



4 Maintenance Works

In response to the claim for government reorganization manpower streamlining and 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 to lower 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, bridges embankments, cuts, tunnels and the additional facilities of freeways in sound condition for safe traffic on a regular basis, a wide variety of maintenance measures have been adopted and various maintenance tasks 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 our bureau are required to notify immediately, repair or restoration assuring sound service at all times on freeways, which are expected to be used as life passages in case of disaster.

Regular maintenance tasks 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 according to road conditions and updated needs before assigning required tasks. As of late 2012, total distance requiring maintenance went at 1,026.6kms.

Tables of Maintenance Mileage

Routes	Route Mileage (km)	Toll stations (section)	Interchange (place)	Service Area (area)	Remark
National Freeway No. 1	393.4	11	69	6	Containing Xiwu Viaduct 20.7km and Wuyang Viaduct 12km in section of Chungli to Yangmei
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 A	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	-	
Tai No. 2 F Provincial Highway	4.0	-	3	-	
Total	1,026.6	23	168	14	

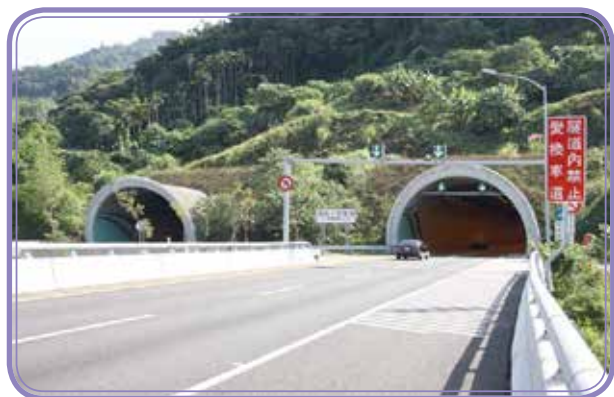
2 Tunnel Management and Maintenance

Of the 58 tunnels in the national freeways open to traffic, 2 are in the National Freeway No.1, 4 in the National Freeway No.3 Line A, 30 are in the National Freeway No.3, 10 in the National Freeway No.5, 6 in the National Freeway No.6 and another 6 in the Tai - 2F for a total distance of 81.319kms. The regional traffic control centers monitor all movements in the tunnels and all incidents are timely notified for immediate solution. Vehicles carrying hazardous materials are banned from traveling sections with tunnels (except for those having duly approved).

In addition to daily patrols and monthly cleaning the 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 according to 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.



Dawulun tunnel



Guosing No. 1 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	Northbound	0k+020 ~ 0k+574	554
National Freeway No. 3 Line A	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

Freeway No.	Tunnel Name	Driving Direction	Starting and Ending Mileage	Length (m)
National Freeway No. 3	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
	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
Provincial Highway Tai No. 2 Line F	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



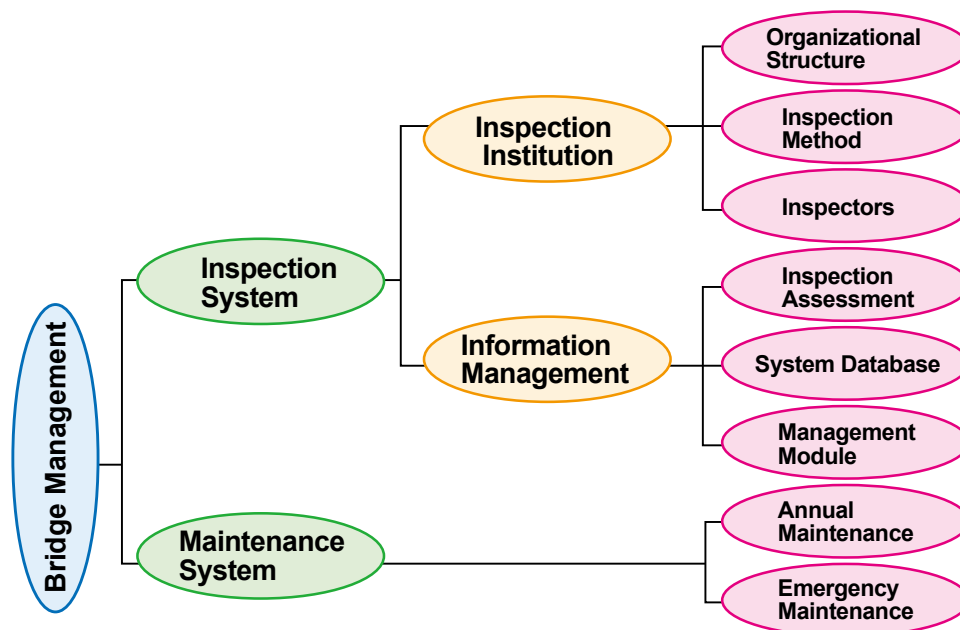
3 Inspection, Maintenance and Management of Bridges

As transportation projects evolve, river bridges and viaducts are playing growingly important roles in transportation works. In Taiwan, bridges are vulnerable to frequent man-made destructions (collision impacts, fire) and natural disasters (such as earthquake and flood). Regular and optional are required for operational bridges along with sound data filing. According to this, we evaluate the safty condition based on damages suffered in bridges and plan for eventual maintenance and reinforcement remedies.

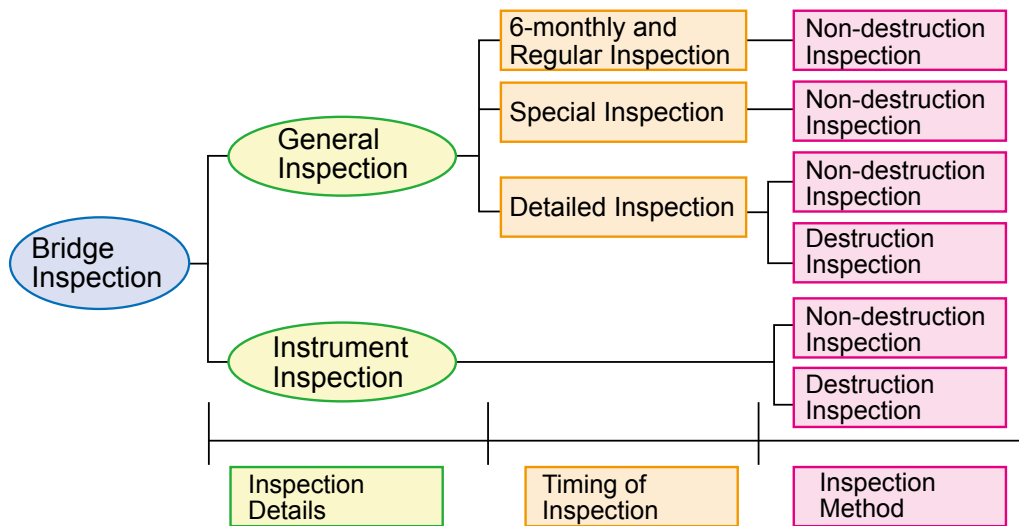
There were 245 bridges in the National Freeway No. 1 when it was fully open for traffic in 1978. Today, there are 2,229 and make TANFB become growingly responsible for maintenance and management of the bridges. As the ones in the 30-and-odd-year-old National Freeway No. 1 are severely aging, inspections and maintenance operations become imminent.

By following the Bridge Inspection operating guidelines by Taiwan Area National Freeway Bureau, Ministry of Transportation and Communication, 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.

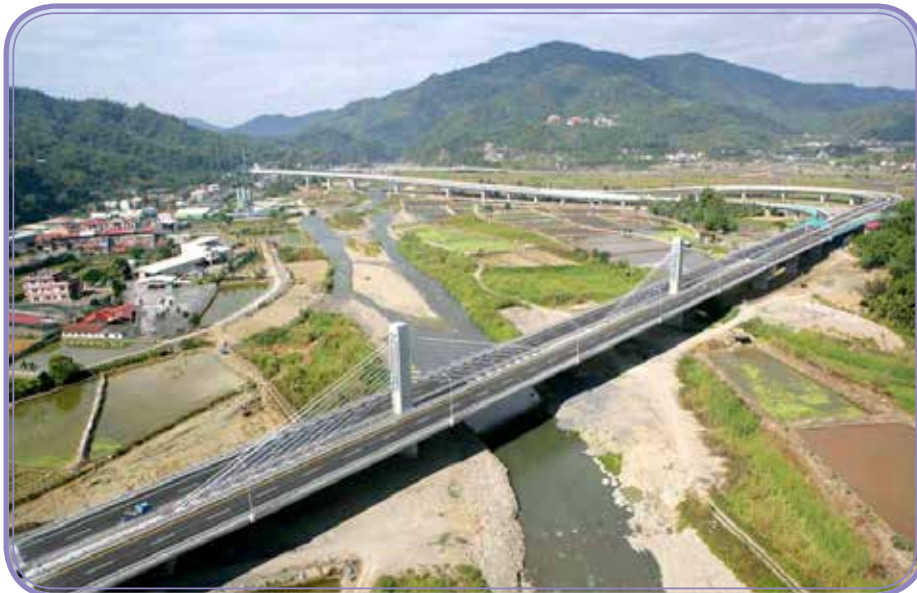
The bridge management system plan diagram is shown below:



Freeway Bridge Management System Chart



Freeway Bridges Inspection Categories



Ailan extradosed bridge of National Road No. 6



Guoxing viaduct of National Road No. 6



4 Freeway Environment

(1) Landscape and Vegetation

The Bureau manages the greenery along freeways, estimated 2,704 hectares, 575 thousand arbors and 293.8 million shrubs. This year, the vegetation landscaping task goes mainly as follows:

1. 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 bump systems to assure safe travel.

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 May 25, 2012 for the review of general operations performance. Based on the conclusions reached in the meeting and the operation instructions were revised and incorporated into the contract 2013 for implementation and they include:

- (1)The contractor shall be responsible for safety training for this contract before and after starting the construction work for the entire manpower involved along with the pre-employment training for the newly hired labors or personnel designated to employed labors.
- (2)Adding outlines for Labor Safety and Health Management Plans allowing the contractor to plan Labor Safety and Health Plans and clear definition of the duties of the contractor (or client) specified in Labor Safety and Health Act and associated codes.
- (3)Adding highlighted operation safety instructions for the protection gears used by personnel involved in mowing and pest control operations

along with additional pest control operations aiming to enhance protection efficiency.

2. Strengthen the landscape improvement of key nodes and slopes

Landscaping efforts are mainly made by planting ornamental plants in mainline roadsides, interchanges and service areas travelers would focus on, such as ornamental plants for landscape diversity plus bridge pier columns, retaining walls, acoustic barriers among other structures. and planting native or adaptive species on the slopes along the freeways to accelerate ecological successions and restore natural scenes.

The landscaping works of successful design or awarding are as follows:

- (1) The reinforced landscaping works include National Freeway No. 1, Wugu to Donghu section Landscape Improvement Projects, National Freeway No. 1, Yuanlin, Dounan and Dalin Interchange *Leucaena Leucocephala* Remove and Landscape Strengthen Projects Taiwan and Xingying Service Area Overall landscape improvement Projects.
- (2) The native plant nursery was established and slope restoration works are planned at 138k ~ 143k, the National Freeway No. 3

Aiming to restore natural scenes and expecting to lower maintenance by native plants which are adaptive to inferior environments. The Central Region Engineering Office District is carrying out plantation of native species in the Dajia Branch with upgraded protection of the habitat with the purpose of restoring its exclusive landscape by means of artificial nursing and habitat reinforcements.

Effective 2008, the side slopes at 138k ~ 143k, the National Freeway No. 3 become new sites for native planting nurseries featuring 24,496 arbor seedlings (including chinaberry, flame gold-rain tree, Chinese tallow tree, ***Pongaoil pongamia***, Taiwan date palm, common free fern and Chinese soap berry etc.) 40,922 shrub seedlings (including Taiwan lily, downy rosemyrtle, ***Bletilla striata***, yedda hawthorn, common melastoma and



vaccinium fig etc.) all in prosperity and an inviting landscape.



The restoration of *Bletilla striata* at National Freeway No. 3, 138k+400



The restoration of Taiwan lily at National Freeway No. 3, 140k+700

(3) For the Afforestation in the Plain Area Program of the Forest Bureau, our bureau the slope greenery land for forestation in natural environment. For this year, we shall keep on carrying out the open-space forestation plan at Zhonggang System Interchange (where the plantation for 12.78 hectares was reduced by fire to 9.1 hectares), Caotun Interchange ~ Zhushan Interchanges (including the 45.11 hectares covering the main-line side slopes and the Minjian Interchange and Nantou Service Area) for a total of 77,964 arbors.



The effort of afforestation at the Yunlin system Interchange, National Freeway No.1



The effort of afforestation at the Caotun to Zhushan Interchange, National Freeway No.3

3. 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.



The following are the new plantation works completed this year:

- (1) The new plantation for Bid No. H20B of National Freeway No. 2 Widening Projects (between Dayuan and Dazhu Interchange) had its maintenance duly accepted in July. On the other hand, the plantations for Bid No. H30B (between Dazhu Interchange and Airport System Interchange), Bid No. H10B (between Airport and Dayuan Interchange) were completed on July 24 and October 25 respectively.



The butterfly sculpture and shrubs at the section of Taoyuan Airport to Dayuan Interchange.

- (2) The plantation for the Taipei County Special No. 2 Road linking the Tucheng Interchange (Bid No. B24B for National Freeway No. 3) was completed on November 26.
- (3) The plantation for the Huwei Interchange, National Freeway No. 1 (Bid No. 524B) was completed on December 12.
- (4) The additional plantation for the Minhsiung Interchange, National Freeway No. 1 was completed on September 21.



The Plantation of Minhsiung Interchange, National Freeway No.1

4. The “Total Examination of National Freeway Public Art works and Public Art Establishment Plans”:

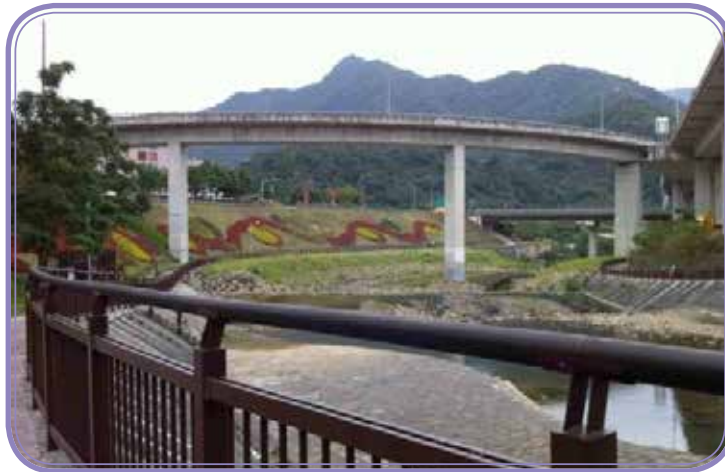
Of the 27 public art works located on 11 sites along the national freeways, most are there for 5 or more years; to give the public art works a new look as they are required to become part of the environment. For the project by proposing improvement schemes for the public art works available. The efforts include profile of the works along with maintenance and management systems and other suggestions on maintenance, repair and removals as well as rules for future installations.

Next year, there will be a public art plans for major construction works for the Taian Service Area, National Freeway No. 1 with the expectation that the Public Art Establishment Plans would activate the service areas by adding eye-catching attractions as part of lively art.



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

Of the 44 agencies participating for the maintenance and adoption of side slope, interchange and landscapes under viaduct by freeways this year (2012), 11 were graded by Engineering Office with over 80 points. The Pinglin District of New Taipei City that had adopted the Pinglin Interchange, National Freeway No. 5 and the Tainan City Government Tourism Bureau, which had adopted the Exit & Entrance of Wusanto Interchange, National Freeway No. 3, were appraised publicly by our bureau as both met the criteria for rewarding.



The slope of National Freeway No. 5, Pinglin Interchange adopted by Pinglin District Office, New Taipei City



The landscape facilities at National Freeway No. 3, Wushantou Interchange entrance adopted by Tourism Bureau of Tainan City Government

6. Research and Development

(1) Hosting the “Ecological topics investigation along the National Freeways and Friendly Measures Assessment Plan”.

For the sake of outlining the biological impacts by the national freeway facilities and greenification, sustainable utilization and development strategies are to be launched assuring that road construction does become part of the environment. This year, we shall keep on carrying out the “Sustainable Development and Environmental Restoration Plan for National Freeways”, which was completed between 2008~2011, for 2 years.

The preliminary report filed in September this year includes: preliminary biological survey for the line, gathering relevant information and survey, research and filing of biological footages along with National Freeway ecological database as well as the design for the multi-function fauna passage for the Tongsiao cross-bridge No. 1, National Freeway No. 3.

(2) Revising the “Technical Specifications for Construction of Plant Cultivation Projects”

As TANEED is due to be merged into this bureau, for successful integration of all regulations concerning the plantation works waged by the 2 bureaus, CECI Engineering Consultants, Inc., Taiwan was contracted for the task in May this year by following the form the structure of the Construction Specifications for Public Works for successful implementation in the future.

The program in question is supported by a review committee formed by industrials, government officials and scholars involved in 2 seminars and 7 review conferences before filing the draft of the final report that was approved on November 16 this year. The same will be followed by campaigning seminars when the formal result is produced.



(2) Prevention and Eradication of Alien Invasive Species

1. Red Imported Fire Ants Prevention

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 2012, the effort of prevention and eradication of imported red fire ants waged by our bureau covered 12 areas that covered 82 hectares (49.5 hectares in the National Freeway No. 1, 5.1 hectares in the National Freeway No. 2 and 27.4 hectares in the National Freeway No. 3), all in the jurisdiction of the Northern Region Engineering Office. The budget for prevention and eradication of imported red fire ants this year (including agents, manpower, campaigning and equipment) totals NT\$ 830,000. 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.

2. Invasive plant controlling

Presently, the task of fighting invasive plants in the side slope entitled to rights of way is focused on the fast-growing species like ***Mikania micrantha***, ***Eupatorium odoratum*** and silver wattle and others that create severe impacts to the ecosystem in the area.

In 2005 and by following the Prevention Code granted by Forestry Bureau, Council of Agriculture, our bureau launched its version of prevention plan for implementations on an annual basis and, beginning 2006, products are produced between January and February to the Endemic Species Research Institute, Forestry Bureau.

The efforts waged this year include the removal of ***Mikania micrantha*** for 22.75 hectares (by National Freeway No. 1, the species are mainly

allocated at the Miaoli Guanxi Branch jurisdiction and southward and, by National Freeway No. 3, at Guanxi Branch jurisdiction and southward, where *Eupatorium odoratum* is found in 11.02 hectares (mainly allocated at Baihe and Pingtung Branch jurisdiction, National Freeway No. 3. As of the removal of *Leucaena leucocephala*, for the lack of manpower and budget, the effort is conducted on an irregular basis; at the same time, plantation of a wide variety of suitable arbor and shrub species followed to keep indigenous plants dominant ethnic from further invading.

5 Pavement rehabilitation Project

The highlighted projects for pavement rehabilitation 2012 are as follows:

No.	Project Title	Length (m)	Area (m ²)	Expense (NT\$1,000)
1	National Freeway No. 1, pavement improvement projects for open traffic of the side shoulders for the section from Neihu to Yuanshan	22,962	80,367	48,780
2	National Freeway No. 1, pavement improvement projects for addition of auxiliary lanes from Donghu to Neihu (two-way)	13,538	49,580	44,026
3	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Keelung to Neihu	64,360	225,260	77,526
4	Neihu Branch rigid pavement rehabilitation projects	214	750	2,350
5	Neihu Branch jurisdictional potholes repair projects	490	1,162	4,200
6	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Taoyuan to Linkou	8,269	220,245	102,190
7	National Freeway No. 1 southbound, Porous Asphalt Concrete pavement testing projects for the section from Yangmei to Hukou	4,800	54,000	66,430
8	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Yangmei to Zhongli	16,700	253,813	148,600
9	National Freeway No. 1, 45k nearby pavement emergency repair projects	662	2,750	4,800
10	Asphalt concrete pavement refurbishment projects for the A Lane and the section from Xizhi to Muzha, National Freeway No. 3	32,500	251,924	98,480
11	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section of Zhonghe and Xizhi System Interchanges	14,500	115,322	65,650
12	Muzha Branch jurisdictional asphalt concrete pavement potholes repair works	136	1,090	5,102
13	National Freeway No. 3, Guanxi Service Area, small car parking lot pavement rehabilitation projects		4,518	5,829
14	Guanxi Branch jurisdiction, Tucheng to Guanxi asphalt concrete pavement rehabilitation projects in 2011	55,436	207,885	68,087



No.	Project Title	Length (m)	Area (m ²)	Expense (NT\$1,000)
15	Asphalt concrete pavement rehabilitation projects for the Guanxi Branch, Guanxi to Xiangshan, National Freeway No. 3 and the Hsinchu section, National Freeway No. 1	85,860	321,975	95,890
16	Guanxi Branch jurisdictional rigid pavement repair and caulk projects	22,510	253,237	4,497
17	National Freeway No. 5, south of Toucheng asphalt concrete pavement rehabilitation projects	9,419	52,920	45,700
18	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Touwu to Tongluo	41,874	152,841	41,056
19	Asphalt concrete pavement rehabilitation projects for the section from Qingshui to Shengang, the National Freeway No. 4, and Sanyi section, National Freeway No. 1	23,072	84,215	43,273
20	Miaoli Branch jurisdictional pavement maintenance projects	682	1427.9	15,220
21	Miaoli Branch jurisdictional cement concrete pavement rehabilitation projects	168	839	4,691
22	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section from Houlong to Hemei	52,511	222,489	44,000
23	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section from Xiangshan Interchange to Zhanghua	38,580	146,800	46,000
24	National Freeway No. 3, Dajia Branch jurisdictional cement concrete pavement rehabilitation projects	27	115	1,300
25	Dajia Branch jurisdictional pavement maintenance projects	4,356	16,473	16,546
26	Dounan Branch jurisdictional asphalt concrete pavement rehabilitation projects	3,954	15,027	14,356
27	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Yuanlin to Dalin	3,981	176,317	44,637
28	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Daya to Yuanlin	3,543	133,861	38,878
29	National Freeway No. 1, Dounan Branch jurisdictional cement concrete pavement refurbish projects	764	2,902	8,762
30	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section from Taichung to Zhanghua	20,888	230,758	33,687
31	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section from Nantou to Yunlin	44,952	152,304	56,626
32	Nantou Branch jurisdictional cement concrete pavement overlay AC flatness improvement projects	3,832	53,214	28,536
33	Nantou Branch jurisdictional asphalt concrete pavement rehabilitation projects	2,291	9,168	15,780
34	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the sections of Dalin and Xinying	26,193	94,032	47,771
35	Asphalt concrete pavement rehabilitation projects for the section of Xinying and Yongkang, the National Freeway No. 1 and the National Freeway No. 8	23,115	95,527	42,747
36	Xinying Branch jurisdictional cement concrete pavement rehabilitation projects	5,420	22	1,552
37	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Yongkang to Dingjin	19,900	70,655	49,622

No.	Project Title	Length (m)	Area (m2)	Expense (NT\$1,000)
38	National Freeway No. 1, asphalt concrete pavement rehabilitation projects for the section from Dingjin to Kaohsiung	18,100	61,134	48,638
39	Asphalt concrete pavement rehabilitation projects for every interchange, the National Freeway No. 10 & the National Freeway No. 1	13,000	32,188	19,000
40	Ganshan Branch jurisdictional cement concrete pavement maintenance projects	323	1,242	6,449
41	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section of Gukeng and Baihe	12,963	121,756	27,109
42	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the sections of Baihe and Guanmiao	12,475	149,037	28,341
43	Baihe Branch jurisdictional cement concrete pavement maintenance projects	17,301	14,475	16,228
44	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section of Guanmiao and Jiuru	24,894	77,048	29,454
45	National Freeway No. 3, asphalt concrete pavement rehabilitation projects for the section of Jiuru and Linbian	39,088	9,226	32,963
46	Pingtung Branch jurisdictional cement concrete pavement rehabilitation projects	827	797	3,740
	Total	1,063,139	3,707,968	1,557,693

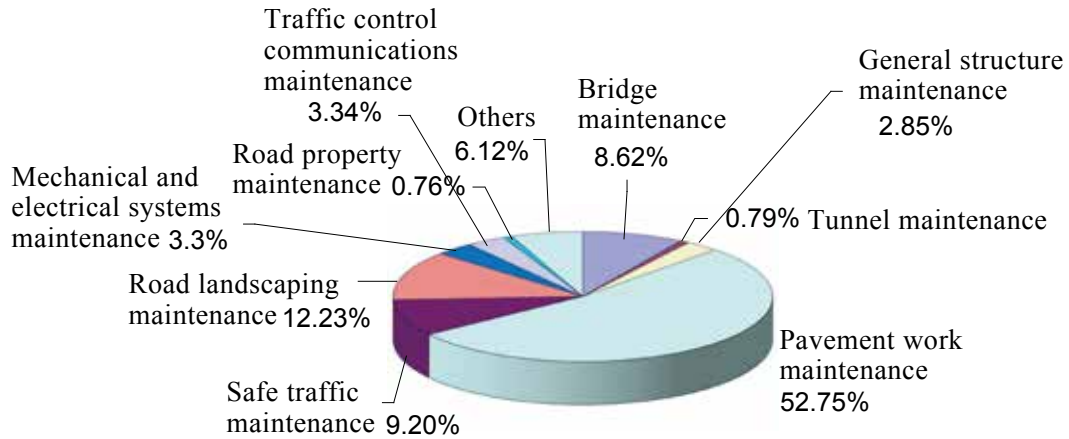
6 Maintenance Expenditure Project

Unit: NT\$ 1,000

Item	Northern Region Engineering Office	Central Region Engineering Office	Southern Region Engineering Office	Total	Percentage
Bridge maintenance	53,714	321,176	68,044	442,934	8.62%
Tunnel maintenance	24,569	8,872	7,039	40,480	0.79%
General structure maintenance	75,920	35,064	35,443	146,427	2.85%
Pavement work maintenance	1,383,677	776,319	550,693	2,710,689	52.75%
Safe traffic maintenance	139,667	158,639	174,191	472,497	9.20%
Road Landscaping maintenance	306,816	182,435	139,212	628,463	12.23%
Mechanical and electrical systems maintenance	23,858	137,444	10,490	171,792	3.34%
Traffic control communications maintenance	19,407	96,417	55,765	171,589	3.34%
Road property maintenance	13,406	0	25,460	38,866	0.76%
Others	25,366	273,442	15,845	314,653	6.12%
Total	2,066,400	1,989,808	1,082,182	5,138,390	100.00%



2012 National Freeway Maintenance Budgets Statistical Table



7 Road Assets

Region/Office			Northern Region Engineering Office	Central Region Engineering Office	Southern Region Engineering Office	Total
Item						
Pavement (km)	Asphalt Concrete Pavement	4 lanes	112.279	36.230	71.617	220.126
		5 lanes	3.700	2	0	5.700
		6 lanes	137.564	254.132	234.214	625.910
		7 lanes	18.467	34.340	0	52.807
		8 lanes	36.235	23.943	8.620	68.798
		9 lanes	13.603	1.680	0	15.283
		10 lanes	0.15	0	3.210	3.360
	Cement concrete Pavement		17.971	17.971	15.179	45.805
Bridge (Unit)	River Bridge		147	88	142	377
	Overpass Bridge		125	62	76	263
	Crossing Bridge		152	199	239	590
	Flume Bridge		10	3	46	59
	Viaduct (South, North)		135	124	78	337
	Ramp/Loop Road Bridge		72	105	118	295
	Access Road Bridge		10	15	2	27
Tunnels (Unit)			46	6	6	58
Box Culvert (Unit)	Drainage		165	509	527	1,171
	Passages		249	344	343	929
Pipe Culvert (m)			16,638	25,656.559	67,217	109,511.559
Guard Railn-lear (m)	Guardrail Barrier		615,235	721,266	447,932	1,784,433
	Concrete		544,496	293,108	629,889	1,467,493
Signs (pc/set)	E-type Signs		1,236	1,134	503	2,873
	T-type Signs		4,031	3,660	2,141	9,832
	Overhead Signs		368	328	457	1,153
Interchanges			69	55	44	168
Service Areas			4	5	5	14
Combat-Readiness Runways			0	1	3	4
Toll Station			7	8	8	23
Weigh Station			16	17	16	49
U-turn Lanes			52	4	4	60

8 Management and Maintenance of National Freeway slopes

Because of the terrain in Taiwan, it would be hard to have national freeways built without having to conduct excavation on slopes. The slopes on the freeway sides are mostly questionable of geologic conditions (such as joints and fractured rock) and vulnerable to frequent natural hazards (earthquakes and rainstorms). Accordingly, it is necessary to conduct regular monitoring and inspection for slopes, establish complete life-cycle slope maintenance and management, and prepare remedies based on the slope safety evaluations.

After the serious landslide incident occurred at 3.1K of National Freeway No. 3 on April 25, 2010, the Taiwan Area National Freeway Bureau (TANFB) had launched the Reinforcement Project for National Freeway Slopes to actively manage the slope safety. The process and schedule are shown as Fig. 1 and Table 1. The management and maintenance tasks for the freeway slopes had been carried out vigorously. After the aforementioned incident, an overall examination for slope safety had been conducted, and the inspection was completed in May 2010. According to the investigation report provided by a group of experts and engineers, 58 slopes were with high potential of safety issue. Among them, 26 slopes were classified as Priority Slopes for immediate improvement, and the rest 32 slopes were Secondary Slopes for later improvement measures, as indicated in Table 2. For the 26 priority slopes, the NFB in August 2010 had completed the installation of monitoring instruments, the inclinometer, water level observation well, and tiltmeter. Fig. 2 shows the installation of an automatic inclinometer. The inspection of ground anchors had been completed in December 2010, and the slope safety evaluation and reinforcement designs were finished in February 2011 for the priority slopes. The slope reinforcement was completed by September 30, 2011. For the 32 secondary slopes, the ground anchor inspection had been completed on June 2011, and the slope safety evaluation and designs of slope reinforcement were



finished by August 2011. The slope reinforcement at the secondary slopes is under implementation and will be completed by August 31, 2013.

In addition to the priority and secondary slopes, the TANFB had also conducted complete investigation of other slopes in 2011, as a part of the Reinforcement Project for National Freeway Slopes. There are total of 881 other slopes, as shown in Table 2. The anchor inspections and tests, slope safety evaluation and reinforcement design had been completed by December 2011. The reinforcement projects had been contracted out in 2012, and the engineering practices will be completed by August 31, 2013.

Lessons and experience of ground anchor applications have been learned in Taiwan for the past years. Issues on ground anchor engineering have also been studied. After the landslide incident on the national freeway in 2010, the safety and performance of ground anchored slopes has been a major concern. The process of ground anchor testing and inspection performed by the professional consultant companies is shown in Fig. 3. The procedure begins with the basic data collection of the ground anchors to continue visual inspection, preliminary safety evaluation, and anchor numbering. Along with the weeding on the slopes, the overall inspection is conducted on anchor head, appearance of pressure plates, and seepage conditions. Based on the basic data and the results of on-site inspection, several ground anchors are chosen for detail examination on anchor head components and steel rods after removing the concrete seating. Based on the detail examination results, the endoscope inspection is conducted on several anchors to check the rust conditions of steel rods, and perform the lift-off testing to understand the residual loading and pull resistance of the fixed section. Table 3 shows the testing items, descriptions, and purposes of ground anchor performance testing. Fig. 4 shows an example of on-site ground anchor testing. Finally, based on the basic data of the slopes and the test results, the

performance evaluation for the ground anchor is given. If the performance of the ground anchor cannot meet the design requirements or demonstrates irregularities making the anchor not stable for long-term use, an improvement program will be planned for later maintenance, reinforcement, or replacement. From the inspection results of ground anchors, the rusty steel tendons at the free length section influence significantly the performance of a ground anchor. Therefore, the TANFB had applied concrete grout filling in the free length sections to prevent rust of tendons. The procedure was completed by the end of 2012.

To ensure the consistent requirements on slope maintenance and inspections, the TANFB had published the first revision of Freeway Slope Maintenance Handbook on February 2011, and announced 12 propositions about slope maintenance enhancement for regional offices and agencies. The new propositions include testing criteria of ground anchors, principle of free length grouting, qualitative rating and performance evaluation of ground anchors, warning values of slope monitoring, slope safety grading, design and installation of permanent ground anchor, and name plate formats of slope and anchors. Further, the TANFB has begun revising the Chapter 5 of the Freeway Slope Maintenance Handbook on July 2012. In addition to the 12 propositions, specifications, regulations, and standards from both domestic and international areas will be considered in the revision. The new version of the Handbook will be finished on October 2013.

To train the engineers and workers of TANFB about the slope maintenance and management, the short, medium, and long-term training courses has been planned since July 2012. Fig. 5 shows the training courses. The training plan includes (1) cultivation classes for people responsible for slope business. The classes are designed to provide practices to help a person capable of



slope management and understand the requirements and procedures of slope maintenance. Table 4 shows the class content, and the training is expected to be completed by October 2013; (2) advanced classes for persons with years of experience on slope management. The classes are designed to provide complete concepts, like the slope management system, slope failure mechanism, and slope stability, as well as the latest knowledge about slope management. The courses will be taught by experts, and Table 5 shows the class material.

The original Freeway Slope Management System had been modified and revised to adopt the life-cycle management concept, and the newly developed system, Lifecycle-Based Freeway Slope Management System (LFSMS), has provided service online since January 1, 2012, to provide better efficiency and increasing the capability to disaster response. The new system contains databases of designs, construction, maintenance, and monitoring information, using the GIS platform to present the slope conditions. The alert notice is also included in the system for slope monitoring. Fig. 6 shows the GIS platform of the system. An online file inventory, called Freeway Slope Information Exchange Platform (FSIEP), had also been established and activated on September 24, 2012, to provide storage spaces for local offices to upload and exchange files like references, maps, reports, and training materials. The file exchange platform can assist the TANFB on data sharing and enhance the slope management. Fig. 7 shows the connections between the LFSMS and FSIEP.

To achieve the slope management and complete the lifecycle-based management system, the TANFB has conducted a plan of Basic Data Implementation of national freeway slopes, starting from December 2012. The implementation plan will be carried by each regional office to collect necessary documents, evaluate and compare the records, and complete the design figures and profiles. All the revised data will be updated in the Lifecycle-Based Freeway

Slope Management System. The plan is scheduled as Table 6.

The TANFB will finish the reinforcement works by August 31, 2013. Besides, the TANFB will actively perform slope inspection each year, and continue to monitor the slope safety. Every 3~5 years, a complete inspection and testing plan, including slope stability evaluation and reinforcement designs, will be conducted to ensure the freeway safety.

Table 1: Schedule of Reinforcement Project for National Freeway Slopes

Tasks	Priority Slopes	Secondary Slopes	Other Slopes
Ground anchor test	Completed on December 15, 2010	Completed on June 30, 2011	Completed on December 31, 2011
Safety evaluation and reinforcement designs	Completed on February 15, 2011	Completed on August 31, 2011	Completed on December 31, 2011
Reinforcement works started	April 1, 2011	September 1, 2011	February 15, 2012
Reinforcement work completed	September 30, 2011	August 31, 2013	August 31, 2013

Table 2: National Freeway Slopes

Offices	Priority Slopes	Secondary Slopes	Other Slopes	Total*
Northern Region Engineering Office	7	12	499	518
Central Region Engineering Office	6	2	157	165
Southern Region Engineering Office	13	18	225	256
Total*	26	32	881	939

* as of December 31, 2012.



Table 3: Tests, Contents, and Purposes of the Ground Anchor Inspection

Test	Content	Purpose
Appearance check of the protection seat	<ul style="list-style-type: none"> •Hammering •Visual inspection on the seat •Visual inspection on pressure plates and components •Connection inspection of pressure plates •Seepage check and water quality test 	<ul style="list-style-type: none"> •Inspection of the ground anchor appearance (including the seating, pressure components and seepage) •Corrosiveness
Anchor head components	<ul style="list-style-type: none"> •Head clip and steel rod corrosion check •Seepage check 	<ul style="list-style-type: none"> •Corrosion check of the anchor head components and seepage condition
Endoscope inspection	<ul style="list-style-type: none"> •Steel tendon corrosion check •Length measurement for the non-grouted section •Fall-apart and breakage check on steel tendons •Seepage condition at the free length section 	<ul style="list-style-type: none"> •Check the corrosion of steel tendons behind the anchor head, measure the length of non-grouted section, and understand the seepage condition.
Lift-off test	<ul style="list-style-type: none"> •Measure the residual loading 	<ul style="list-style-type: none"> •Check the residual loading

Table 4: Training Plan of Freeway Slope Management and Business

Course	Basic	Intermediate	Advanced
Goal	For NFB employees: Understand the content and procedures of slope management and tasks, including inspection and monitoring. For contract-out workers: Be familiar with the regulations and standards. Overall, the training is to ensure the operations to meet the consistent standards.	Comprehensive understanding on slope management and business, including site investigation, for the NFB employees and contract-out companies. Learn how to determine the slope safety class based on data from the slope inspection, monitoring, and ground anchor testings.	Learn the concept and strategies of lifecycle management on slopes, and the principles and regulations of slope maintenance and reinforcement.
Target	<ol style="list-style-type: none"> 1.The NFB employees responsible for freeway slope management. 2.The contract-out workers involved in slope inspection and monitoring. 	<ol style="list-style-type: none"> 1.The NFB employees who had finished the basic classes. 2.The contract-out workers involved in slope inspection, monitoring, and ground anchor testing. 	<ol style="list-style-type: none"> 1.The NFB employees who had finished the basic and intermediate classes. 2.The contract-out workers involved in slope maintenance and reinforcement.
Classes	Slope patrol and inspection	Data analysis of slope monitoring	Lifecycle maintenance system and strategies on slopes
	Freeway Slope Inspection System	Ground anchor testing	Slope maintenance
	Freeway slope monitoring	Slope safety assessment and grading	Slope reinforcement design and methods
	Introduction to Lifecycle-Based Freeway Management System and Freeway Slope Information Exchange Platform	Advanced operation of Lifecycle-Based Freeway Slope Management System	Ground anchor design, construction, and maintenance.
	Slope inspection practice		

Table 5: Advanced Training Courses for Freeway Slope Business

Unit	Main Office	Regional Office
Training Classes	Slope management	Geological environment of the region
	Slope failure and prevention	Types of slope failure in the region
	Ground anchor maintenance and durability study	Slope monitoring and the determination of warning levels
	Slope disaster and response under the extreme climate	Slope inspection and maintenance priority
	Introduction to slope-related regulations	Regional status of the ground anchor and its failure mechanisms
	Requirements of slope management by NFB	Introduction to slope maintenance and reinforcement methods
	Other relevant classes	Other relevant classes

Table 6: Schedule of Freeway Slope Basic Data Implementation

Tasks	Freeway No. 1	Other Freeways	Other Administrated Highways
Collection and comparison of historical data (including slope safety assessment)	June 30, 2013	June 30, 2013	June 30, 2013
Profiles of the slope (current slope profile, geological profile,...,etc.)	October 31, 2013	October 31, 2013	October 31, 2013
Data classification and upload/update	October 31, 2013	October 31, 2013	October 31, 2013

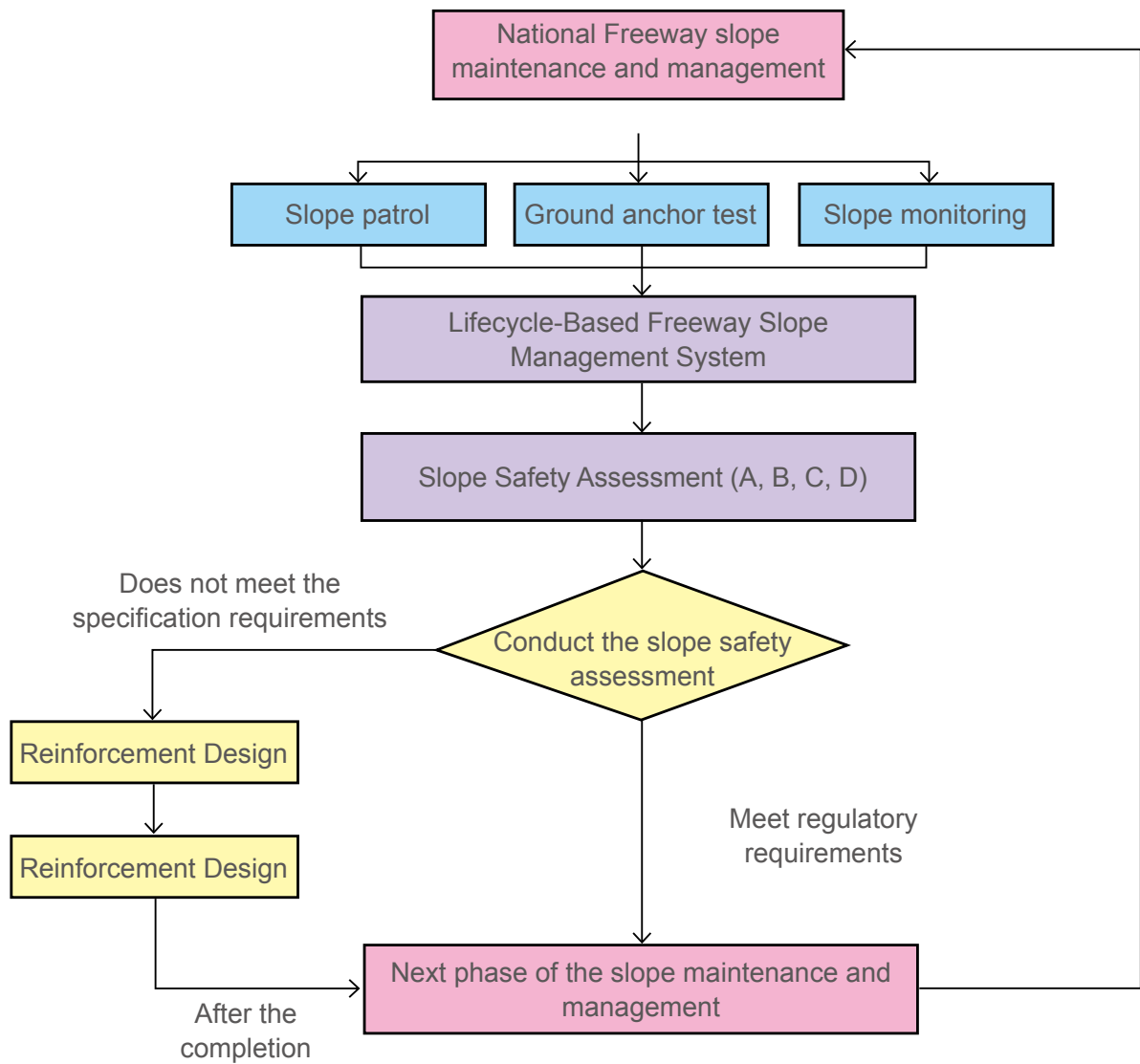


Fig. 1: Process of the Reinforcement Project for National Freeway Slopes



Fig. 2: Installation of automated and self-recording inclinometer.

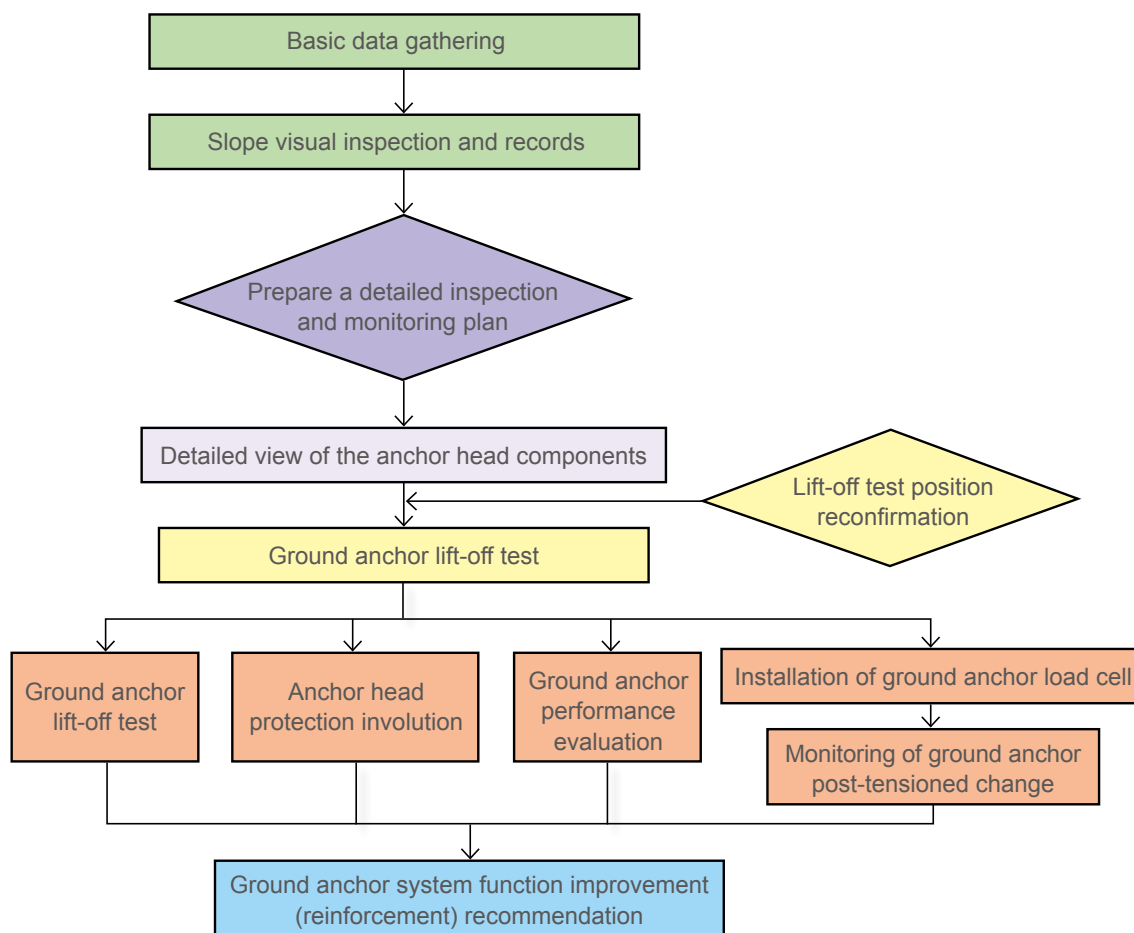


Fig. 3: Procedure of the ground anchor performance evaluation



(a) Appearance check on the protection seat



(b) Inspection on the anchor head components



(c) Endoscope inspection



(d) Lift-off test

Fig. 4: Examples of the Ground Anchor Inspection

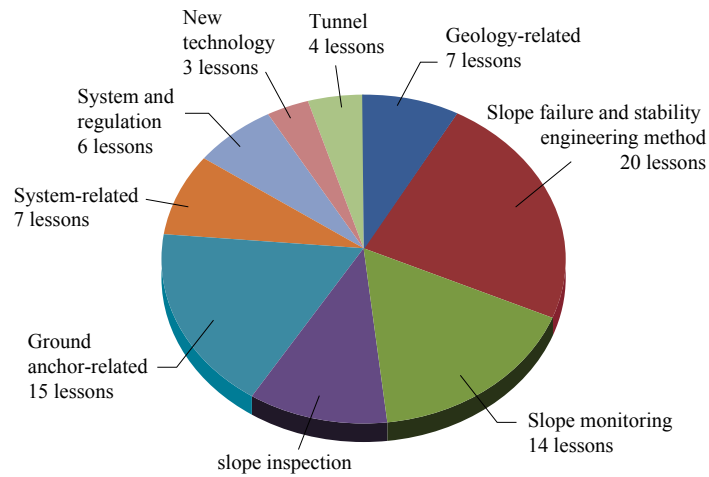


Fig. 5: Training Classes of NFB from 2011 to 2012.

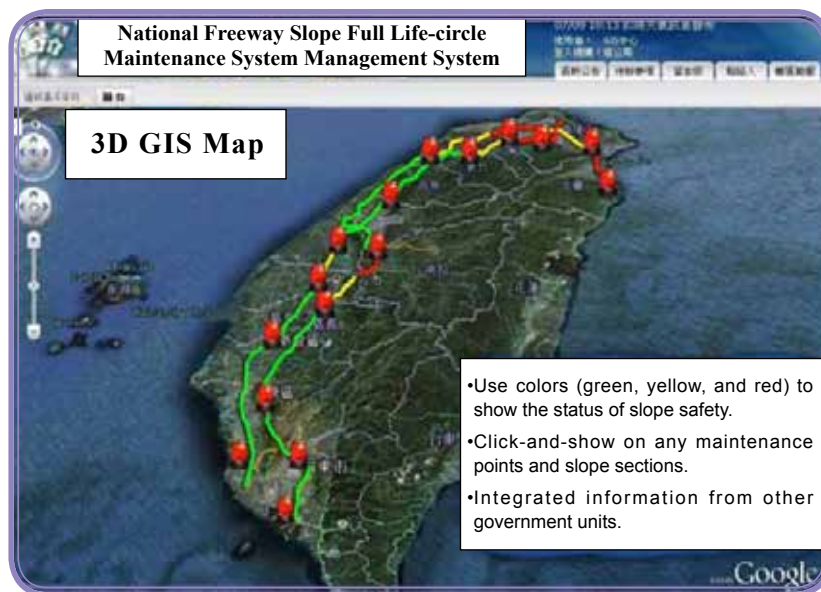


Fig. 6: 3D GIS Map of Lifecycle-Based Freeway Slope Management System

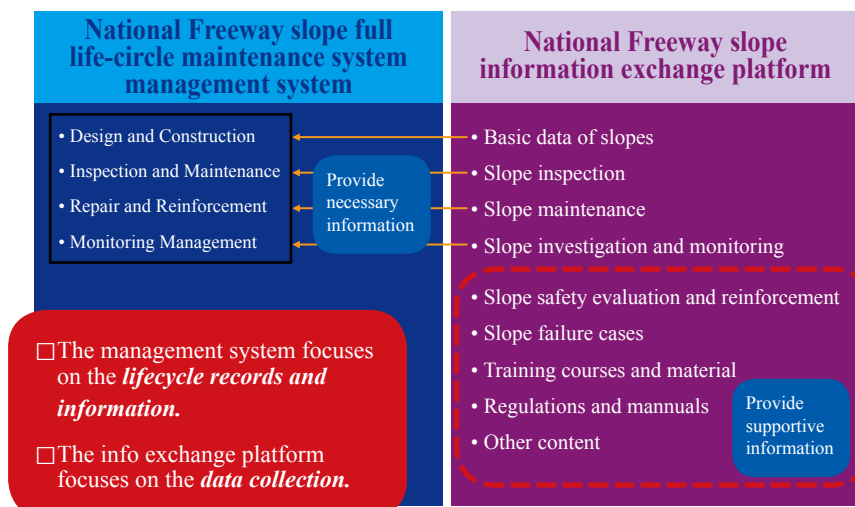


Fig. 7: Connection and System Architecture between Lifecycle-Based Freeway Slope Management System and Freeway Slope Information Exchange Platform