



4 Maintenance Works

In response to the claim for government reorganization and manpower streamlining and to meet the increasing tasks generated by the multiplying growing number of road management tasks over the years as well as guided by the business management concepts introduced from the private sector and eventually lowering the government operation costs, contracted maintenance operations of like nature have been successfully integrated for minimum operations demanded by government purchase. At this time, except for those demanding immediate repairs, all other maintenance operations are awarded to private corporations.

1. Maintenance works

In order to keep freeways, bridges and the additional facilities in sound condition for safe traffic on a regular basis, a wide variety of maintenance measures have been adopted and, various maintenance works have been practiced by following different maintenance principles and methods for



existing facilities. Again, as freeways are vulnerable to typhoons, earthquakes and damages by humans that result in interrupted traffic or unsafe travels among other risks, the maintenance agencies in this office are required to produce immediate report, repair or restoration assuring sound service at all times on freeways, which are expected to be used as life rescue line in case of disaster.

Regular maintenance works involve repairs of freeway sub grades, pavements and shoulders, management and maintenance of freeway bridges and tunnels, drainage facilities, roadside landscaping and traffic facilities. Regular patrols in the jurisdictional sections are conducted by designated maintenance personnel; plans are prepared per road conditions and updated needs before assigning required works. As of late 2011, total distance requiring maintenance went at 1,014.6kms.

Tables of Maintenance Mileage

Routes	Route Mileage (km)	Toll stations (section)	Interchange (place)	Service Area (area)	Remark
National Freeway No. 1	393.4	11	67	6	Containing Xiwu elevated road 20.7km.
National Freeway No. 2	20.4	-	5	-	
National Freeway No. 3	432.9	11	63	7	Containing Nangang access road 1.4km.
National Freeway No. 3 Jia	5.6	-	3	-	
National Freeway No. 4	17.2	-	4	-	
National Freeway No. 5	54.2	1	6	1	
National Freeway No. 6	37.6	-	6	-	
National Freeway No. 8	15.5	-	4	-	
National Freeway No. 10	33.8	-	5	-	
Ji Lane of Tai No. 2 Provincial Highway	4.0	-	3	-	
Total	1,014.6	23	166	14	

2. Tunnel Management and Maintenance

Of the 58 tunnels in the national freeways open for traffic, 2 are in National Freeway No. 1, 4 in National Freeway No. 3 Line A, 30 are in National Freeway No. 3, 10 in National Freeway No. 5, 6 in National Freeway No. 6 and another 6 in Tai 6 for a total distance of 81.319kms. The regional traffic control centers



monitor all movements in the tunnels and all incidents are timely reported for immediate solution; vehicles carrying hazard materials are banned from traveling sections with tunnels (except for those having duly approved).

In addition to daily patrols and monthly cleaning and lining in the night, all mechanical and electrical systems and traffic control facilities in the tunnels and machine rooms are checked on a weekly, bi-weekly, monthly, quarterly and annual basis. Management highlights are given per characteristics, function, safety demand and use for sound maintenance tasks. Each year, an overall equipment performance test is ordered for the sake of safe travel and comfortable travel environment.



Zhongliao Tunnel



Zhongxing, Daye Tunnel



National Freeway Tunnels

Freeway No.	Tunnel Name	Driving Direction	Starting and Ending Mileage	Length (m)
National Freeway No. 1	Zhongxing	Southbound	0k+020 ~ 0k+421	401
	Daye	Southbound	0k+020 ~ 0k+574	554
Jia Lane, National Freeway No. 1	Taipei No.1 Tunnel	Eastbound	2k+026 ~ 2k+826	800
		Westbound	2k+008 ~ 2k+798	790
	Taipei No.2 Tunnel	Eastbound	0k+705 ~ 0k+897	192
		Westbound	0k+682 ~ 0k+893	211
National Freeway No. 3	Keelung	Southbound	0k+805 ~ 2k+060	1,255
		Northbound	0k+840 ~ 2k+118	1,278
	Qidu	Southbound	5k+795 ~ 6k+325	530
		Northbound	5k+745 ~ 6k+300	555
	Xizhi	Southbound	8k+160 ~ 8k+826	666
		Northbound	8k+175 ~ 8k+818	643
	Fude	Southbound	18k+268 ~ 19k+994	1,726
		Northbound	18k+185 ~ 19k-911	1,726
	Muzha	Southbound	21k+888 ~ 23k-736	1,848
		Northbound	21k+860 ~ 23k+735	1,875
	Jingmei	Southbound	23k+939 ~ 24k+503	564
		Northbound	23k+919 ~ 24k+492	573
	Xindian	Southbound	27k+219 ~ 28k+404	1,185
		Northbound	27k+170 ~ 28k+392	1,222
	Bitan	Southbound	28k+559 ~ 29k+080	521
		Northbound	28k+541 ~ 29k+044	503
	Ankeng	Southbound	32k+626 ~ 33k+092	466
		Northbound	32k+710 ~ 33k+108	398
	Zhonghe	Southbound	34k+223 ~ 35k+095	872
		Northbound	34k+262 ~ 35k-093	831
	Puding No. 1	Southbound	59k+510 ~ 60k+040	530
		Northbound	59k+510 ~ 60k+065	555
	Puding No. 2	Southbound	60k+300 ~ 60k+635	335
		Northbound	60k+325 ~ 60k+660	335
	Dalin	Southbound	281k+696 ~ 281k+850	154
		Northbound	281k+696 ~ 281k+850	154
	Lantang	Southbound	292k+880 ~ 294k+134	1,254
		Northbound	292k+880 ~ 294k+092	1,212
	Zhongliao	Southbound	378k+780 ~ 380k+638	1,858
		Northbound	378k+780 ~ 380k+605	1,825
National Freeway No. 5	Nangang	Southbound	0k+237~0k+575	456
		Northbound	0k+234~0k+572	431
	Shiding	Southbound	0k+692~3k+480	2,698
		Northbound	0k+689~3k+514	2,720
	Wutu	Southbound	7k+677~7k+892	215
		Northbound	7k+894~7k+645	249



Freeway No.	Tunnel Name	Driving Direction	Starting and Ending Mileage	Length (m)
National Freeway No. 5	Pengshan	Southbound	9k+441 ~ 13k+302	3,861
		Northbound	13k+263 ~ 9k+457	3,806
	Hsuehshan	Southbound	15k+263 ~ 28k+134	12,871
		Northbound	15k+180 ~ 28k+127	12,947
National Freeway No. 6	Guoxing No. 1	Eastbound	17k+678 ~ 20k+142	2,464
		Westbound	17k+690 ~ 20k+138	2,447
	Guoxing No. 2	Eastbound	24k+502 ~ 25k+037	535
		Westbound	24k+522 ~ 25k+002	480
	Puli	Eastbound	27k+469 ~ 28k+778	1,309
		Westbound	27k+466 ~ 28k+728	1,262
Ji Lane of Tai No. 2 Provincial Highway	Zhongxiao	Southbound	0k+495 ~ 0k+913	418
	RenAi	Northbound	0k+495 ~ 0k+913	418
	Xinyi	Southbound	2k+570 ~ 2k+845	275
	Heping	Northbound	2k+570 ~ 2k+770	200
	Dawulun	Southbound	3k+260 ~ 3k+662	402
	Daganlin	Northbound	3k+204 ~ 3k+662	458
Total		58		81.319 km

3. Inspection, Maintenance and Management of Bridges

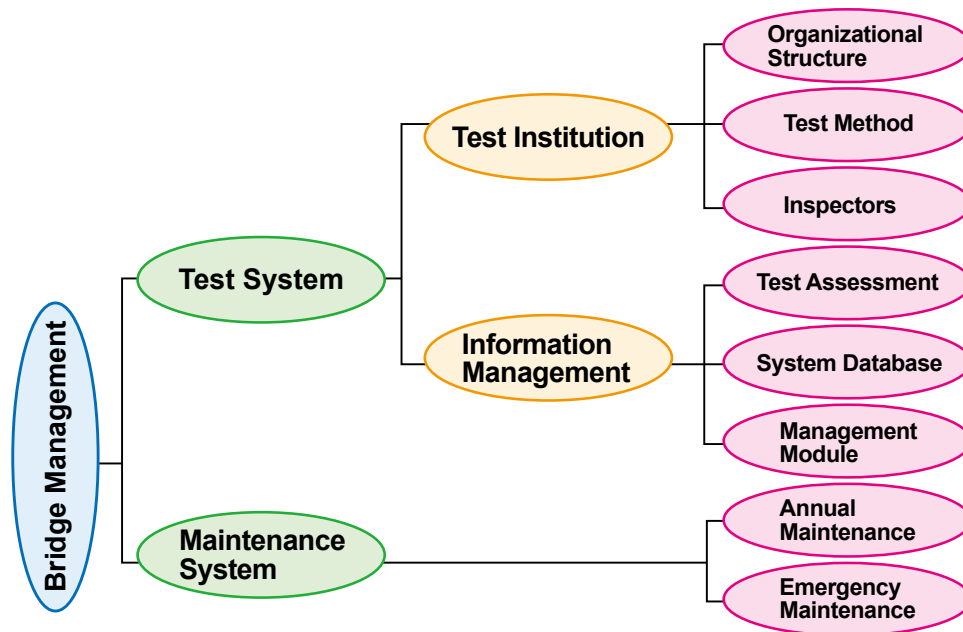
As transportation projects evolve, river bridges and overhead bridges are playing growingly important roles in transportation works. In Taiwan, bridges are vulnerable to frequent man-made destructions (collision impacts, fire) and disasters (such as earthquake and flood), regular tests are required for operational bridges along with sound data filing before safety evaluations based on damages suffered in bridges for plans for eventual maintenance and reinforcement remedies.

When the National Freeway No. 1 was fully open for traffic in 1978, there were 245 bridges and today, there are 2,192 of them. As we become growingly responsible for maintenance and management of the bridges, of which the ones in the 30-and-odd-year-old National Freeway No. 1 are severely aging and tests and maintenance operations become imminent.

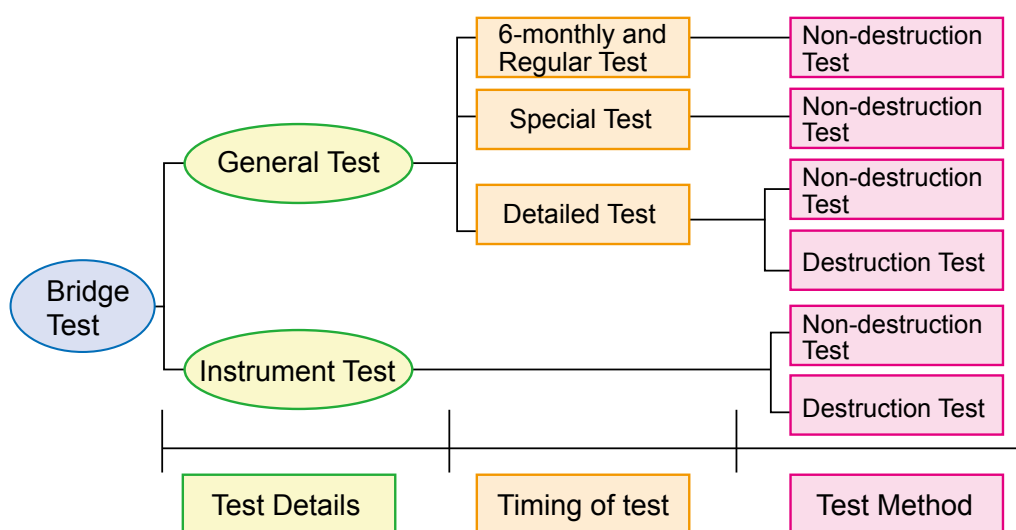
By following the Bridge Test operating guidelines by Taiwan Area National Freeway Bureau, MOTC, the Region Engineering Offices in this bureau carry out regular inspections and tests to the bridges in their districts and the results are

kept in the Taiwan Bridge Management System for reference of maintenance or reinforcement works.

The bridge management system plan diagram is shown below:



Freeway Bridge Management System Chart



Freeway Bridges Test Categories



4. Freeway Environment

(1). Landscape and Vegetation

The Bureau manages the greenery on its lands, estimated total greenery coverage to 2,692 hectares, 494 thousand trees and 2.79 million shrubs. This year, the vegetation landscaping task goes mainly as follows:

A. Road Cleaning Work and Vegetation Maintenance

In addition to the currently scheduled daily outer road shoulder garbage collection, and weekly sweeps, the work crew combines inner road shoulder sweeps and garbage collection to twice or four times per month. This year, we kept on deploying inner signing cars and mobile anti-collision facilities to ensure the safety of work crew and road user.

Any maintenance work must be implemented during non-rush hours to keep traffic flow smooth. The maintenance work has to be stopped, and the work crew must evacuate as soon as possible if the operation causes a traffic jam stretching for 5km, or an average road speed of less than 30 kilometers per hour.

A meeting was called on August 25 2011 in this office for the review of general operations performance. Based on the conclusions reached in the meeting and the Guideline for Traffic Control for Construction Works revised in October 2011, the operation instructions were revised and incorporated into the contract 2012 for implementation and they include:

- a). The adding of signing cars with mobile anti-collision facilities to mobile and transient construction on inner lanes and the uniform specifications, standards as well as implementation regulations for anti-collision facilities.
- b). The adding of punitive measures to working personnel standing on Jersey barriers without erecting traffic control measures or without having participated in construction safety training programs among other violations.
- c). All short-term, temporary or mobile construction vehicles parked on shoulders must be in yellow-color car body with a yellow-color warning light on the top of the vehicle.



B. Strengthen the landscape improvement of key nodes and slopes

The most important landscape improvements are as follows: planting ornamental plants in the visual focus areas of road users like main road sides, interchanges and service areas; covering the retaining walls, bridge piers and noise barriers by planting vines and bushes; and planting native or adaptive species on the slopes along the freeways to accelerate ecological successions and restore natural scenes.

The details of landscape improvement projects including planting and contract award that were completed or contracted out in this year are as follows:

- a).As highlighted landscaping works, they are the reinforcement works for central median landscape of National Freeway Linkou upper and lower separation lane and Kaohsiung metropolitan area slope planting beautification works in the National Freeway No. 1).
- b).For the Plains Reforestation Program of the Forest Bureau, our bureau the slope greenery land for forestation in natural environment:



The reinforcement works for central median landscape of National Freeway No. 1 Linkou upper and lower separation lane, which include local-produced and ornamental species in multi-layer and irregular curves for diverse colors and scenes.

I. Central Region Engineering Office District:

The green forestation program materialized in 2009 in Yunlin System Interchange, National Freeway No. 1 and Kuaiguan Interchange, National Freeway No. 3 (totaling 25.3 hectares) included 23,823 trees



that remain under preservation. The forestation program carried out this year in the open area beneath the Puyan Interchange and Yunlin System Interchange overpasses, National Freeway No. 1 (totaling some 10 hectares) was completed in November and 9,980 trees were planted. Additionally, open areas beneath Zhonggang System Interchange (totaling some 12.8 hectares), Caotun Interchange to Zhushan Interchange (totaling 43.2 hectares) will also be designated as lands for forestation.



Growth of the plants made in the Yunlin System Interchange, the National Freeway No. 1 in 2009



Open area forestation made in the Puyan System Interchange, the National Freeway No. 1 this year

II.Southern Region Engineering Office District:

In addition to the forestation program materialized in the slopes and open areas by the Shueishang System Interchange, Tainan Interchange to Zhutian System Interchange and Pingtung Section District in the National Freeway No. 3, forestation was carried out between June and July this year in the slopes on the interchanges in Gangshan Section District and the open areas on the interchanges in Rende System, Luzhu, Gaoke, Gangshan, Dingjin System in National Freeway No. 1, where 14,115 trees were planted (in approximate 17.6 hectares).

C).Landscape Improvement Projects in Incorporation with Freeway Widening Construction or Facilities

To preserve green resources and reduce the impact of construction projects on the vegetation, the planning of transplantation and new plantation had been processed incorporating with the widening construction.



Upon completion of the contract for the widening project of National Freeway No. 2, the new plantation work under Contract H20B (between Dayuan and Dazhu Interchanges) began in late September 2010. The works were successfully completed in February 2011 for maintenance after passing tests.



In the widening project of the road-cutting sections between Dayuan and Dazhu in the National Freeway No. 2, the plantation in the side slopes remains and bushes are added to make the side an avenue greeting visitors.

D).Evaluation of the adoption of National Freeway Interchange and Slope Landscape Maintenance

There are 42 organizations this (2011) year participating in the contest of adoption of landscape maintenance of interchanges, slopes and the areas under viaduct. Among them, 8 organizations were initially rated by engineering offices at 80 and more points. After having been repeatedly rated, Weide Neighborhood Office in Sanchong District that had adopted the side slop green to the right side northbound of the Sanchong Interchange, National Freeway No. 1 and Miaoli County Government, which had adopted the greenery lands in National Freeway No. 1 and National Freeway No. 3 interchanges in Miaoli County, were appraised publicly by this office as both met the criteria for rewarding.



Planting beautification for side slope of the northbound exit, Sanchong Interchange, the National Freeway No. 1 (adopted by the Weide Neighborhood Office, Sanchong District)



Tunghsiao Interchange planting beautification, the National Freeway No. 3 (adopted by the Miaoli County Government)

E). Prevention and Removal of Foreign Invasive Species

Invasive species, such as *Mikania micrantha*, *Eupatorium odoratum* Linn and *Leucaena leucocephala* grow and spread rapidly to cause a considerable threat to the local flora. thus inaccordance with Forestry Bureau's recommendation with current prevention, the Bureau established hacking away plans in May 2005 to positively accelerate vegetation restoration on slopes to establish biodiversity to prevent reinvasion.

Effective 2006, these data will be taken from January to February each year to the Epidemic Species Research Institute of Council of Agriculture to assess progress of actual species spread and total removal areas to closely monitor the scale of the invasion.

The treatments of this year are as follows:

(a). *Mikania micrantha*:

In May each year, a survey is conducted on growth and areas of spreading to verify the area of eradication; a monthly eradication is conducted between July and September and in the blossoming period between October and November, another survey is conducted on remaining areas for evaluation of performance of the effort. This year, the effort covered 24.14 hectares including Guanxi, Miaoli, Dajia, Nantou, Dounan, Baihe and the areas in the



jurisdictional sections in the Pingtung District.

(b).*Eupatorium odoratum* Linn:

Pursuant to the eradication and survey and monitoring timing for *mikania micrantha*, a thorough pruning is conducted between August and October and in the blossoming period between December and January, a survey is conducted on remaining areas. This year, the effort covered 4.47 hectares in Baihe and the areas in the jurisdictional sections in the Pingtung District.

(c).*Leucaena leucocephala*:

Due to the manpower and budget available, pruning on an irregular basis is conducted along with new plantations or maintenance tasks. In the area of eradication, a variety of tree and shrub species are planted to keep alien species from coming in.

F).Research and Development

In order to learn potential ecological impacts on the facilities and landscaping efforts along the national freeways before defining development strategies for sustainable use to assure road building according to the environment, our bureau has invited Observer Ecological Consultant Co., Ltd. to prepare the Sustainable Development and Environmental Restoration Plan for National Freeways, which became effective in December 2008. In November 2011, the final report filed included sustainable management frameworks and objectives for the national freeways, survey on ecological resources along the national freeways, evaluation and grading of ecologically sensitive sections in the national freeways and national freeway fatalities survey and analysis among others. Animal protection measures in 5kms were properly improved this year. On October 24, 25, a number of successful works were made public in the National Freeway Sustainable Management and Environmental Restoration Seminar.



Deputy Minister Yeh, MOTC speaking at the inauguration ceremony for the seminar

(2).Red Imported Fire Ants (RIFA) Control

In May 2004 and based on the resolutions reached in the 1st National Conference for Prevention and Eradication called by the Bureau of Animal and Plant Health Test and Quarantine, Council of Agriculture, our bureau conducted a plague survey in all national freeways that covered 110 hectares, where active measures were implemented. As of 2011, the effort of prevention and eradication of alien red fire ants waged by this office covered 8 areas including the left side of the northbound entrance loop of the Sanying Interchange, the National Freeway No. 3 at 67k+400 and the southbound at 65k+400 in 4 spots totaling 55.5 hectares (46.4hectares in the National Freeway No. 1, 5.1 hectares in the National Freeway No. 2 and 4 hectares in the National Freeway No. 3), all in the jurisdiction of the Northern Region Engineering Office. Besides, in the worksites of the National Freeway No. 1 at 52k~60k and the Neili Interchange in the Wugu Yangmei Section in the National Freeway No. 1, where widening works are conducted, and the prevention and eradication efforts are currently waged by TANFB.

While conducting regular maintenance and patrols, our bureau is implementing relevant measures within 1 week upon detecting red fire ants. A bi-weekly monitoring follows and on a monthly basis, performance of the effort is published on the Website for Plant Health Inspection and Quarantine, BAPHIQ. In areas restrictive measures have been lifted, ongoing monitoring and medication is implemented to keep new occurrences from taking place.



Further, in the contract entered by this office for new plantations and road works, mobile quarantine for fire ants in new plants and earths is specified to minimize spreading and infection rates as a way to avoid further spreading.

5. Pavement Rehabilitation Project

The highlighted projects for pavement rehabilitation 2011 are as follows:

No	Project title	Length (m)	Area (m ²)	Expense (NT\$1,000)
1	Asphalt concrete pavement rehabilitation for the section between Yuanshan and Linkou, the National Freeway No. 1	34,553	160,805	48,500
2	Asphalt concrete pavement rehabilitation for the section between Keelung and Donghu, the National Freeway No. 1	40,225	140,788	47,320
3	Rigid pavement rehabilitation for the Neihu Section	214	750	3,715
4	Pavement improvement works for open traffic side shoulders between Neihu and Yuanshan, the National Freeway No. 1	22,962	80,367	48,780
5	Pavement improvement works for the additional auxiliary lanes between Donghu and Neihu (two-way), the National Freeway No. 1	9,670	35,420	32,530
6	Asphalt concrete pavement rehabilitation for the section between Linkou and Yangmei, the National Freeway No. 1	61,056	228,959	70,094
7	Asphalt concrete pavement rehabilitation for the section between Taoyuan to Hukou, the National Freeway No. 1	46,427	174,104	70,389
8	Rigid pavement rehabilitation for the Yangmei Toll Station, the National Freeway No. 1	6,850	233	2,586
9	Asphalt concrete pavement rehabilitation for the section between Guanxi and Xiangshan, the National Freeway No. 3 and the Hsinchu Section, the National Freeway No. 1	39,077	145,893	45,197
10	Asphalt concrete pavement rehabilitation for the section between Guanxi and Xiangshan, the National Freeway No. 3	6,244	23,293	7,216
11	Rigid pavement rehabilitation for the large parking lot, the Guanxi Service Area, the National Freeway No. 3	5,727	21,476	7,290
12	Rigid pavement rehabilitation and caulking works in the Guanxi Section District	34	131	5,460
13	Asphalt concrete pavement rehabilitation for the section between Keelung and Xizhi, the National Freeway No. 3	26,000	203,177	70,353
14	AC pavement rehabilitation for the section between Muzha and Zhonghe, the National Freeway No. 3	7,230	160,512	67,351
15	Asphalt concrete pavement rehabilitation for the Xindian steel bridge slab, the National Freeway No. 3	800	12,129	7,176
16	Rigid pavement rehabilitation for the Qidu Toll Station, the National Freeway No. 3	400	5,000	3,429
17	Asphalt concrete pavement rehabilitation for the section between Toucheng to Suao, the National Freeway No. 5	425	1,700	11,423
18	Asphalt concrete pavement rehabilitation for the section between Touwu and Tongluo, the National Freeway No. 1	34,313	120,097	42,539
19	Asphalt concrete pavement rehabilitation for the section between Taichung System and the Shengang, the National Freeway No. 4	46,080	184,320	42,341
20	Pavement maintenance works in the Miaoli Branch District	2,823	14,119	14,763
21	Cement concrete pavement rehabilitation for the Miaoli Section District Toll Station, the National Freeway	200	1,000	5,391



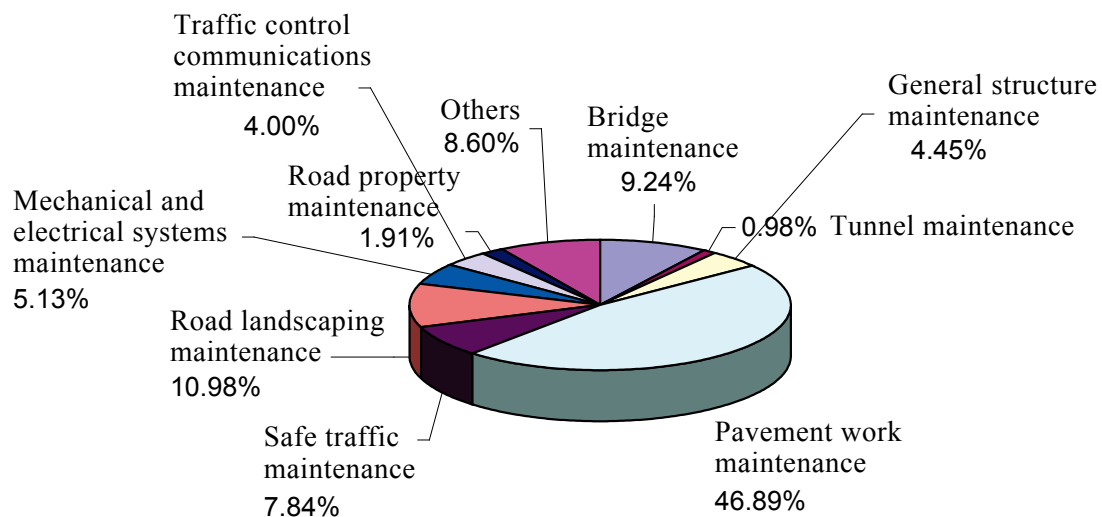
No	Project title	Length (m)	Area (m ²)	Expense (NT\$1,000)
22	Asphalt concrete pavement rehabilitation for the section between Yuanlin and Xiluo, the National Freeway No. 1	21,428	87,682	34,238
23	Asphalt concrete pavement rehabilitation for the section between Beidou and Dalin, the National Freeway No. 1	13,113	51,792.2	26,402
24	Cement concrete pavement rehabilitation for the Yuanlin and Dounan Toll Stations	852	2,982	8,710
25	Asphalt concrete pavement rehabilitation for the section between Houlong and Hemei, the National Freeway No. 3	299,990	82,189	41,871
26	Asphalt concrete pavement rehabilitation for the section between Xiangshan and Zhanghua, the National Freeway No. 3	8,167	29,811	24,965
27	Asphalt concrete pavement rehabilitation for the section between Taichung and Zhanghua, the National Freeway No. 3	23,643	115,847	20,175
28	Asphalt concrete pavement rehabilitation for the section between Nantou and Yunlin, the National Freeway No. 3	45,897	191,716	40,860
29	Cement concrete pavement rehabilitation for the Nantou Section District	678	2,475	13,687
30	Asphalt concrete pavement rehabilitation for the Dalin Xinying Section, the National Freeway No. 1	22,212	83,295	48,706
31	Asphalt concrete pavement rehabilitation for the Xinying Yongkang Section, the National Freeway No. 1	17,999	66,596	49,252
32	Asphalt concrete pavement rehabilitation for the Madou e Section for Defense Purpose	25,264	93,477	39,583
33	Pavement rehabilitation for the Xinying Branch District	3,443	12,791	15,000
34	Cement concrete pavement rehabilitation for the Xinying Branch District	100	344	3,254
35	Asphalt concrete pavement rehabilitation for the section between Luzhu and Nanzi, the National Freeway No. 1	22,447	84,304	43,325
36	Asphalt concrete pavement rehabilitation for the section between Yongkang to Dingjin, the National Freeway No. 1	19,715	73,862	50,121
37	Asphalt concrete pavement rehabilitation for the section between Gangshan and Kaohsiung, the National Freeway No. 1 and the National Freeway No. 10	17,436	63,869	43,058
38	Asphalt concrete pavement rehabilitation for the section between Rende and Gangshan, the National Freeway No. 1	17,129	69,418	49,494
39	Cement concrete pavement rehabilitation in the Gangshan Branch District	266	1,045	6,295
40	Asphalt concrete pavement rehabilitation for the Baihe Guanmiao Section, the National Freeway No. 3	11,368	147,745	30,043
41	Asphalt concrete pavement rehabilitation for the Gukeng Baihe Section, the National Freeway No. 3	11,149	106,525	17,979
42	Rigid pavement maintenance works in the Baihe Branch District	370	4,181	10,343
43	Asphalt concrete pavement rehabilitation in the Pingtung Branch	20,654	177,288	30,362
44	Cement concrete pavement rehabilitation in the Pingtung Branch District	180	760	5,162
Total		1,010,199	3,329,316	1,327,517



6. Maintenance Expenditure

Unit: NT\$1,000

Item	Northern Region Engineering Office	Central Region Engineering Office	Southern Region Engineering Office	Total	Percentage
Bridge maintenance	53,268	294,625	58,170	405,703	9.24%
Tunnel maintenance	19,335	5,000	18,713	43,048	0.98%
General structure maintenance	116,183	31,020	48,247	195,450	4.45%
Pavement work maintenance	719,468	592,725	747,621	2,059,814	46.89%
Safe traffic maintenance	113,820	106,399	124,032	344,251	7.84%
Road landscaping maintenance	161,432	177,359	143,649	482,330	10.98%
Mechanical and electrical systems maintenance	71,239	143,937	10,270	225,446	5.13%
Traffic control communications maintenance	108,698	19,511	47,279	175,506	4.00%
Road property maintenance	28,424	30,435	24,830	83,689	1.91%
Others	110,864	259,940	6,870	377,674	8.60%
Total	1,502,731	1,660,591	1,229,699	4,393,021	100.00%



Statistical maintenance budgets for National Freeways 2011



7. Road Assets

Item			Region/Office	Northern Region Engineering Office	Central Region Engineering Office	Southern Region Engineering Office	Total
Pavement (km)	Asphalt Concrete Pavement	4 lanes	115.491	31.800	71.617	218.908	
		5 lanes	43.240	0	0	43.240	
		6 lanes	101.058	261.097	233.509	595.664	
		7 lanes	24.167	29.115	0	53.282	
		8 lanes	24.497	23.353	8.620	53.127	
		9 lanes	13.603	1.680	0	15.283	
		10 lanes	0.150	0	3.210	3.360	
	Cement concrete Pavement		17.567	16.820	15.521	49.908	
Bridge (Block)	River Bridge		162	88	142	392	
	Stride Bridge		97	62	76	235	
	Overpass Bridge		241	367	239	847	
	Flams Bridge		8	3	46	57	
	Viaduct(South, North)		135	124	78	337	
	Ramp/Loop Road Bridge		83	105	118	306	
	Access Road Bridge		7	15	2	24	
Tunnels (block)			46	6	6	58	
Box Culvert (set)	Drainage		165	486	527	1,178	
	Passages		252	326	343	921	
Pipe Culvert (m)			16,638	25,656.559	67,212	109,506.559	
Guard Railw-lear (m)	Guardrail Barrier		617,322	744,462	460,518	1,822,302	
	Concrete		541,090	260,168	614,984	1,416,242	
Signs (pc/set)	E-type Signs		1,237	817	428	2,482	
	T-type Signs		4,019	3,114	1,617	8,750	
	Overhead Signs		380	443	477	1,300	
Interchanges			49	53	44	166	
Service Areas			4	5	5	14	
Combat-Readiness Runways			0	1	3	4	
Toll Station			7	8	8	23	
Weigh Station			18	17	16	51	
U-turn Lanes			38	4	2	44	

8. Management and maintenance of National Freeway slopes

In Taiwan, because of the terrain, it would be hard to have national freeways built without having to conduct excavations for slopes, which are mostly of poor geologic conditions (such as joints and broken rocks) and vulnerability to frequent natural catastrophes (earthquakes and rainstorms); accordingly, it is necessary to conduct regular monitoring (testing) to slopes by national freeways while building complete databases aiming to assure service-life maintenance and management before defining remedies based on slope



safety evaluations.

To keep the collapse of slopes occurred in April 2010 at 3.1K in National Freeway No. 3 from happening again while assuring sound control and management of national freeway slopes, this office launched the Reinforcement Project for National Freeway Slopes and, by following the flow process given in Fig. 1 and the scheduled specified in Table 1, management and maintenance works for national freeway slopes are carried out vigorously. After the aforementioned incident, an overall examination of national freeway slopes was conducted by this office and the full examination and patrol was completed in May 2010. Besides, of the 58 slopes for a full examination as proposed by the Project Team, 26 were set for immediate improvement and the rest, that is to say, 32 others were to meet improvement measures later on, as indicated in Table 2. For the sections where slopes are to be improved immediately, this office completed the installation of tilt tubes, water-level hoist and tilt gauges among other monitoring systems in August 2010. Fig. 2 shows the installation of the automated tilt tubes. The ground anchor test was conducted in December 2010, followed by the slope safety evaluation and reinforcement engineering in February 2011. The reinforcement engineering was fully completed on September 30 2011. Besides, for the other 32 slopes Project Team proposed for improvement works, ground anchor tests were completed in June 2011 and in August 2011, the slope safety evaluation and reinforcement engineering was ready. At this time, the reinforcement works are under way and are all scheduled to complete by August 31 2013.

As ground anchors used in local construction works build experiences, problems have also be found and immediate solutions are needed. After the incident of ground anchor slope collapse in 2010 at 3.1k in National Freeway No. 3, safety and performance of ground anchors are major concerns. The process of the ground anchor test conducted by a dedicated firm appointed by this office is shown in Fig. 3. In the first place, it was to gather basic data of the slopes for visual inspection. Preliminary studies were focused on the safety of the slopes while numbering the ground anchors. Along with the weed of the slopes, a full inspection was conducted to the appearance, pressure structure and water seeping of all ground anchors. Based on the basic data gathered and the appearance checks and after thorough evaluation, highlighted ground anchors were selected for detailed examination and recording of the anchor head components and the steel studs on the rear after removing the



RC seat. Later on, based on the examination of the anchor head components, a few ground anchors were chosen for endoscope checks of potential rusts and lifting tests with the purpose of determining the current conditions and the residual load weight as well as anchorage segment pull resistance of the ground anchors. Table 3 shows the items, description and purpose of the ground anchor test and Fig. 4 demonstrates the field operations. Finally, based on the basic data of the slopes and the test results, a performance evaluation for the ground anchor is given. If any ground anchor fails to meet the designated criteria or demonstrates other irregularities making it not apt for long-term use, an improvement program would follow for ongoing maintenance, reinforcement or replacement.

In addition to the slopes in the sections of priority and other sections proposed by Project Team, to assure safety of the slopes in all sections, a full-scale inspection of slopes in other sections was conducted by this office in 2011 as part of National Freeway Slope Reinforcing Implementation Project. As of this day, there are 871 slopes in other sections, as indicated in Table 2. As of December 2011, ground anchor tests, safety evaluation and reinforcement designs had been completed for other sections and contracts for the reinforcement works will be awarded for construction in February 2012 for completion by August 31 2013 as scheduled.

This office expects to complete the reinforcement works for the rest of the sections and other sections within 2 years, by August 31 2013. Besides, for the sake of safe slopes by national freeways, this office will conduct slope patrols and monitoring works for the next 3~5 years as part of the slope safety and reinforcement works to assure safe travel.

Table 1: Project Schedule for National Freeway Slope Reinforcement Implementation

Description	Sections in priority	Other sections	Other sections
Ground anchor test	Completed on Dec. 15 2010	Completed on June 30 2011	Completed on Dec. 31 2011
Safety evaluation and reinforcement works	Completed on Feb. 15 2011	Completed on Aug. 31 2011	Completed on Dec. 31 2011
Reinforcement works begin	Works began on Apr. 1 2011	Works began on Sept. 1 2011	Contract awarded and works began on Feb. 15 2012
Reinforcement works completed	Completed on Sept. 30 2011	To be completed on Aug. 31 2013	To be completed on Aug. 31 2013



Table 2: National Freeway Slopes

Description	Sections in priority	Other sections	Other sections	Total (Slopes)
Northern Region Engineering Office	7	12	504	523
Central Region Engineering Office	6	2	155	163
Southern Region Engineering Office	13	18	204	235
Total (office)	26	32	871	921

Remarks: Slopes per statistics made on Dec. 31 2011.

Table 3: Item, Description and Purpose of G round Anchor Test

Item	Description	Purpose
Protective seat appearance test	<ul style="list-style-type: none"> • Hammering test • Protective seat appearance test • Load structure appearance test • Load structure adjoining test • Water seepage situation view water quality test 	<ul style="list-style-type: none"> • Ground anchor appearance (including protective seat, load structure and slope seepage) irregularity survey • Water corrosion
Anchor head component check	<ul style="list-style-type: none"> • Anchor head clip & Steel stud corrosion view • Component water seepage check 	<ul style="list-style-type: none"> • Anchor head component corrosion and water seepage situation
Endoscope check	<ul style="list-style-type: none"> • Anchor head back steel stud corrosion view • Free segment length measurement • Steel stud line spreading or breakage test • Free segment wet or water seepage 	<ul style="list-style-type: none"> • Checking of the back of the anchor head stud corrosion, free segment length and water seepage situation
Lift-off Test	<ul style="list-style-type: none"> • Residual load weight measurement 	<ul style="list-style-type: none"> • Ground anchor residual load confirmation

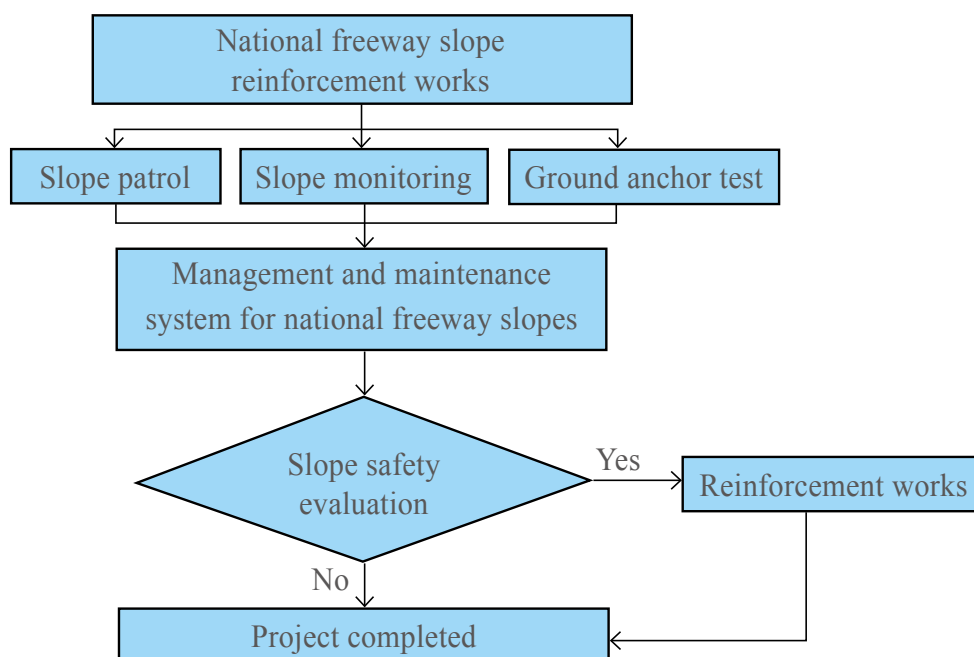


Fig. 1: Flow process of National Freeway Slope Reinforcement Works



Fig. 2: Automated measurement of tilt tubes

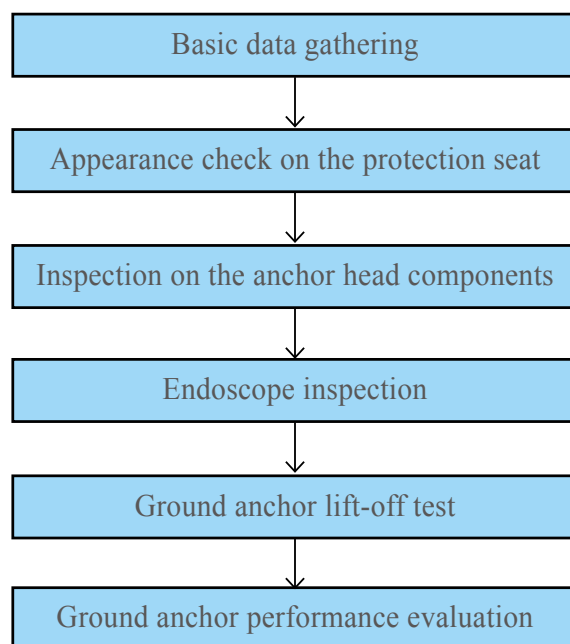


Fig. 3: Ground anchor performance evaluation flow process



(a) Appearance check on the protection seat



(b) Inspection on the anchor head components



(c) Endoscope inspection



(d) Lift-off test

Fig. 4: Ground anchor function inspection photo