Railway Operators

Railway Operators in Japan 15

Untypical Railways

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Introduction

All the previous articles in this series have dealt with normal passenger railways with rolling stock running on rails. However, Japan has many other types of passenger systems such as straddle-beam and suspended monorails, trolleybuses, automated guided transit (AGT) systems, magnetic levitation systems, etc., that are all legally defined as railways of one category or another. This article will describe such systems in Japan that fall outside the scope of normal passenger railways, as well as other systems like ropeways, cable railways or funiculars. It also offers a brief description of the current state of the nation's heritage railways.

Medium-capacity Urban Transit Systems

If we combine the networks of the six JR passenger railways and the other private operators, Japan has an extensive railway network of about 28,000 km. However, since public transport infrastructure cannot keep pace with the rapid spread of urbanization, many people still suffer from inconvenience. In urbanizing areas, there has been increasing expenditure to construct new railway lines such as subways, etc., but seen from the viewpoint of investment effectiveness, these proposals are only good business if there is a sufficient passenger base. In several regional cities, although there has been progress with construction of subways, etc., growth in passenger numbers is flat and in more than a few cases the business strength is weak. Recently Kawasaki City, the second largest city in Kanagawa Prefecture after Yokohama City published its decision to delay subway construction and is re-evaluating the business.

On the other hand, tramways and trolleybuses started disappearing nationwide during the 1970s as their operations became severely impacted by the effects of worsening road congestion. Today, there are only 18 tramway operators and just two trolleybus services left in operation throughout the whole of Japan. More recently, there has been increasing focus on light-rail transit (LRT) systems. In Toyama City on the Sea-of-Japan coast, there has been progress with a project to combine an existing JR line with a newly constructed tramway to form an ultra-low floor transit system that is planned to open in 2006. However, it would not be an exaggeration to say that there are very few other regional cities with these types of plans for LRTs.

Bus services provide insufficient transport capacity and their operations are adversely impacted by road congestion. As a consequence of these circumstances, a variety of new medium-capacity rail systems like monorails and AGT systems are being developed to meet the need for transport capacities that are less than that offered by a full heavy railway but are more than that offered by buses, etc.

New Class 40 TMG suspended monorail car at Ueno Zoo introduced in May 2001. The monorail was developed as a tram substitute but has never come into widespread use. The Ueno Zoo monorail carries about 900,000 people each year. (Author)

Monorails

The first passenger monorail in Japan was opened by the Tokyo Metropolitan Government Transportation Bureau (TMG TB) in December 1957 on a 0.3-km track in Ueno Zoo. At that time, Tokyo's urban transport needs were met largely by trams, buses and trolleybuses but there was a growing realization that the system would soon be inadequate due to growing road congestion caused by rapid increases in private car ownership. As a result, the TMG TB commenced joint development of a unique suspended-type monorail as a substitute new transportation system. The first commercial test runs were made by building a small scale monorail in Ueno Zoo using a two-car set with a total length of just 19 m. Construction of the stations, supports and rail itself was simplified by building over an existing road. Notwithstanding this, due to the promotion of subways as the main transport mode, the Ueno monorail was not really used as a commercial transit system. In the 1980s there was talk of a temporary suspension of the monorail but it was decided to continue with the space-age transportation system of children's dreams and 2001 saw the introduction the fourth generation monorail system. Currently, there are 11 monorails operating in Japan but their transport roles can be classified into four categories. The first role is as an air–rail link (ARL) between major cities and airports. The first example of this type in Japan is the straddle beam-type Tokyo Monorail running between Hamamatsucho on JR East's Yamanote Line and Tokyo International Airport (Haneda). It was opened in 1964 in time for the Tokyo Olympics and soon had the major share of the airport access market. However, the 1993 opening of the Keihin Electric Express Railway to Haneda caused a rapid drop in the number of monorail passengers. In response, the operator established new rapid-express services followed by a commercial business tie-up with JR East as a new holding company in 2002 to facilitate new services such as sales of discount through tickets in the metropolitan area. Two other monorails that play some role in airport access are the Osaka Monorail, a straddle-beam

Size and Financial Status of Untypical Railways

	Headquarters (Location of operating lines)	Route-km	Capital (¥1000)	Operating Revenues (¥1000)		Operating Expenses (¥1000)		Operating Profits/Losses (¥1000)		Ordinary Profits/ Losses (¥1000)	Regulating Laws[1)]	Types[2)]
				Railway	Non-railway	Railway	Non-railway	Railway	Non-railway			
Monorails												
TMG TB	Tokyo	0.3	-	117,351,953	37,554,031	119,564,528	42,784,124	-2,212,575	-5,230,093	-13,874,461	RBL	S
Tokyo Monorail	Tokyo	16.9	3,000,000	14,141,248	311,403	12,952,172	121,808	1,189,076	189,595	1,371,214	RBL	SB
Tokyo Tama Intercity Monorail	Tokyo	16.0	20,539,000	6,176,173	-	6,705,943	-	-529,770	-	1,910,950	RBL	SB
Shonan Monorail	Kanagawa	6.6	8,000,000	1,694,018	201,394	1,408,630	142,400	285,388	58,944	328,949	RBL	S
Chiba Urban Monorail	Chiba	15.2	10,000,000	3,117,605	-	3,984,308	-	-866,703	-	760,093	TL	S
Maihama Resort Line	Chiba	5.0	3,000,000	3,304,649	-	4,190,116	-	-885,467	-	-1,480,945	RBL	SB
Meitetsu	Aichi	1.2	74,357,000	82,344,203	38,499,792	69,189,967	32,378,438	13,154,236	6,121,354	13,214,503	RBL	SB
Osaka Monorail	Osaka	23.8	14,538,000	7,256,392	431,332	5,864,621	324,741	1,391,771	106,691	510,050	TL	SB
Sky Rail Service	Hiroshima	1.3	20,000	174,089	17,714	193,355	15,897	-19,266	1,817	-3,299	TL	S
Kita-kyushu Urban Monorail	Fukuoka	8.8	8,150,000	2,242,572	52,226	1,866,070	52,226	376,502	0	462,655	TL	SB
Okinawa Urban Monorail	Okinawa	12.9	7,333,000	1,475,578	-	2,598,079	-	-1,122,501	-	-1,767,663	TL	SB
AGT systems, etc.												
Yurikamome	Tokyo	6.8	11,603,000	8,487,271	-	7,125,880	-	1,361,391	-	6,686	RBL, TL	LGR
New Shuttle	Saitama	12.7	2,000,000	2,368,872	310,942	2,267,255	282,834	101,617	28,108	-1,382,397	RBL	LGR
Yamaman Railway	Tokyo (Tokyo, Saitama)	4.1	800,000	212,138	17,592,125	332,627	15,962,934	120,489	1,629,191	165,587	RBL	CMB
Seibu Railway	Saitama (Tokyo, Saitama)	2.8	21,665,000	100,508,940	27,621,284	82,864,150	25,094,451	17,644,790	2,526,833	3,464,906	RBL	LGRI
Seaside Line	Kanagawa	10.6	7,600,000	3,333,454	162,046	2,491,777	133,494	841,677	28,552	-12,804,743	TL	LGR
Tokadai New Transit	Aichi	7.4	3,000,000	232,965	-	500,306	-	-267,341	-	-265,160	TL	CMB
Aichi Rapid Transit Transport	Aichi	8.9	1,290,000	-	-	-	-	-	-	-	TL	L
Osaka Municipal Transportation Bureau	Osaka	6.6		151,357,136	22,414,995	124,341,537	26,388,535	27,015,599	-3,973,540	4,524,226	RBL, TL	LGR
Osaka Port Transport System	Osaka	1.3	4,000,000	2,207,195	2,956,353	2,856,176	1,855,886	-648,981	1,100,467	48,333	RBL, TL	LGR
Kobe New Transit (Port Island Line)	Hyogo	6.4	21,400,000	4,263,229	1,469,812	3,715,555	1,410,129	547,674	59,683	264,549	TL	LGR
Kobe New Transit (Rokko Island Line)	Hyogo	4.5	21,400,000	4,263,229	1,469,812	3,715,555	1,410,129	547,674	59,683	264,549	RBL	LGR
Astram Line	Hiroshima	18.4	10,000,000	4,194,830	266,931	4,439,956	116,620	-245,126	150,311	-1,006,203	RBL, TL	LGR
Trolleybuses, guideway buses												
Kansai Electric Power	Osaka (Nagano, Toyama)	6.1	489,320,000	1,247,173	2,373,991,873	3,025,211	2,044,410,717	977,288	329,581,156	188,833,328	RBL	T
Tateyama Kurobe Kanko	Toyama	3.7	4,160,000	2,000,666	2,403,084	1,400,693	2,328,749	599,973	74,335	669,127	RBL	T
Nagoya Guideway Bus	Aichi	6.5	3,000,000	525,759	-	878,918	-	-353,159	-	-393,330	TL	GB
Cable railways												
Seikan Tunnel Museum	Aomori	0.8		34,782	69,751	50,015	70,258	-15,233	-507	-15,138	RBL	F
Tsukuba Kanko Railway	Ibaraki	1.6	47,350	149,801	526,812	103,925	512,366	45,876	14,446	45,801	RBL	F
Takao Mountain Railroad	Tokyo	1.0	100,000	356,701	503,409	335,176	444,714	21,525	58,695	75,989	RBL	F
Mitake Tozan Railway	Tokyo	1.0	100,000	228,346	208,009	273,458	149,018	-45,112	58,991	22,543	RBL	F
Hakone Tozan Railway	Kanagawa	1.2	2,000,000	2,926,058	2,592,545	2,483,187	2,347,664	442,871	244,881	524,531	RBL	F
Oyama Kanko Electric Railway	Kanagawa	0.8	100,000	159,617	29,441	157,166	31,656	3,451	-2,215	4,160	RBL	F
Izu-Hakone Railway	Shizuoka (Kanagawa, Shizuoka)	0.7, 0.3	640,000	3,161,506	14,872,831	2,913,635	15,032,702	247,871	-159,871	-303,214	RBL	F
Tateyama Kaihatsu Railway	Toyama	1.3	930,000	510,234	1,802,612	466,212	1,600,433	44,022	202,179	191,772	RBL	F
Tateyama Kurobe Kanko	Toyama	0.8	4,160,000	2,000,666	2,403,084	1,400,693	2,328,749	599,973	74,335	669,127	RBL	F
Hieizan Railway	Shiga	2.0	20,000	105,192	5,759	125,487	9,810	-20,295	-4,051	-23,409	RBL	F
Keifuku Electric Railroad	Kyoto	1.3	1,000,000	1,153,340	1,643,831	1,188,527	1,427,842	-35,187	215,989	66,688	RBL	F
Kurama Temple	Kyoto	0.2		N/A	N/A	N/A	N/A	N/A	N/A	N/A	RBL	F
Tankai Bus	Kyoto	0.4	160,000	259,966	1,342,471	206,177	1,508,204	53,789	-165,733	-114,284	RBL	F
Keihan Electric Railway	Osaka (Kyoto)	0.4	51,466,000	55,612,771	29,776,099	46,147,481	24,706,785	9,465,290	5,069,314	8,486,778	RBL	F
Kintetsu Corp.	Osaka (Osaka, Nara)	2.0, 1.3	92,741,000	172,552,014	90,455,032	136,254,264	85,551,013	36,297,750	2,309,174	22,205,242	RBL	F
Nankai Electric Railway	Osaka (Wakayama)	0.8	63,739,000	59,378,195	42,460,148	49,864,595	33,455,314	9,513,600	9,004,834	6,890,870	RBL	F
Rokko Cable	Hyogo	1.7	80,976	196,981	352,605	216,922	348,193	-19,941	4,412	-14,225	RBL	F
Nose Electric Railway	Hyogo	0.6	1,051,520	4,223,702	3,791,130	2,684,390	3,054,496	1,539,312	736,634	1,511,747	RBL	F
Kobe City Urban Development Corporation	Hyogo	0.9	20,500	35,646	24,603,203	108,046	24,376,574	-72,400	226,629	154,700	RBL	F
Shikoku Cable	Kagawa	0.7	160,000	133,398	698,001	97,679	657,484	35,719	40,517	55,163	RBL	F
Yashima Tozan Railway	Kagawa	0.8	60,000	31,547	174,523	29,385	182,854	2,162	-8,331	-5,623	RBL	F
Hobashira Cable Car	Fukuoka	1.1	1,683,000	55,915	144,478	197,684	99,213	-141,769	45,265	-100,653	RBL	F
Okamoto MFG. Co.	Oita	0.3	78,000	1,225	985,306	2,993	943,708	-1,768	41,598	65,740	RBL	F

Source: *Tetsudo tokei nempo* (Railway Annual Statistics), MLIT, 2001 and Tetsudo yoran (Railway Directory), MLIT, 2003
1) RBL = Railway Business Law, TL = Tramway Law
2) S = Suspended, SB = Straddle beam, LGR = Lateral guidance rail, CMB = Centrally-mounted beam, L = Levitation, T = Trolley bus, GB = Guideway bus, F = Funicular

Passenger Volume and Density by Railway Company

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TMG TB Ueno Monorail	No. of Passengers (1000)	1,223	1,176	1,083	1,029	994	987	965	798	0	518	906
	Passenger Density*	4,124	3,966	3,652	3,472	3,425	3,364	3,258	3,515	0	3,444	3,056
Tokyo Monorail	Volume	51,081	57,013	61,394	62,006	64,693	65,208	63,148	53,905	51,413	50,341	49,532
	Density	121,246	121,455	118,657	117,530	119,612	121,026	117,613	102,715	97,039	93,627	92,725
Tokyo Tama Intercity Monorail	Volume	-	-	-	-	-	-	2,387	11,059	29,132	33,834	35,512
	Density	-	-	-	-	-	-	13,281	18,282	28,017	32,125	33,634
Odakyu Electric Railway Mukogaoka Monorail	Volume	670	547	551	486	442	400	363	323	-	-	-
	Density	1,945	1,582	1,595	1,401	1,346	1,232	1,053	1,309	-	-	-
Shonan Monorail	Volume	11,298	11,346	11,165	11,073	11,107	10,939	10,848	10,663	10,429	10,362	10,088
	Density	15,951	16,184	15,878	15,729	18,664	15,499	15,358	15,043	14,740	14,667	14,356
Chiba Urban Monorail	Volume	12,451	13,279	13,274	15,450	16,689	16,465	16,061	16,654	16,432	16,176	16,059
	Density	14,351	13,185	13,345	13,911	14,740	14,426	14,133	102,715	12,162	11,995	11,801
Maihama Resort Line	Volume	-	-	-	-	-	-	-	-	-	17,377	19,374
	Density	-	-	-	-	-	-	-	-	-	45,479	26,699
MeitetsuInuyama Monorail	Volume	641	649	576	566	642	816	695	705	723	747	724
	Density	1,468	1,484	1,322	1,212	1,322	1,470	1,224	1,241	1,276	1,304	1,240
Osaka Monorail	Volume	7,827	8,373	8,766	10,523	10,992	21,485	26,298	27,591	28,499	28,425	29,016
	Density	12,917	13,797	11,664	11,707	12,355	19,458	21,192	21,338	22,028	21,829	22,343
Sky Rail Service	Volume	-	-	-	-	-	-	45	59	66	88	150
	Density	-	-	-	-	-	-	185	134	154	196	349
Kita-kyushu Urban Monorail	Volume	11,143	11,691	11,846	11,424	11,181	11,047	12,346	12,485	12,148	11,587	11,497
	Density	17,232	17,996	18,361	17,883	17,757	17,733	19,192	19,211	18,174	17,350	17,303
Okinawa Urban Monorail	Volume	-	-	-	-	-	-	-	-	-	-	-
	Density	-	-	-	-	-	-	-	-	-	-	-
Yurikamome	Volume	-	-	-	4,132	23,531	26,117	28,541	35,347	38,062	37,810	36,756
	Density	-	-	-	15,509	40,475	45,337	49,970	62,807	67,628	66,537	63,578
New Shuttle	Volume	11,419	11,869	11,942	12,275	12,578	12,458	12,670	12,677	12,657	12,656	12,521
	Density	15,494	16,099	16,226	16,462	1,685	16,676	16,893	16,937	17,256	17,284	17,252
Yamaman Railway	Volume	573	571	603	649	657	666	714	731	731	734	702
	Density	833	856	847	898	897	904	981	990	994	1,001	958
Seibu Railway Yamaguchi Line	Volume	1,440	1,489	1,568	1,329	1,414	1,264	1,155	1,216	1,133	1,092	1,092
	Density	3,266	3,371	3,569	2,936	3,137	2,791	2,572	2,749	2,585	2,501	2,518
Seaside Line	Volume	15,046	19,077	18,238	17,487	17,477	17,038	18,621	17,583	16,761	16,474	16,346
	Density	17,720	23,265	22,174	20,753	20,790	20,250	21,515	19,990	19,152	18,815	18,627
Tokadai New Transport	Volume	964	923	913	1,011	1,048	959	930	869	826	797	812
	Density	1,994	1,910	1,868	2,063	2,153	1,950	1,895	1,773	1,679	1,616	1,646
Aichi Rapid Transit Transport	Volume	-	-	-	-	-	-	-	-	-	-	-
	Density	-	-	-	-	-	-	-	-	-	-	-
Kobe New Transit	Volume	27,912	29,558	22,785	19,379	28,375	26,618	25,871	24,750	24,323	24,044	23,796
	Density	26,385	28,498	27,505	20,976	27,364	25,507	24,704	23,578	23,217	22,703	22,441
Osaka Municipal Transportation Bureau Nanko Port Town Line	Volume	22,542	21,521	24,196	24,809	24,845	25,487	24,741	24,343	24,083	24,778	24,008
	Density	43,613	42,846	49,663	51,142	52,562	51,861	49,486	47,601	47,007	48,240	46,592
Osaka Port Transport System New Tram Techno Port Line	Volume	-	-	-	-	-	2,672	10,815	11,663	11,345	12,521	11,758
	Density	-	-	-	-	-	6,527	26,417	28,425	26,722	27,039	24,219
Astram Line	Volume	-	-	9,761	16,623	17,813	18,335	18,836	19,234	19,344	19,315	18,130
	Density	-	-	20,175	19,511	20,798	21,170	21,622	22,207	22,535	22,124	19,985
Kansai Power Electric	Volume	1,546	1,480	1,604	1,205	1,324	1,333	1,137	1,073	1,164	1,070	1,054
	Density	7,029	6,819	7,289	5,550	6,051	6,005	5,145	4,833	5,172	4,752	4,683
Tateyama Kurobe Kanko Trolleybus Line	Volume	-	-	-	-	-	974	822	800	840	784	735
	Density	-	-	-	-	-	4,390	3,704	3,605	3,731	3,483	3,265
Nagoya Guideway Bus	Volume	-	-	-	-	-	-	-	-	55	1,930	2,272
	Density	-	-	-	-	-	-	-	-	4,678	3,742	4,370
Seikan Tunnel Museum	Volume	120	110	115	117	114	124	109	92	104	96	101
	Density	581	538	556	583	544	600	538	444	506	463	500
Tsukuba Kanko Railway	Volume	492	466	427	443	436	384	360	350	322	355	350
	Density	1,386	1,295	1,326	1,227	1,208	1,068	1,000	976	900	1,012	981
Takao Mountain Railroad	Volume	1,117	1,001	982	942	950	878	823	843	802	864	861
	Density	3,069	2,804	2,705	2,639	2,603	2,405	2,273	2,303	2,222	2,462	2,365
Mitake Tozan Railway	Volume	799	758	724	704	695	623	568	564	517	529	500
	Density	2,189	2,077	1,984	1,923	1,904	1,790	1,556	1,541	1,416	1,449	1,374
Izu-Hakone Railway Komagatake Cable Car	Volume	140	127	129	129	102	93	79	82	71	78	66
	Density	421	357	363	364	285	314	255	263	205	255	212
Hakone Tozan Railway Sounzan Cable Car	Volume	1,502	1,560	1,402	1,509	1,601	1,527	1,506	1,435	1,349	1,289	1,260
	Density	3,614	3,735	3,366	3,606	3,881	3,700	3,636	3,476	3,265	3,130	3,082
Oyama Kanko Electric Railway	Volume	666	624	602	590	581	522	483	483	423	494	451
	Density	1,839	1,706	1,648	1,611	1,574	1,415	1,316	1,303	1,157	1,345	1,263
Izu-Hakone Railway Jukkoku Cable Car	Volume	706	653	657	593	568	482	429	458	368	419	380
	Density	1,927	1,798	1,791	1,618	1,560	1,321	1,183	1,245	1,009	1,145	1,041
Tateyama Kaihatsu Railway	Volume	1,029	982	1,054	849	1,073	974	862	844	881	842	803
	Density	4,387	4,170	4,477	3,608	4,562	4,141	3,663	3,588	3,745	3,578	3,412
Tateyama Kurobe Kanko Cable Car	Volume	1,195	1,143	1,299	954	2,022	1,072	909	872	923	858	825
	Density	5,432	5,193	5,903	4,341	4,422	4,820	4,084	3,921	4,100	3,811	3,667
Hieizan Railway	Volume	148	178	200	177	198	165	174	163	157	165	157
	Density	388	532	512	482	518	444	459	443	419	453	430
Keifuku Electric Railroad Eizan Cable Car	Volume	218	207	227	194	180	144	150	142	116	184	142
	Density	596	564	621	532	493	394	412	389	318	503	394
Kurama Temple	Volume	336	347	358	325	251	322	320	309	288	298	274
	Density	955	970	1,091	910	902	889	889	861	806	833	746
Tankai Bus	Volume	1,114	1,094	854	991	950	971	888	814	781	821	806
	Density	3,163	3,000	2,850	2,712	2,734	2,658	2,432	2,233	2,137	2,247	2,205
Keihan Electric Railway Otokoyama Cable Car	Volume	483	477	440	424	410	363	345	335	317	321	315
	Density	1,329	1,308	1,205	1,158	1,123	993	945	918	870	1,058	863
Kintetsu Corp. Nishi Shigi Cable Car	Volume	164	164	147	138	132	164	125	109	852	101	93
	Density	451	451	403	376	361	449	341	296	284	276	253
Kintetsu Corp. Ikoma Cable Car	Volume	1,075	943	922	909	891	801	733	782	103	630	569
	Density	1,967	1,670	1,623	1,597	1,547	1,385	1,234	1,388	1,351	1,092	964
Nankai Electric Railway Koyasan Cable Car	Volume	980	934	919	927	884	886	822	777	699	677	637
	Density	2,682	2,558	2,548	2,529	2,421	2,428	2,253	2,123	1,914	1,853	1,743
Rokko Cable	Volume	827	750	667	279	440	410	387	449	405	370	396
	Density	1,353	1,233	1,373	715	788	734	855	808	1,115	1,104	1,084
Nose Electric Railway Myokensan Cable Car	Volume	120	136	147	131	134	129	131	129	108	131	120
	Density	354	393	440	373	389	374	383	449	376	458	421
Kobe City Urban Development Corporation	Volume	-	-	-	-	-	-	-	-	17	229	128
	Density	-	-	-	-	-	-	-	-	1,071	684	470
Yashima Tozan Railway	Volume	132	124	90	92	94	78	73	68	60	60	58
	Density	360	339	247	253	257	212	199	184	164	164	171
Shikoku Cable	Volume	394	389	357	352	342	322	324	328	327	355	335
	Density	1,078	1,063	977	961	934	879	887	898	895	973	918
Hobashira Cable Car	Volume	183	158	182	140	146	129	138	120	89	243	203
	Density	508	440	504	388	408	403	387	332	469	896	676
Okamoto Mfg. Co.	Volume	437	383	319	302	286	231	216	176	156	142	120
	Density	1,191	1,045	1,182	827	782	627	591	482	427	391	327

Source: *Tetsudo tokei nempo* (Railway Annual Statistics), MLIT
Note: Passenger Density = Daily passenger-km/route-km

monorail (see *JRTR* 36, pp. 56–63) and the *Yui-rail*, a straddle-beam monorail (see *JRTR* 39, pp. 4–14) operated by the Okinawa Urban Monorail Co., Ltd. However, considering the construction process, both these monorails probably come under the second category below.

The second role is as a rail-based medium-capacity urban transport system serving the needs of growing cities; about half of Japan's monorails come into this category. Typical examples are the suspended Shonan Monorail in Kanagawa Prefecture, the suspended Chiba Urban Monorail in Chiba Prefecture (see *JRTR* 33, pp. 50–59), the straddle-beam Tokyo Tama Intercity Monorail in Tama City, Tokyo (see *JRTR* 32, pp. 52–62), and the straddle-beam Kita-kyushu Urban Monorail in Fukuoka Prefecture. In fact, both the previously described Osaka Monorail and the *Yui-rail* really come into the urban monorail category. *Yui-rail* is the first rail-based transport system in Okinawa Prefecture since the end of WWII when an existing war-damaged line was abandoned leaving Okinawans without a railway of any sort for many years. However, with the opening of this monorail, Naha now holds the record for Japan's most southerly (Akamine) and westerly (Naha-kuko) 'railway' stations.

The third role is as a link with stations serving tourism destinations. Two examples of this type are the straddle-beam Disney Resort Line in Chiba Prefecture near Tokyo and the straddle-beam Monkeypark Monorail in Aichi Prefecture. The former line links Tokyo Disneyland and Tokyo DisneySea with the nearby JR East Maihama Station and is 100% owned by the theme park operators. The latter line links a theme park and the Japan Monkey Park both owned by the monorail operator to the nearest railway-station owned by Nagoya Railroad (Meitetsu). The growth of these monorails was heavily impacted by their positive image as a modern transport mode suiting theme parks and expositions, etc., but more than a few have reached the end of this role due to Japan's aging society and the closure of leisure facilities. An example of the fourth case is the Sky Rail Service suspended monorail built to provide access to a large area of development land. It is a rather unique cross between a cableway and a monorail in which small unpowered 8-seat carriages are moved in the station by a linear motor but between stations, the carriages are moved by a connected cable. It could be described as a Rope Driven Suspended Transportation System (see *JRTR* 39, pp. 36–43). There are quite a few of these small volume transport systems that do not have any legal basis. For example, the *Pastoral View* Katsuradai in Yamanashi Prefecture is a magnetic belt transit system that could be described as a straddle-beam monorail linking high pastoral scenic areas with the nearby JR East Saruhashi Station, but in legal terms it is unclear whether it is a true railway, tramway, etc.

There is no single law regulating monorails and AGT systems described above are regulated by the Railway Business Law and the Tramway Law. The early monorails opened before 1970 were regulated by the Railway Business Law (then called the Local Railway Law). But after the 1980s, since it was decided to create a new system for assisting links with the road infrastructure, some cases were interpreted as coming under the Tramway Law on the premise that construction was over roads. Monorails completed by this type of procedure were called 'urban monorails.'

AGT Systems

Automatic Guideway Transit systems offering medium transport capacities similar to monorails between the high capacity levels of railways and the smaller capacities of buses became a popular form of city transport from the 1980s. Some use rubber-tyred articulated vehicles running along a dedicated guideway. In addition, use of high-technology drive and control systems has achieved high-reliability automated operation and better safety, and some operators have introduced driverless services using automatic train operation (ATO) systems. At the same time, AGTs are reducing pollution, such as noise and vibration, commonly caused by existing transport systems, such as railways, buses and private cars.

Against this background of rapid development of these types of medium

Tokyo Tama Intercity Monorail running between redevelopments in West Tokyo. This monorail on the western side of Tokyo acts as a link between three radial commuter lines running from Shinjuku. The track is built mainly over roads and developed land but there are some tunnels on sections through the Tama Hills. (Author)

Yurikamome AGT System linking Tokyo's New Waterfront Development areas. In the 10 years since opening in 1995, it has carried 300 million people—a large number for an AGT system. A 2.8-km extension is planned to open in March 2006. (Author)

capacity transit system, construction in publicly owned spaces such as above roads, has made it possible to cut construction costs by eliminating land purchase costs so that new infrastructure can be built at lower costs than railways. In addition, another merit is the fact that the track supporting structures can be built as part of the road funded as a public works project, while the operator only has to bear the financial burden of providing the other infrastructure such as rolling stock, power supply, signalling equipment, station infrastructure, etc. In more recent years, to be able to receive the above-described public assistance, new monorail and AGT operators have established themselves as third-sector businesses with the majority of capital being provided by regional public bodies. However, although it is possible to build infrastructure for AGTs over publicly owned roads, even the main roads in many Japanese cities are very cramped and restricted so there have been a number of instances where construction has been undertaken after road widening projects. Furthermore, the high initial investment costs in new technologies coupled with low transport volumes have caused financial headaches for operators of AGT systems.

Japan's first AGT system was introduced in the Kansai district (encompassing Osaka, Kobe and Kyoto) with the February 1981 opening of the 9.2-km Port Island Line in Sannomiya, Kobe City (see *JRTR* 16, pp. 4–14, *JRTR* 26, pp. 58–67, *JRTR* 36, pp. 56–63) and the March 1981 opening of the 6.6-km Nanko Port Town Line in Osaka City. In the Kanto district (encompassing Tokyo, Yokohama, Kawasaki and Chiba), the first AGT systems were the Yukarigaoka Line operated by the Yamaman Co., Ltd opened in Chiba Prefecture in 1982 (see *JRTR* 31, pp. 44–54), the 13-km Saitama *New Shuttle* linking Ina Town to the JR East Omiya Station opened in 1985 and the Seibu Railway's Yamaguchi Line also opened in 1985. Lines in the Kansai district have often been built to link newly reclaimed coastal land with the nearest main line railway station and are mostly third-sector businesses with infrastructure built using government assistance. Conversely, lines in the Kanto district have a variety of development backgrounds; they have either been built by private developers to provide better access to residential development land that they are selling (the Chiba's Yamaman Railway is one example), or have been built to strengthen capacity on existing lines (Seibu Railway's Yamaguchi Line) or to compensate for shinkansen developments (Saitama's *New Shuttle*). The first line in the Kanto district built with government assistance was the Yokohama Seaside Line in Kanagawa Prefecture opened in 1989. This was followed in 1995 by the opening of the Tokyo Waterfront New Transit, which is now known as *Yurikamome*. In FY2003, it was carrying an average of 94,000 passengers a day to and from Tokyo Big Sight (Tokyo International Exhibition Center) and a large amusement area built on newly reclaimed land in the waterfront area. In the first days of operations in 1995, the number of passengers was only 27,000 per day but this soon expanded threefold due to new trackside development. AGT systems opened in regions outside the Kansai and Kanto districts include the 18.4-km Astram Line with rubber-tyred EMU vehicles running on a concrete track to serve 21 stations in Hiroshima Prefecture (see *JRTR* 39, pp. 36–43), and the 7.4-km Tokadai New Transit's *Peach Liner* with rubber-tyred four-car train sets, serving 20 stations between Komaki and Tokadai-higashi stations in Aichi Prefecture (see *JRTR* 34, pp. 52–63).

These AGT systems are almost exclusively short lines of less than 20 km running rubber-tyred electric vehicles powered by either three-phase 600 V ac or 750 V dc supplies along some form of guideway. In terms of specifications, there are a number of similarities but the various makers incorporate their own unique specifications in the carriages and systems so compatibility is generally poor. In other words, nationwide operators of AGT systems are using a few train sets from a variety of makers, meaning that there is little progress with specification compatibility. Moreover, except for the Nippori–Toneri Line currently under construction in northern Tokyo and extensions planned by two other operators, no other new infrastructure for AGT systems is currently being planned in Japan. It is unlikely that future costs

Nagoya Guideway Bus running on dedicated elevated guideway using modified buses. This new system avoids traffic congestion on normal roads to assure on-time operation. While on the elevated section, operations are regulated by the Tramway Law and a central Operations Control Room manages the bus operations as a whole.
(Author)

will drop with the spread of AGT systems. The maintenance costs of vehicles and infrastructure such as elevated guideways, signalling and control systems, etc., will remain comparatively high, so operators cannot achieve the low operation costs as expected.

The *Peach Liner* in Aichi Prefecture used much lower-cost specifications than other AGT systems but even so its operations have continued to run in the red due to extremely low passenger levels with accumulated losses exceeding ¥600 million. Furthermore, after more than 10 years of operations, the expensive time for renewing vehicles and infrastructure, etc., is arriving and solutions such as abandoning current operations or changing to another system are being investigated.

Through Operations

Since AGT systems have good transportation capacity, they are sometimes used when normal buses are unable to meet demand as in the case of the Nagoya Guideway Bus introduced in 2001 in Aichi Prefecture. The buses run on a dedicated elevated guideway in the centre of Nagoya City where traffic congestion is very severe but run on normal roads away from the city centre. This rather unique dual-mode system combines a road transport system and trackless transport system. Operations are managed as a third-sector company and the cost of building the elevated guideway infrastructure was borne by the Nagoya City roads budget. The sides of the buses have guiding devices mounted on them to perform automatic steering while the bus is running on the guideway, freeing the driver from the need to steer the bus. Like a train driver, the bus driver just has to accelerate, decelerate and stop. This setup permits them to run safely at high-speed along the narrow guideway and allows the buses to keep on schedule, which is a problem for normal buses. In addition, although the vehicles are simply modified buses with a normal diesel engine, when running on the elevated guideway, they are subject to the Tramway Law in the same way as tramway services and some other AGT systems, and the driver is required to obtain a trolleybus driver's licence. Moreover, with future large expansion of transport demand and practical application of elevated guideways, there is a possibility of a move towards AGT systems.

On the other hand, there is some progress in development of AGT systems making use of railway infrastructure that has been badly affected by loss of passengers to

JR Hokkaido's Dual Mode Vehicle during test runs on the Sassho Line. This microbus-based vehicle was developed to revitalize business on under-used lines in Hokkaido. It has been in testing on commercial lines and public roads since 2004 and development of a two-vehicle coupled set is underway to strengthen future transport capacity.
(JR Hokkaido)

other transport modes. In 2002, JR Hokkaido announced a dual-mode vehicle (DMV) consisting of a device for allowing a microbus to run on rails but which could also switch to running on normal roads. On a normal road, it operates in the same way as a normal microbus, and when on the railway section, it is able to achieve speeds of 70 km/h running on rubber tyres using metal wheels following the rails as guides. As a result, in addition to offering the railways' advantage of on-time scheduling and high speeds, this system also offers the advantages of bus maneuverability and low initial and maintenance costs. Furthermore, tests are also underway to secure sufficient transport capacity for the evening and morning rush hours by coupling two buses together. If this system is put into revenue operation, JR Hokkaido has high hopes that it might bolster revenues on under-used sections and has various high expectations for this sensational AGT system. For example, they are investigating the possibilities of using the ability of this system to climb steep grades that cannot be passed easily by conventional railways to provide access to airports on higher land, revitalize regional railways in difficult economic circumstances, link tourist spots and town areas with the nearest railway station, etc.

Magnetic Levitation (MAGLEV)

Two years before the 1964 opening of the Tokaido Shinkansen, engineers at Japanese National Railways (JNR) were already embarking on development of the next-generation of high-speed railways. The idea was to break the mold of the old concept of adhesion between metal wheels running on metal rails, which imposed maximum speed limits, by starting R&D into a superconducting magnetic levitation technology using the repulsive interaction between superconducting magnets installed on the vehicles and electromagnetic coils installed on the ground infrastructure to levitate and propel the vehicle at very high speeds exceeding 500 km/h. Following the 1987 JNR division and privatization, R&D into the system was started under the leadership of the Railway Technical Research Institute (RTRI) and JR Central.

JR Central's MLX01-901 Maglev on RTRI's Yamanashi Test Track opened in 1997. The new long-nose lead carriage design was introduced in 2002 and is currently in testing. (RTRI)

An 18.4-km test track was built in Yamanashi Prefecture in 1997, where test runs achieved a manned world speed record of 581 km/h in 2003. Based on these test results, in 2005 the Ministry of Land Infrastructure and Transport's Superconducting Maglev Commercialization Technology Evaluation Committee decided to establish the basic technology needed for commercial application. Although the aim is to build a magnetic levitation (MAGLEV) system from Tokyo through the central part of Honshu Island linking Nagoya and Osaka, there are still many remaining problems before such a system can become reality, not least of which is the funding.

Elsewhere, other private sectors started development of MAGLEV railways in 1972, 10 years after JNR. At that time, Japan Air Lines (today's JAL) was investigating and promoting a RAL system named HSST for access to New Tokyo International Airport (Narita). They held test runs at various regional expositions in the late 1980s to build up experience and in 1989 were joined by Meitetsu and Aichi Prefecture in building a 1.5-km test track in Aichi Prefecture. They performed various types of tests positioning the HSST as a medium-capacity transport system with good ability to climb steep grades and low infrastructure costs. In 1993, the then Japanese Ministry of Transport (now Ministry of Land, Infrastructure and Transport) expressed the opinion that there were no technical problems with commercialization and in March 2005, Japan's first non-superconducting maglev train using a linear motor entered permanent commercial service as the *Linimo* operated at speeds up to 100 km/h by the Aichi Rapid Transit Company to serve the Aichi Exposition. Like the earlier AGT systems, the infrastructure was built by the local government and the other equipment was constructed by Aichi Rapid Transit,

Aichi Rapid Transit's for *Linimo* levitating 6 mm above the track. This is Japan's first magnetic levitation system for commercial service, carrying more than 10 million people to the Aichi Exposition by July 2005. (Author)

operating as a third sector company. The propulsion system uses a linear induction motor (LIM), which is different from the linear synchronous motor used by JR. The earlier JR levitation method used magnetic repulsion whereas the HSST uses attraction. In other words, when current is passed through electromagnets mounted under the carriages, attraction generated by magnetic force causes the carriage to float 6 mm above the rail. As a result, there is much less running noise or vibration than conventional railways and there is little effect caused by bad weather conditions such as heavy rain or snow accumulation. In addition, since there are few parts like rails and wheels to wear, maintenance costs are expected to be very low. It has been a success using computer-controlled driverless operation to carry more than 1.5 million people in the first month after the Expo opened.

Cable Railways or Funiculars and Ropeways

Cable railways or funiculars carry cars pulled by a wire cable along a track built over the ground. In the three main islands of Honshu, Shikoku and Kyushu, there are 22 operators of 26 cable systems. Many are about 1-km long the longest is the 2.0-km Sakamoto Cable Railway at Hieizan in Shiga Prefecture. It links Sakamoto with the Hieizan Enryakuji Buddhist Temple by an 11-minute ride. The shortest is the 0.3-km Beppu Wonder Rakutenchi Cable Railway in Oita Prefecture. Many cable railways in Japan are located at famous sites such as mountain temples and shrines, or at tourist sights such as panorama viewing platforms. There are almost none serving daily life activities.

Japan's first cable railway was opened in 1918 to carry people to the Hozan Temple at Mt Ikoma in the Kansai District. It was incredibly popular as the first funicular ride and marked the start of a subsequent cable railway boom. The second cable railway was opened at the world-famous Hakone Mountains with rich hot springs in the Kanto District in 1921. These two cable railways are still very popular and Hakone Tozan Railway's cable system (1.2-km) is now using 4th generation cars built by Swiss Von Roll. It is Japan's first cable railway using trains composed of permanently coupled two cars. There was a sharp drop in cable railway construction, coming to a complete stop after the 1988 opening of the Seikan Tunnel Memorial Hall in Aomori Prefecture. This cable system was built in an inclined shaft for excavating the undersea tunnel, but was then remodelled into a passenger service. As a result, more than 30 years have passed since the last true new build for passenger operation opened as the Tateyama-Kurobe Kanko's cable system in 1969 in Toyama Prefecture. Currently, worn-out vehicles and infrastructure are being upgraded, but some operators are withdrawing form the market due to worsening business conditions.

At the end of March 2004, there were 2888 ropeways in Japan; 185 localities are classified as 'ordinary ropeways' using enclosed cabin to carry passengers or both passengers and goods, while 2703 localities are 'special' ropeways using the open chairs. The former type are usually called ropeways or gondola lifts while the latter are known as either ski lifts or chair lifts. In both cases, the majority are located at tourist destinations, particularly in Hokkaido, Tohoku, Hokuriku and Shin'etsu where heavy snow falls attract a lot of skiers to the slopes.

In 2001, the world's longest ropeway nicknamed the Dragondola was opened between Naeba and Tashiro (5481 m) at the Naeba Ski Resort in Niigata Prefecture. Some ropeways also introduced very large gondolas; Mt Hakodate Ropeway introduced in 1988 gondolas each carrying 126 passengers, followed by the Ryuo Ropeway in Nagano Prefecture and the Yuzawa Onsen Ropeway introducing 166-passenger gondolas in 1991. 1998 marked the opening of the 2nd Shin Hotaka Ropeway in Gifu Prefecture using Japan's first two-storey gondolas each carrying 121 people. There have also been speed increases and currently both Kokudo's Hakkaisan Ropeway (Niigata

Takao Mountain Railroad's cable car operates over the highest grade (31°18') in Japan. Like many other cable cars in Japan, operations were suspended during WWII when the rails, were removed for war production, but it was restarted again in 1949. (Author)

Prefecture) and Shikoku Cable's Umpenji Ropeway (Kagawa Prefecture) have the fastest speeds in Japan of 10 m/s.

From the technical viewpoint, the Hashikurayama Ropeway in Tokushima Prefecture and the Hakone Ropeway in Kanagawa Prefecture were upgraded in 1999 and 2002, respectively to the Double Loop Mono Cable Gondola (DLM) Funitel method. In mountainous areas like Hakone, high wind speeds causing suspension of services for about 30 days a year were limiting business. To solve this problem, in addition to increasing the gondola size, the Funitel system with a double loop and a wider body than the gondola was introduced for more stable operation. This has resulted in a 50% increase in transportation capacity per hour and has greatly reduced waiting times during the tourist season.

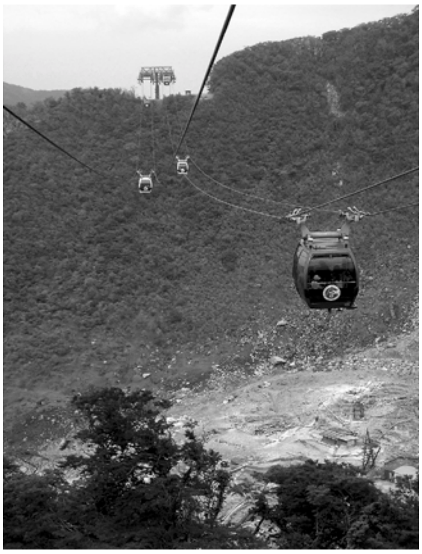
The number of regular customers for cable railways and ropeways in mountainous regions with poor transport is dropping due to diversification of leisure activities and easier access to tourist sites by cars and tourist buses. As a result, more than a few operators have experienced drops in passenger numbers. Moreover, some regional operators are withdrawing from the market due to the high costs of maintaining aging infrastructure. In 2004, the Yashima Tozan Railway applied for bankruptcy and suspended operations, while the Komagatake Ropeway of Izu-Hakone Railway experienced a 5% drop in passengers during the high season and decided to withdraw from the business in 2005.

Heritage Railways

Unfortunately, Japan has yet to make the same investment in heritage railways as seen in the UK. In addition to Japan being relatively late in preserving railways and railway infrastructure as a cultural asset, there are strict regulations governing railways, public volunteers are not able to manage railways themselves. However, there have been long-term movements to preserve historic rolling stock starting with steam engines across the country from Hokkaido to Kyushu.

These preservation activities can be split into three types. First, railway operators are operating historic rolling stock on their own lines. Second, preservation groups are operating rolling stock on lines

The Hakone Ropeway has recently been upgraded to become Japan's first Funitel system using a wider gondola and a double-loop mono cable, resulting in higher stability during windy conditions and a more comfortable ride. (Y. Kuroda)



Harunasan Ropeway using two linked gondolas. This fixed mono-cable pulse ropeway in Gunma Prefecture features linked gondolas with a simple structure like a ski lift to cut costs. (Y. Kuroda) borrowed from railway operators. Third, historic rolling stock is being operated on dedicated tracks inside facilities such as parks and museums that are not connected to commercial lines.

JNR retired steam engines from revenue service in 1975, but the private Oigawa Railway in Shizuoka Prefecture took over some of JNR's abandoned steam locomotives, starting steam operations between regular services from the summer of 1976. Today, they have five locomotives in working order, which they operate throughout the year except weekdays in the off-season. To meet requests from railway enthusiasts not to abandon steam engines and to celebrate the 100th anniversary of Japanese railways in 1972, JNR opened the Umekoji Steam Locomotive Museum in part of the former Umekoji Depot where a large number of steam locomotives were preserved in working order. Following this, in 1979, steam operations were started on the Yamaguchi Line in west Honshu using the preserved locomotives from the Umekoji museum. This operation was taken over by JR West, and subsequently JR East, JR Kyushu and JR Hokkaido started running special steam trains.

As an example of the second type of operation, the Japan National Trust, a non-profit organization funded by public donations, purchased an old Class C12 steam locomotive and passenger carriages that they loan to Oigawa Railway where it is operated as the *Trust Train*.

Examples of the third type of operation are seen in various railway museums. Apart from the short-distance demonstration at the above-mentioned Umekoji museum, the Mikasa Railway Museum and Otaru Transportation Museum (both in Hokkaido) are proud of their short-distance steam operations using surviving very old small locomotives, as well as their good collection of rolling stock from former JNR and private coal mine railways. The Usui Pass Railway Monument Park in Gunma Prefecture attracts people with its rich collections of electric and diesel locomotives. Both the Mikasa and Usui Pass museums provide intending visitors with an opportunity to learn how to drive a steam (Mikasa) or an electric (Usui) locomotive. Furthermore, recently, volunteers groups centred around railway enthusiasts have been rescuing important rolling stock from the breaker's yard. In 1973, the Rasuchijin Railway Association (RASS) was formed for the purpose of preserving 610-mm narrow gauge steam locomotives, etc. They are presently operating some stock on a 500-m track (to be extended to 2 km in the future) at the Narita Yume Bokujo park site in Chiba Prefecture. On the other hand, preservation of 1067-mm narrow-gauge stock in working order is mainly focussed on old abandoned stations. For example, the Katakami Railway Preservation Group (Okayama Prefecture), Kaya Railway Preservation Group (Kyoto), and Ohata Line *Kiha* 85 Working Order Preservation Group (Aomori Prefecture) run operations with historic stock about once a month. None of these groups are railway operators as defined by law, so they operate with the same legal status as amusement facilities. In the future, there are some hopes that heritage railways can be established in Japan following the UK model. ■

Volunteers from the Katakami Railway Preservation Group in Okayama Prefecture run heritage operations about once a month with historic diesel-hydraulic locomotives, passenger cars and freight wagons at an old station on the Katakami Railway abandoned in 1991. The facilities are owned by the municipality. (Author)

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