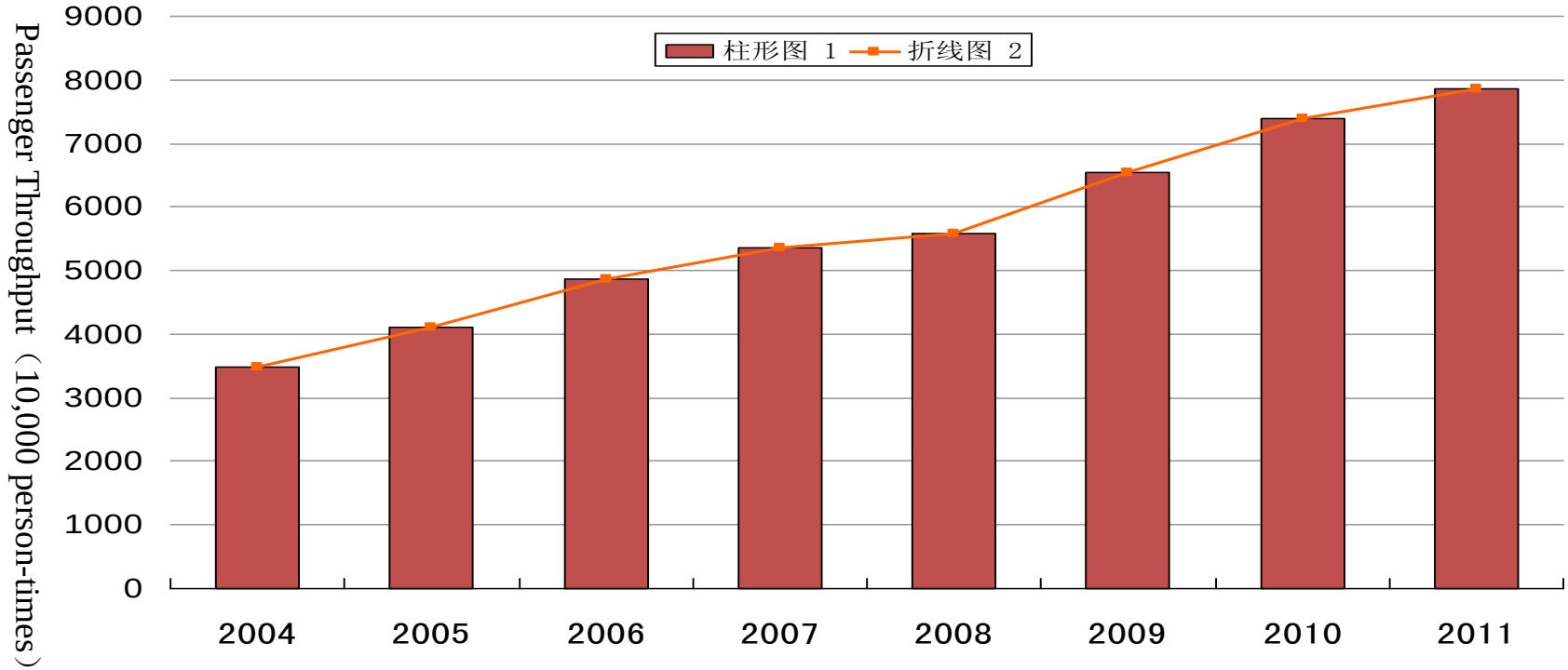
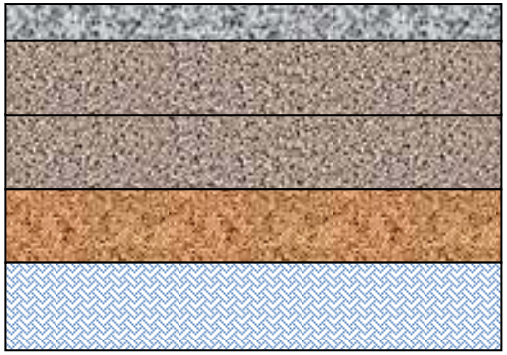

Passenger Throughput（10,000 person-times）
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
柱形图 1
折线图 2
2004
2005
2006
2007
2008
2009
2010
2011

Typical structure



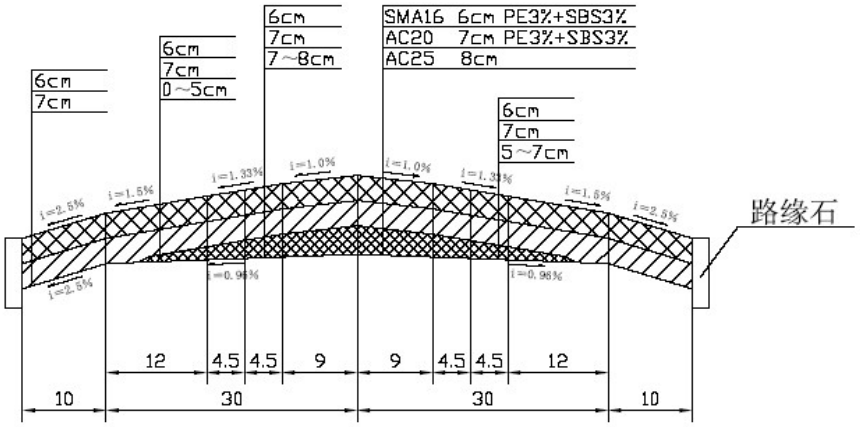
21cm Asphalt surfacing

31～42cm Concrete overlay

25～28cm Concrete

20cm Granular base

Subgrade



Success experience

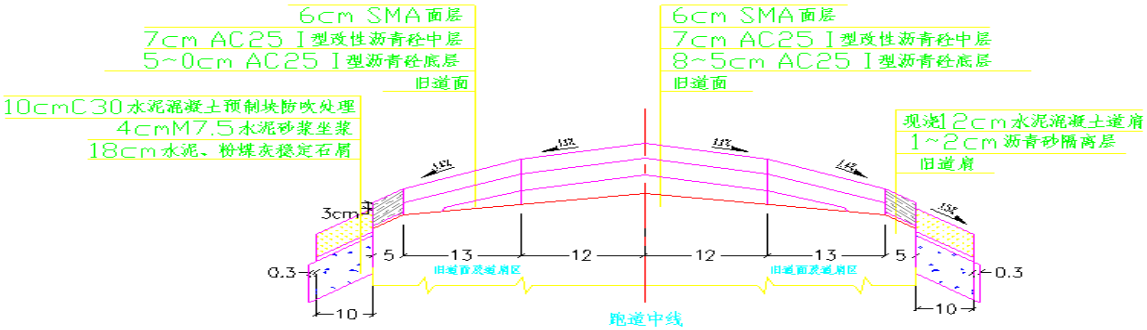
- **Preventing reflection cracks**
  - ✓ **Repairing old pavements**
  - ✓ **Use APP modified asphalt felt**
  - ✓ **Proper thickness**
  - ✓ **Joint cutting between pavement and shoulder**
  - ✓ **……**

Success experience

- **SMA asphalt mixture design**
  - ✓ **Material selecting**
  - ✓ **SBS + PE composite modification**
  - ✓ **Addition of Fibers （JRS－VIATOP 66,0.3%）**
  - ✓ **Gradation design**
  - ✓ **Mixture performance testing**
  - ✓ **……**

Typical application 2– Beijing Capital International Airport western runway

- **Built in 1980,overlaid in 2000**
- **3200m×45m**
- **To solve rutting problem：AH90+SBS+TLA(25%)**
- **Until now, present good performance without any damages**



Evaluation Results of the Eastern Runway

- Pavement damage investigation
- Roughness detection and evaluation
- Pavement deflection test
- Core sample test
- Pavement structure evaluation
- Conclusion and suggestion

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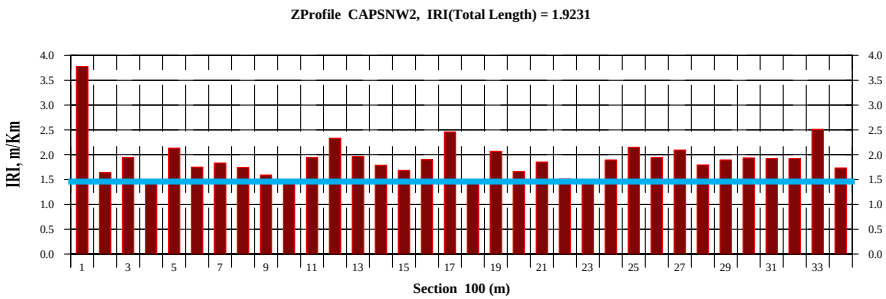
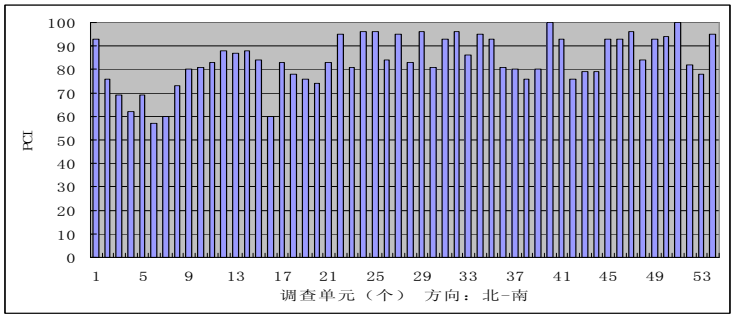
Evaluation Results of 2007

- **PCI: Excellent except the north end**
- **IRI: 1.84 mm**
- **ISM: Except the north end**
- **Performance of Mix：Perfect**
- **Structural life：9years**



PCI 值 Pavement Condition Index



Cantabro Abrasion Test

Position	No.	Before test (g)	After test (g)	Damage（%）	Average
North end	5#	1233.4	1116.5	9.5	34.8
	6#	1125.6	874.6	22.3	
	7#-1	1201.0	328.8	72.6	
	5#	1215.2	1062.3	12.6	20.7
	6#	1214.9	454.5	62.6	
	9#	1226.0	1179.3	3.8	
	10#	1233.2	1188.1	3.7	
Middle and South end	14#	1112.6	1049.2	5.7	4.1
	22#	1260.7	1230.8	2.4	
	24#	1263.7	1211.0	4.2	
	20#	1245.9	1201.6	3.6	3.3
	21#	1262.6	1222.5	3.2	
	22#	1263.4	1223.2	3.2	

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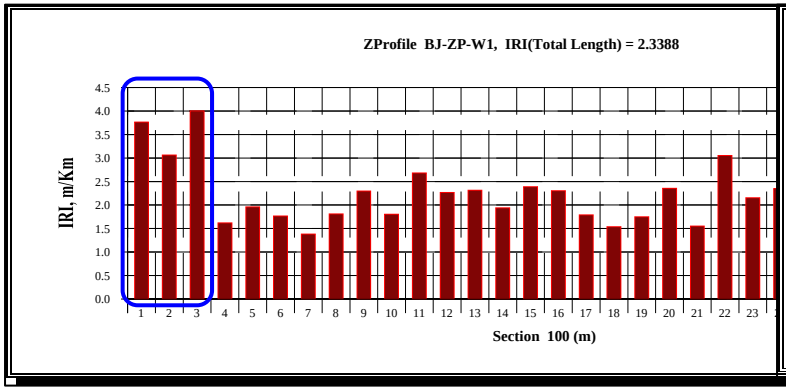
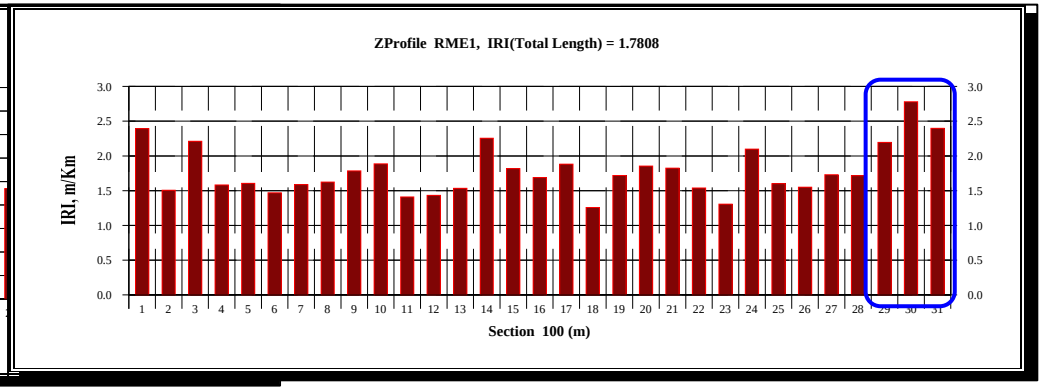
Evaluation Results of 2011

Pavement damage condition

- **Pavement damages centralized in south ends, most of which were ruts, cracks, and grooves for cables.**

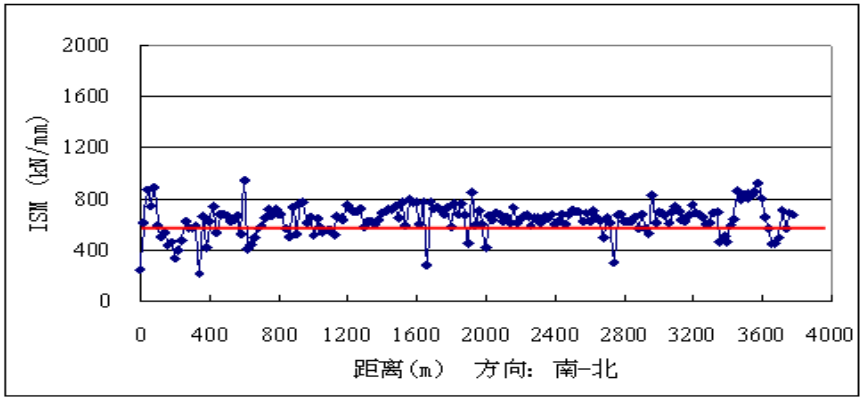
Roughness detection and evaluation

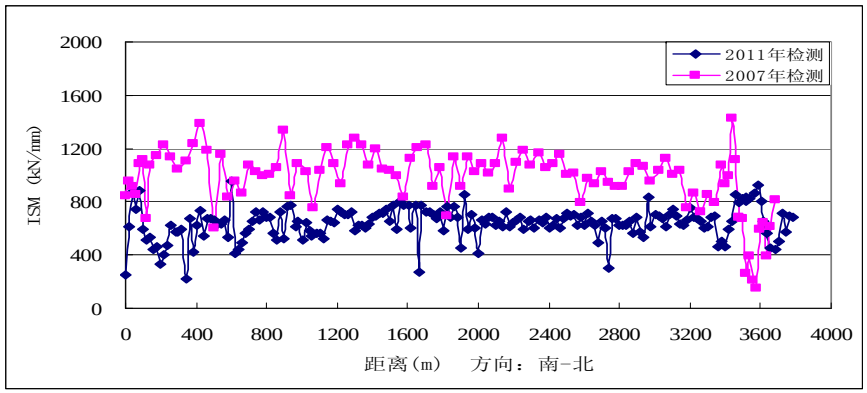




- **Roughness differed between middle section and end sections. It was evaluated as good in the middle while medium in the ends.**

ISM evaluation





- ISM was almost uniformly distributed.
- Aircrafts' slowly taxiing and turning distinctly affected the ISM of pavements.
- ISM decreased for about 34% in 2007.
- North end was heavily repaired in 2008. Other part's ISM decreased, with some points losing about 50%.
- **Temperatures differed during two tests.**

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Asphalt mixture core sample tests

Analysis of test results

Performance comparison between 2007 and 2011 at the end of the runway

Layer	Time	Items			
		Stability（kN）	Asphalt content	Cantabro Abrasion Test	Splitting Test
Wearing Course	2007	7.47	6.80%	4.10%	——
	2011	10.52	6.00%	13.53%	62%
Binder Course	2007	9.17	4.30%	——	——
	2011	12.66	4.05%	——	83%
Base Course	2007	9.17	4.30%	——	——
	2011	9.37	4.05%	——	47%

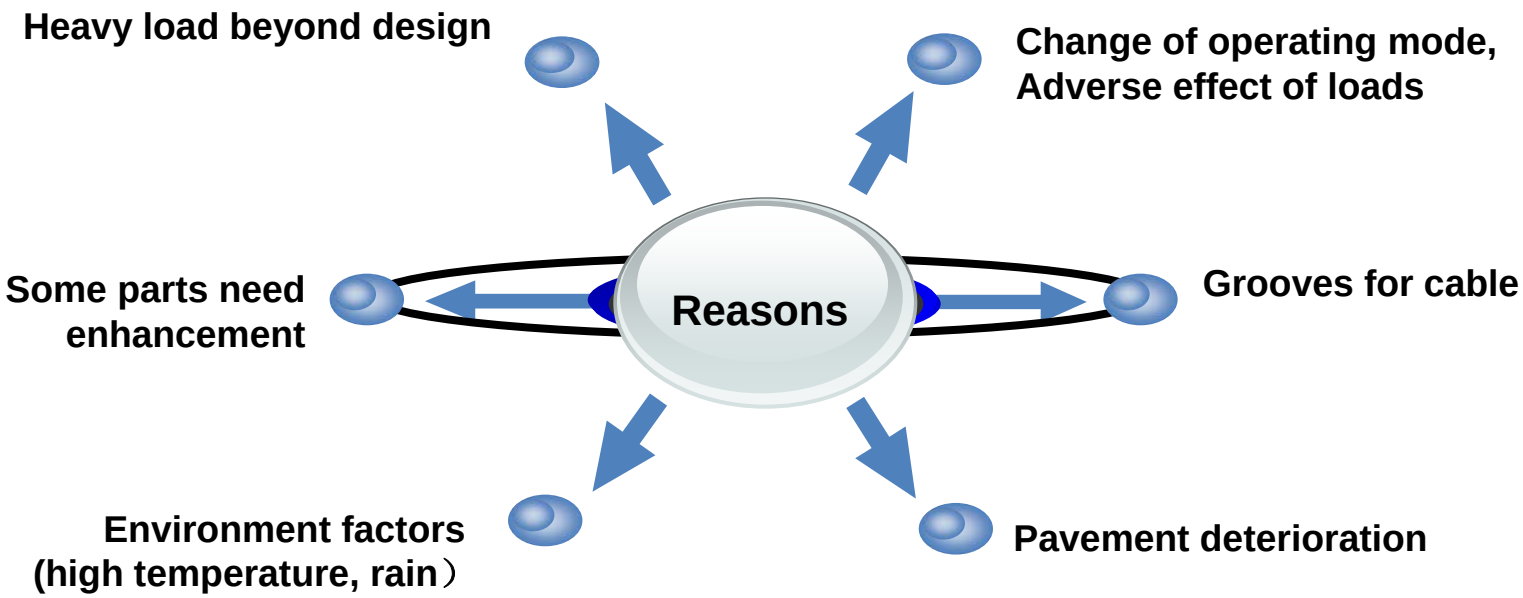
Performance comparison between 2007 and 2011 at the middle of the runway

Layer	Time	Items			
		Stability（kN）	Asphalt content	Cantabro Abrasion Test	Splitting Test
Wearing Course	2007	7.47	6.80%	4.10%	——
	2011	7.7	6.14%	12.77%	77%
Binder Course	2007	9.17	4.30%	——	——
	2011	9.34	4.20%	——	91%
Base Course	2007	9.17	4.30%	——	——
	2011	8.5	3.85%	——	92%

Some Problems:

- Rutting On South End
  - ✓ Disadvantage of loading at the end
  - ✓ Raveling at Binder Course and Base Course
- Cracks
  - ✓ Construction Joints
  - ✓ Cables Cut

Analysis of reasons for damages



Other Chinese airports using SMA

- Harbin
- Xiamen
- Shenyang
- Lhasa
- Kunming
- Qingdao
- Xining
- Changsha……

Related research progress—Uvioresistant ability of airports in high plateaus

Problems in asphalt pavement construction in plateaus

01 High/low temperature performance

02 Adhesion performance

03 Aging and fatigue resistance

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Take Lhasa Gonggar (Tibet) Airport as an example

High altitude
（3600m）

Construction
time limited

Adverse Climate

- The research of uvioresistant ability evaluation was finished; and the service life and performance of overlaid asphalt pavement were improved.
- The project has been completed, and will guide similar asphalt pavement construction in plateau airports.

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What we do in the future?

- More finer Gradation of SMA
- Rubber roller
- Warm Mixed Asphalt
- Uvioresistante
- ……

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Thanks !

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