

中国公路沥青路面再生技术与规范
**Asphalt Pavement Recycling
Practices In China Mainland**



徐剑

XU Jian

Research Institute of Highway
Ministry of Transport, China

Contents

1、China Road Network

2、Asphalt Pavement Recycling

3、About RIOH

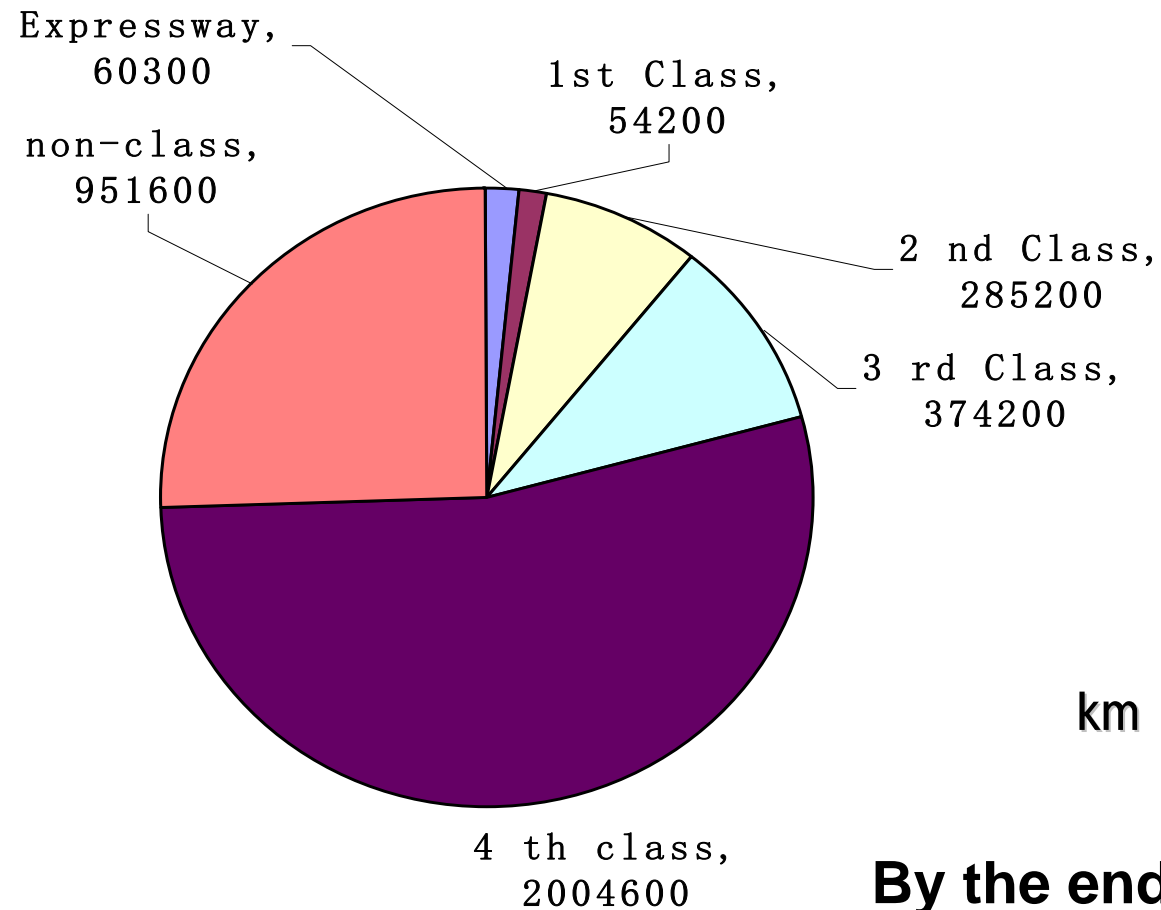
1、中国公路的发展概况

2、沥青路面再生

3、关于公路院

1、 China Road Network

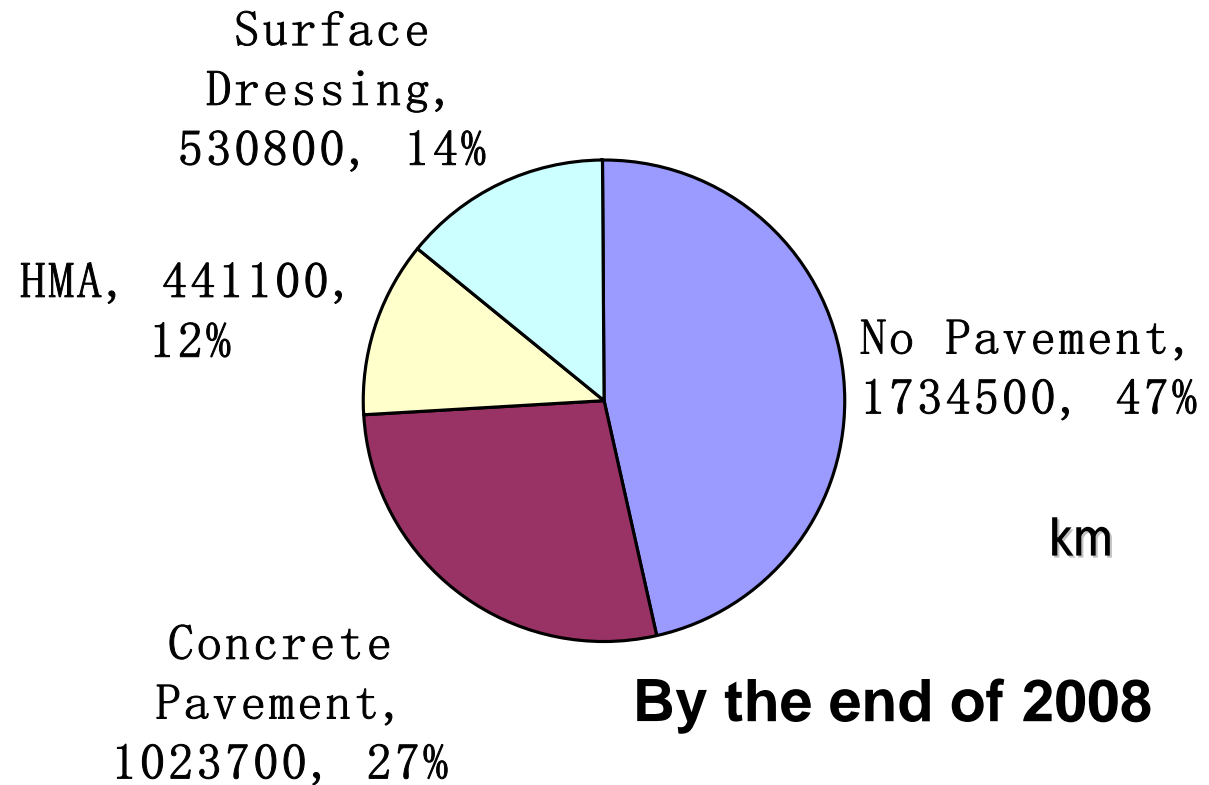
(1)Some facts :Total length of road:3.7 million km



By the end of 2008

1、China Road Network

1.99 million km have pavement.



铺装公路199万km,其中44万km沥青混凝土, 102万km水泥混凝土, 53万km简易铺装。

1、China Road Network

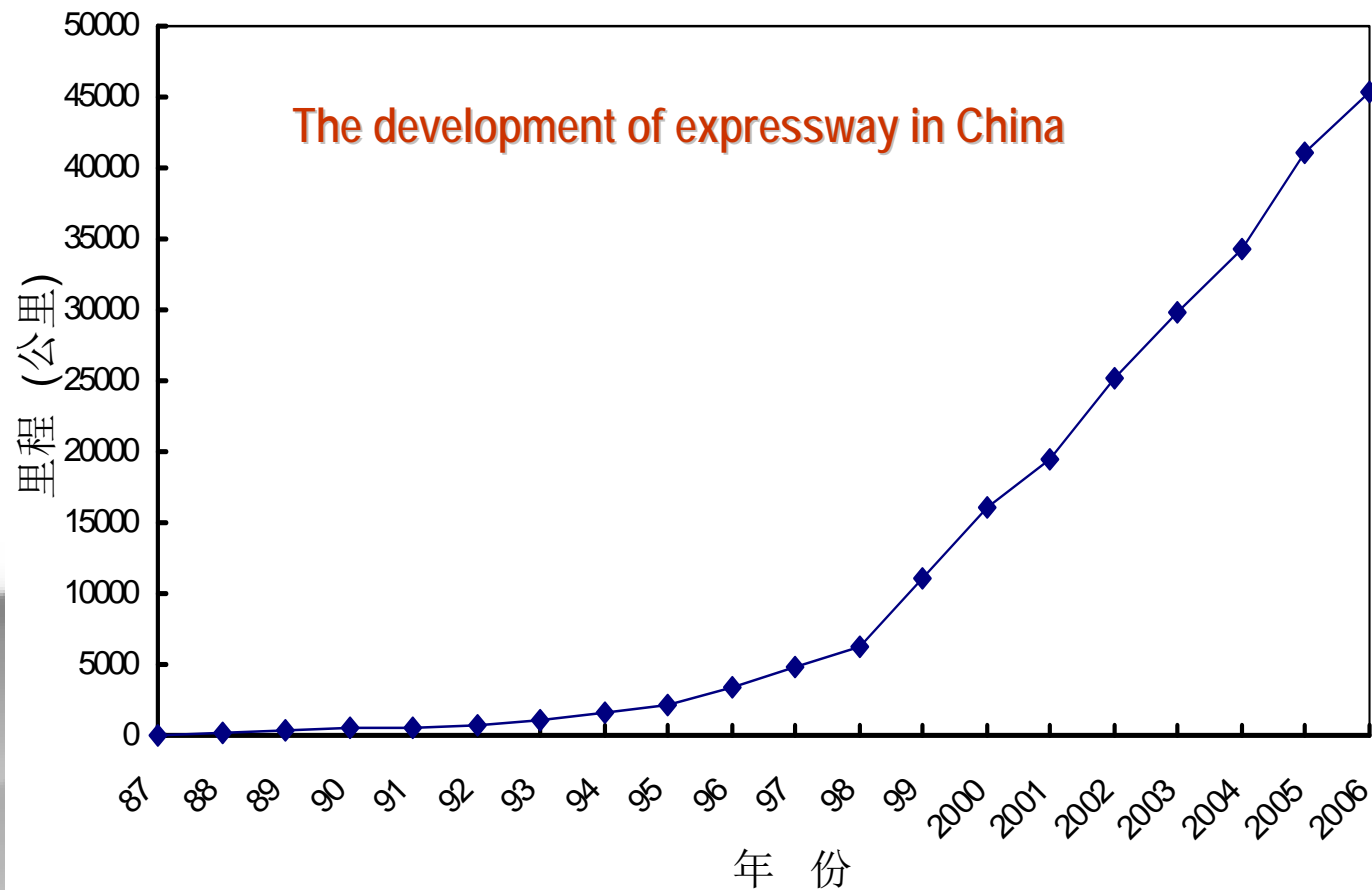
(2)Expressway network

By the end of 2008, the total length of expressway has reached 60,000 km, the second largest right after US.

About 80% of expressway has asphalt pavement, 20% has concrete pavement.

截止08年底，中国高速公路里程超过6万公里，世界第二位。其中80%采用沥青路面，20%为水泥路面。

1、China Road Network



近20年来 中国高速公路通车里程变化曲线

国家高速公路网布局方案

According to the plan issued by the central government in 2004, the total length of national expressway network will reach 85,000 km finally, nearly 25,000 km need newly construction.

按照国务院规划，中国国家高速公路网总规模将达到8.5万公里。

2004年12月17日，《国家高速公路网规划》已经国务院审议通过，为中国高速公路长远发展和交通运输现代化描绘了战略蓝图，标志着中国高速公路发展进入了新的历史阶段，我国公路网规模将进一步扩大，路网技术等级结构向高级化方向发展。

1、China Road Network

China has been the biggest road construction market in the past 2 decades, and it will continue.

- **New construction**
- **Maintenance**
- **Reconstruction and improvement**

过去20年间，中国是全球最大的公路建设市场，这种趋势还将继续保持下去。接下来，中国公路的建设、养护、重建、升级改造任务将交织在一起。



2、Asphalt Pavement Recycling

With more and more roads getting into reconstruction, and concept of sustainable development being widely accepted, Recycling has been becoming one of the hottest topics.

随着我国公路大量进入大中修养护期，随着可持续发展理念的深入人心，路面再生已经成为目前中国最热点的议题之一。

2、Asphalt Pavement Recycling

We began to use asphalt pavement recycling as early as 1980s in China. Asphalt recycling began booming from 2000 in China.

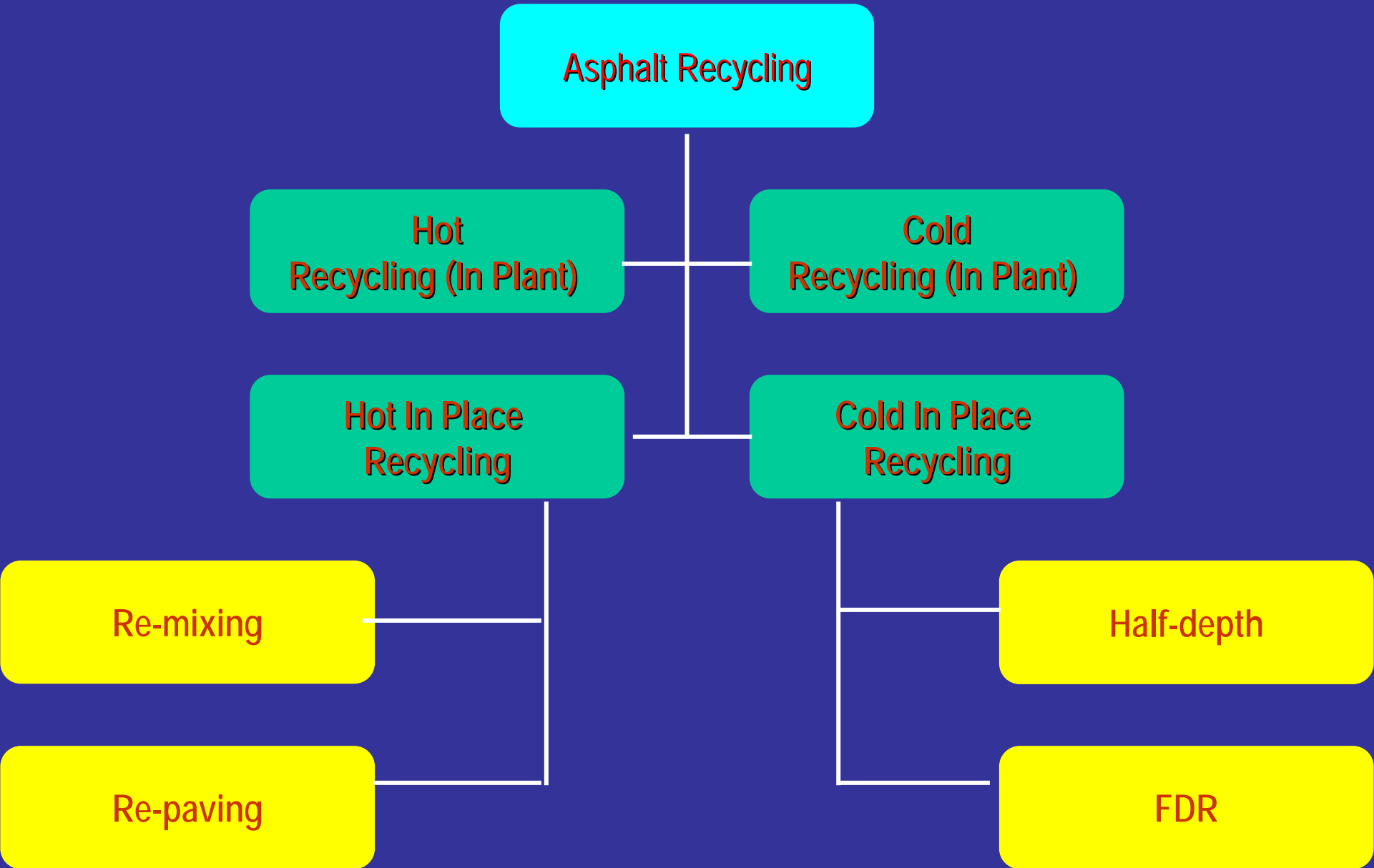


中国从上个世纪80年代起就开始使用沥青路面再生技术。2000年以后真正开始推广。

2、Asphalt Pavement Recycling

The ministry level asphalt pavement recycling specifications, drafted by a team led by RIOH, was enacted by MOT on July 1, 2008. It gives a great push to the use of recycling.

交通部于2008年7月1日颁布实施《公路沥青路面再生技术规范》，对再生技术在中国的应用起到积极推动作用。



Asphalt Recycling

Hot Recycling (In Plant)

Cold Recycling (In Plant)

Hot In Place Recycling

Cold In Place Recycling

Re-mixing

Half-depth

Re-paving

FDR

2、Asphalt Pavement Recycling

(1) Hot-In-Place Recycling

Hot-In-Place Recycling began to be used in China from 1990s, it has seen a rapid increasing.

首先是就地热再生：中国从90年代开始使用，发展比较迅速。

2、Asphalt Pavement Recycling

(1) Hot-In-Place Recycling

More than 7 million m² HIPR has been done.

The specifications define HIPR as a preventive maintenance tech.

目前中国已累计实施就地热再生超过700万平方米。
规范规定其为预防性养护技术措施。

2、Asphalt Pavement Recycling

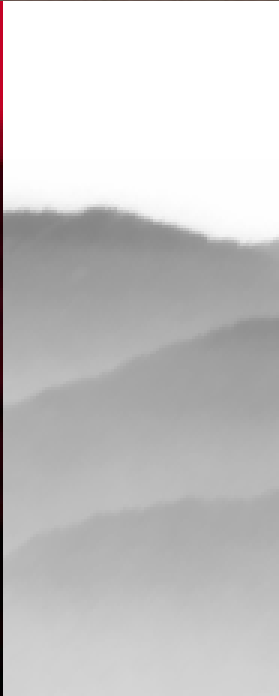
(1) Hot-In-Place Recycling

About 11 sets of HIPR machines, made by WIRTGEN, NIGATA, KALOTTIKONE, MATEC are working in China. Realizing that HIPR is a promising tech, Some local machinery companies have developed HIPR machines.

中国目前有约11套就地热再生机组，分别来自德国维特根、日本新泻、芬兰卡龙、加拿大马太克。一些中国机械制造企业认识到就地热再生的发展潜力，已经开发了就地热再生机组的样机。







Quality Control

Items	Frequency	Requirement	Test methods
Rejuvenator content	At any time	Meet the design	Every day
Compaction ratio	1~2 times/day	94% of maximum theoretical density	T0924, JTG F40-2004
Paving temperature	At any time	>120°C	

Items	Frequency	Requirement	Test methods
width (mm)	Once /100m	>designed width	T0911
Depth (mm)	At any time	±5	T0912
Overlay depth (mm)	At any time	±3	T0912
Unevenness (mm)	At any time	<3	T0931
Unevenness at longitudinal joint (mm)	At any time	<3	三米直尺
Unevenness at transverse joint (mm)	At any time	<3	三米直尺
appearance	At any time	表面平整密实，无明显轮迹、裂痕、推挤、油包、离析等现象	Eyeballing

2、Asphalt Pavement Recycling

(2) Hot Recycling (In Plant)

The consumption of Hot Recycling (In Plant) is relatively small for the time being. But we are sure that this will have the biggest share.

厂拌热再生目前在中国用量相当较小，但是我们相信该技术会成为应用最广的再生技术。

Hot recycling on GF Exp.

Pavement structure

4cm SMA-13 with PMB

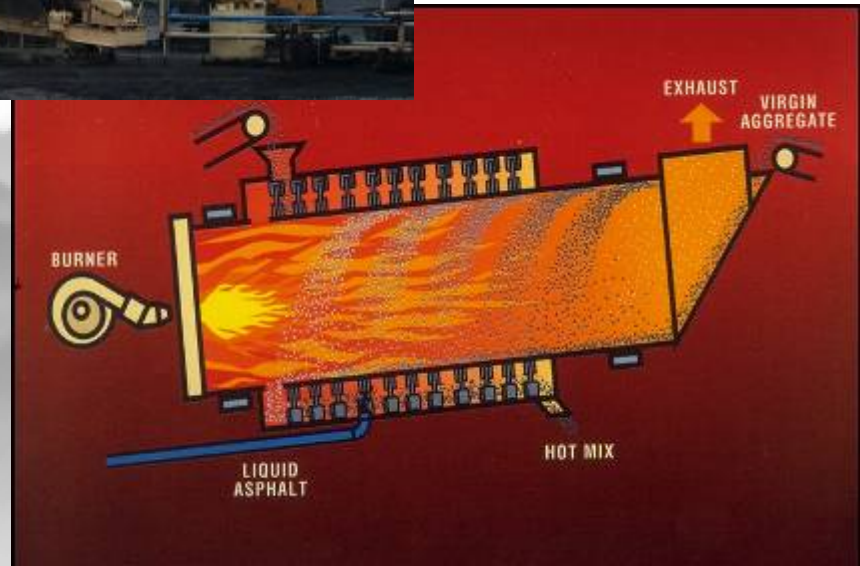
5cm AC -20 with PMB

6cm Hot-recycling AC-25I

Hot-recycling LSM-25 or concrete

Original base layer

Hot Recycling on GF Exp.





Batch Plant with
double drum in
Beijing



2、Asphalt Pavement Recycling

(3) Cold Recycling(In Plant)

Began to be used in recent 5 years. Some

examples:Hu-Ning Exp. , Emulsion; Chang-Jiu

Exp. , Emulsion; Xi-Yan Exp. , Foamed Asphalt.

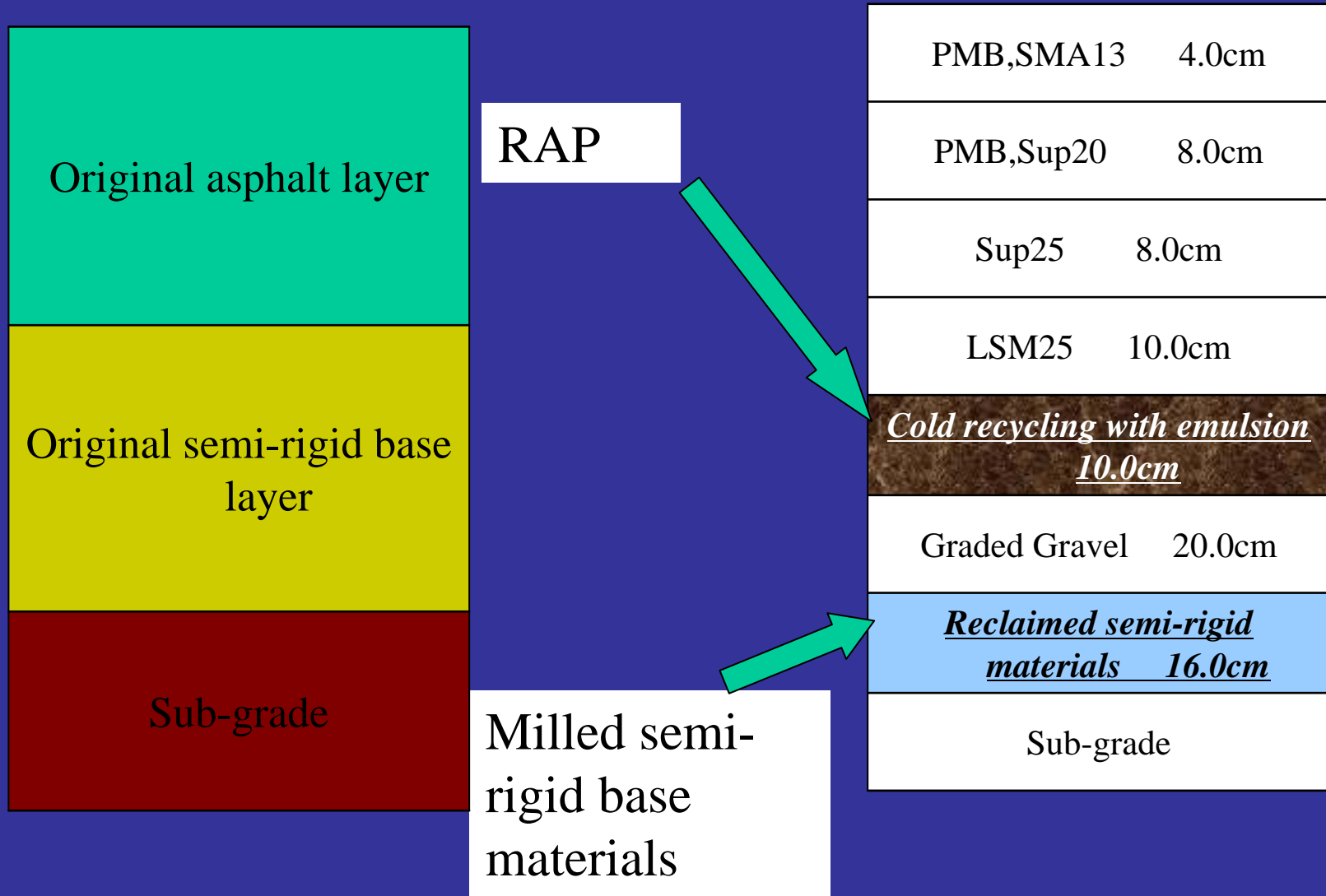
About 700km has been paved on expressways.

厂拌冷再生最近5年来开始在中国得到应用，如沪宁高速（乳化沥青）、昌九高速（乳化沥青）、西阎高速（泡沫沥青）。

Cold Recycling on HN Exp.



Cold Recycling on HN Expressway



Cold Recycling on HN Expressway-Zhenjiang

Asphalt layer (15cm)

**Semi-rigid Base
(15cm)**

Sub-grade

**4cm,PMB,AK-13A
8cm,SUP20
8cm,SUP20)**

**Cold recycling with
emulsion (10cm)**

Sub-grade

Cold Recycling on Changjiu Exp.

Original

Top asphalt	? cm
Second asphalt	4cm
3 rd asphalt layer	6cm
Semi-rigid base	22cm
Graded gravel	33cm

Afterwards

PMB,AC13	4cm
PMB,AC20	6cm
AC20	6cm
Cold recycling	10-12cm
Original base	20cm
Original graded gravel	

Cold Recycling on Changjiu Exp.



Cold Recycling on Changjiu Exp.



Cold Recycling on Xiyan Exp.

Original

AK-16	4cm
AC-20	5cm
AC-25	6cm
Semi-rigid base	20cm
Semi-rigid sub-base	28cm

Afterwards

AC-13	4cm
AC-20	6cm
Cold recycling, foam	14cm
Original base	20cm
Original sub-base	28cm



Aggregate gradation

Cold recycling with emulsion

Seive size (mm)	Percentage passing each seive (%)			
	Coarse	Medium	Fine-A	Fine-B
37.5	100			
26.5	80-100	100		
19		90-100	100	
13.2	60-80	-	90-100	100
9.5	-	60-80	60-80	90-100
4.75	25-60	35-65	45-75	60-80
2.36	15-45	20-50	25-55	35-65
0.3	3-20	3-21	6-25	6-25
0.075	1-7	2-8	2-9	2-10

Aggregate gradation

Cold recycling with foam

Sieve size (mm)	Percentage passing each sieve (%)		
	Coarse	Medium	Fine
37.5	100		
26.5	85-100	100	
19	-	90-100	100
13.2	60-85	-	90-100
9.5	-	60-85	-
4.75	25-65	35-65	45-75
2.36	30-55	30-55	30-55
0.3	10-30	10-30	10-30
0.075	6-20	6-20	6-20

Requirements for cold recycling mixture with emulsion

Items		requirements
Air voids		9%~14%
ITS/ 15°C	ITS at 15 °C, MPa	≥ 0.40 (base) ≥ 0.50 (sub-surface)
	ITS loss after soaking 24h, %	≥ 75
Marshal stability/ 40°C	Marshal stability, kN	≥ 5.0 (base/sub-base) ≥ 6.0 (sub-surface)
	Marshal stability loss after 24h soaking, %	≥ 75
TSR %		≥ 70

Requirements for cold recycling mixture with foam asphalt

Items		requirements
ITS/ 15°C	ITS at 15 °C, MPa	≥ 0.40 (base) ≥ 0.50 (sub-surface)
	ITS loss after soaking 24h, %	≥ 75
Marshal stability/ 40°C	Marshal stability, kN	≥ 5.0 (base/sub-base) ≥ 6.0 (sub-surface)
	Marshal stability loss after 24h soaking, %	≥ 75
TSR %		≥ 70

Aggregate gradation for cold recycling stabilized with cement or lime

Sieve size (mm)	Percentage passing (%)		
	1	2	3
37.5		100	90-100
31.5	100		
26.5	90-100		66-100
19	72-89		54-100
9.5	47-67		39-100
4.75	29-49	50-100	28-84
2.36	17-35		20-70
1.18			14-57
0.6	8-22	17-100	8-47
0.075	0-7	0-30	0-30

Requirements for cold recycling mixture with foam asphalt

Items		Stabling agent			
		Cement		Lime	
		Exp. And first class highway	Second class and below	Exp. And first class highway	Second class and below
UCS (MPa)	Base	$\geq 3 \sim 5$	$\geq 2.5 \sim 3$	-	≥ 0.8
	Sub-base	$\geq 1.5 \sim 2.5$	$\geq 1.5 \sim 2.0$	≥ 0.8	$\geq 0.5 \sim 0.7$

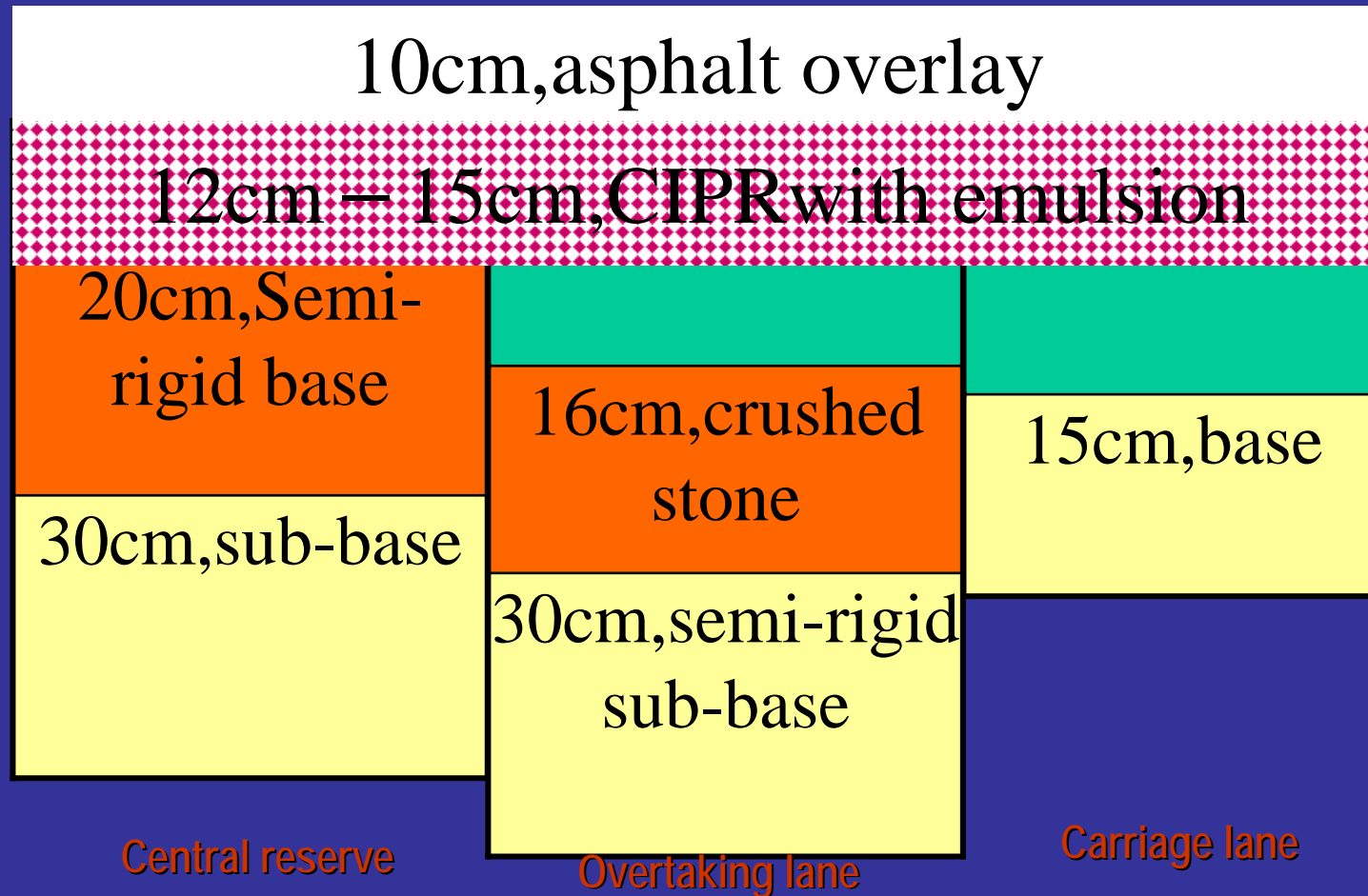
2、Asphalt Pavement Recycling

(4) Cold-In-Place Recycling

CIPR is one of the most popular recycling methods in China. The majority of CIPR in China used Cement or lime, only recent 5 years foamed asphalt and emulsion began to be more popular.

就地冷再生是目前中国应用最多的再生方式之一。绝大多数采用水泥、石灰作为结合料，最近5年应用泡沫沥青、乳化沥青开始多起来。

Cold In Place Recycling on Yingda first class highway



就地冷再生 一营大路



就地冷再生

—营大路



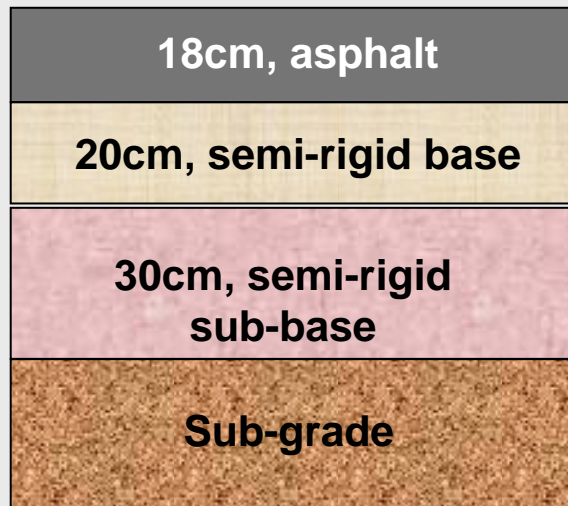
就地冷再生 一营大路

Performing excellent 4 years after construction

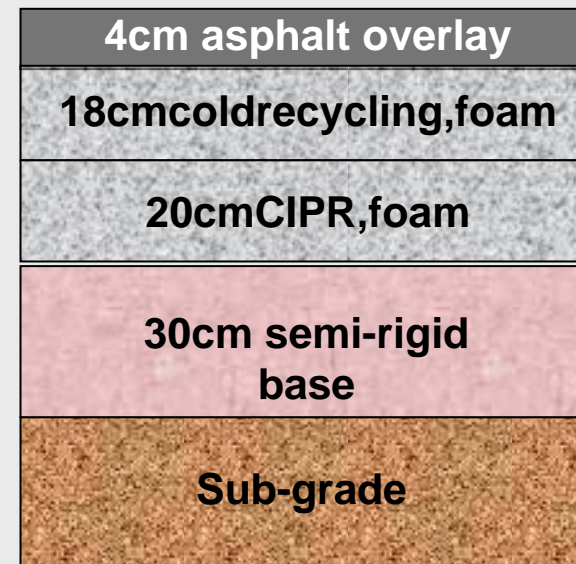


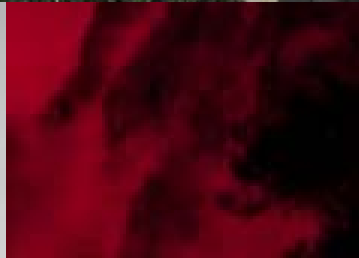
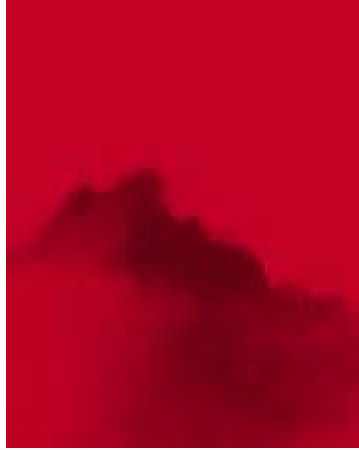
Cold In place recycling on Jingshen Exp.

original



afterwards







Cold in place recycling on Xicheng Road





CIR900-4

ROADTEC



titan titan

titan titan

ABG

21402

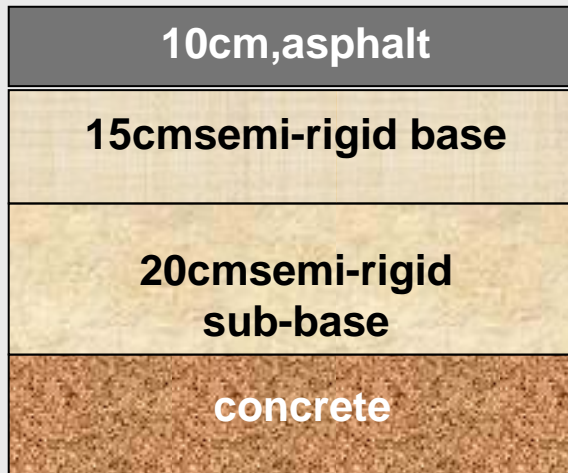
00-4



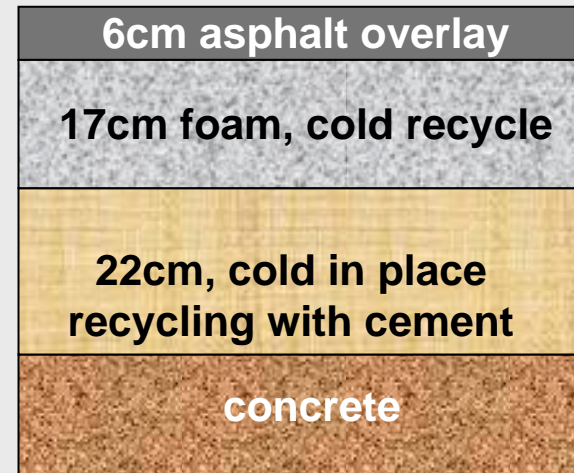


Cold recycling on GD320 Zhe-jiang

Original



afterwards







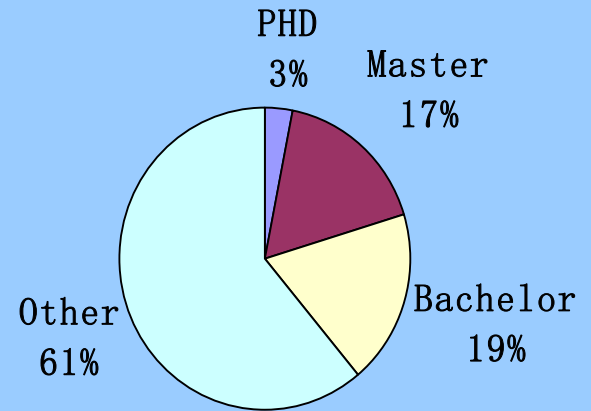
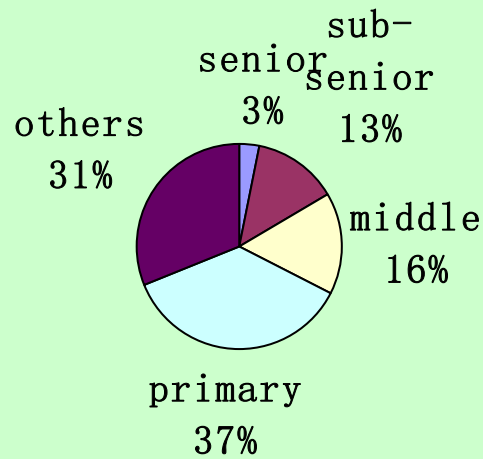
Quality control

items		requirements	Frequency	Test method
Using emulsion	Compaction ratio (%)	≥ 90 (Exp. And first class) ≥ 88 (second class and below)	Once/ one lane km	T0924 or T0921
	Air voids (%)	≤ 10 (Exp. And first class) ≤ 12 (second class and below)		
Using foam	Compaction ratio (%)	≥ 98 (Exp. And first class) ≥ 97 (second class and below)	Once/ one lane km	T0924 or T0921

15°C ITS (MPa)	Meet the design requirement	Once / day	T0716
ITS loss after 24h soaking (%)	Meet the design requirement		T0716
Marshal stability (kN)	Meet the design requirement		T0709
Retained Marshal stability (%)	Meet the design requirement		T0709
TSR (%)	≥ 70	Once / 3 days	T0729
Water content	Meet the design requirement	At any time	T0801
Asphalt content and aggregate gradation	Meet the design requirement	At any time	Extraction and sieving

Items		Requirements	Frequency	Test method
unevenness (mm)		10	2 times/200 m	T0931
Vertical highness (mm)		± 10	1 time / 20 m	T0911
thickne ss (mm)	average	-10	1 time / 10 m lane	-
	Each data	-20		
width (mm)		Wider than design	Once / 40 m	T0911
slope (%)		± 0.3	3 times / 100 m	T0911
appearance		表面平整密实, 无浮石、弹簧, 无明显压路机轮 迹	At any time	eyeballi ng

4、About RIOH



公路院在职职工总数1559人,工程院院士1人,国务院参事1人,博导6人,硕士以上21%专业技术人员69%

Research Centers

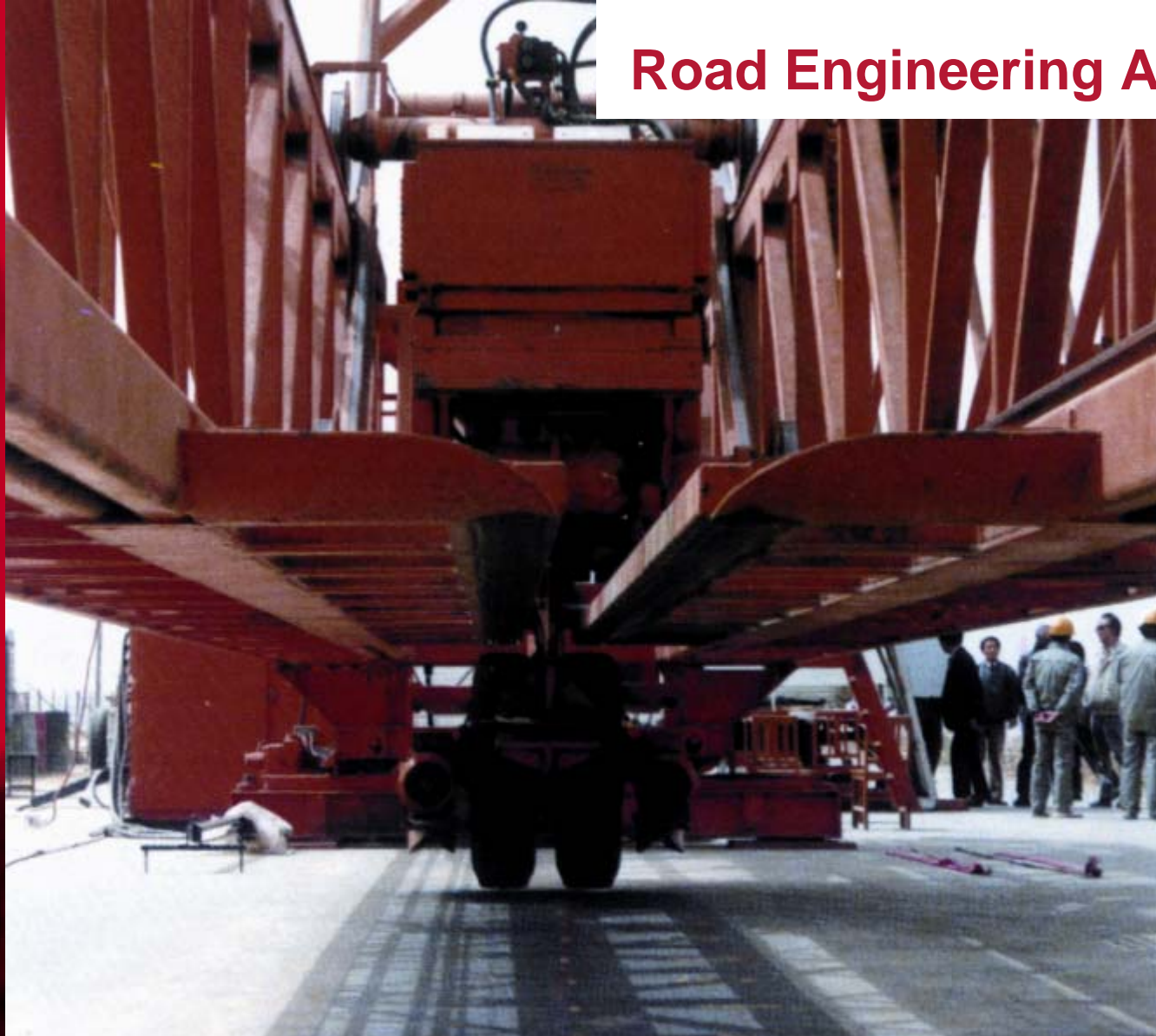
- ❁ Highway Engineering RC
- ❁ Traffic safety RC
- ❁ ITS RC
- ❁ Automobile RC
- ❁ Environment RC
- ❁ Traffic economy RC
- ❁ Logistic RC
- ❁ Maintenance management RC

Proven Ground

汽车运输技术研究实验室（场）



Road Engineering ALF



交通部重点实验室——道路结构与路面材料实验室



Bridge Engineering

重点实验室 —— **桥梁结构
与耐久性实验室**

Emission Test



重点实验室——排放实验室

Collision Test



重点实验室——碰撞实验室



Thank You

XU Jian 徐 剑

Email: j.xu@rioh.cn

Tel: 86-10-62079525