EXPLANATION OF AND COUNTERMEASURES AGAINST TRAFFIC CONGESTION

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Based on a survey on the central area of the city of Tokyo and resort areas in the suburban areas of Tokyo, we understand the status quo of traffic congestion quantitatively and propose short-term measures against it. In conclusion, it was made clear that if the capacity of the existing road facilities are fully utilized through such countermeasures as removal of on-street parking, adjustment of traffic signal control, improvement of intersection configuration, and the designation of, and guidance to an appropriate detour route, it is possible to substantially reduce or eliminate traffic congestion in the short run.

1. EXCESS DEMAND

There is a limit to the number of vehicles which can pass a road section per unit time, and we call this the traffic capacity of the road. On the other hand, we can define the traffic demand as the number of vehicles which want to pass a road per unit time. Traffic congestion occurs when the traffic demand exceeds the traffic capacity, and is similar to the situation where some of the people trying to get into an elevator are left out and are obliged to wait because they exceed the capacity of the elevator.

When we see slowly moving vehicles in a traffic jam, we tend to believe that vehicles are coming onto the road far exceeding the capacity.

However, in daily traffic congestion observed in big urban areas, only an excess demand of about 2 or 3 to 10 or 20 percent is actually generated. Therefore, it is quite possible to reduce the congestion substantially or even eliminate it just by making slightly more effective use of the roads that now exist.

2. THE ROAD BOTTLENECKS

The traffic capacity of roads for one traffic lane is, in general, approximately 2,000 vehicles per hour. However, at signalized intersections with green and red periods of equal length, only about 1,000 vehicles can pass through per hour per lane. At the merging points of the ring and radial lines of the Metropolitan Expressway, since the capacity at the downstream of the merging point is limited, all the vehicles coming from upstream cannot always merge immediately.

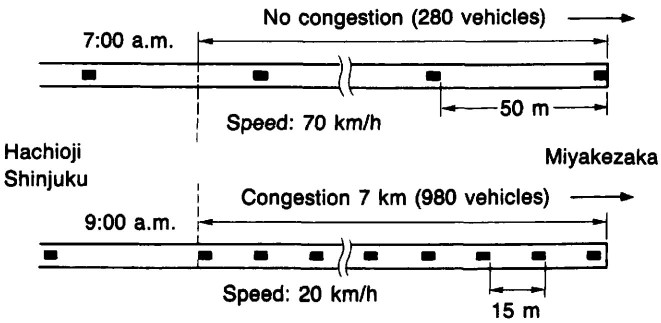
A road section where the traffic capacity is smaller than the upstream section is called a "bottleneck." If a traffic demand that exceeds the traffic capacity flows into the bottleneck, traffic congestion starts from that point.

3. WEEKDAY CONGESTION IN URBAN AREAS

3.1 The Present Status of Traffic Congestion

(1) The Congestion of Inbound Traffic on the Radial Lines of Metropolitan Expressway.

Fig. 1 shows the inbound traffic condition of the No. 4 Metropolitan Expressway, the Shinjuku Line, based on an analysis of detector data. In this case, there was no congestion until around 7:00 a.m., but then the congested section gradually expanded from the Miyakezaka Interchange as the starting point. At around 9:00 a.m. the longest queue of 7 km was observed. In this congested section, the speed of the vehicles was about 20 km/h. Therefore, a total of 980 vehicles would be



Basic Material: Data from Traffic Detector
Source: Metropolitan Expressway Public Corporation

Fig. 1 Traffic condition on No. 4 Metropolitan Expressway, the Shinjuku Line, inbound direction

on both traffic lanes in this section.

Prior to the congestion at 7:00 a.m., the vehicles were moving at a speed of about 70 km/h with a distance headway of about 50 m between them, so there would be a total of 280 vehicles on the two traffic lanes in this 7 km section. The difference of 700 between the number of vehicles existing at 7:00 a.m. and at 9:00 a.m. is the amount of the excess demand of vehicles that could not get through and were stagnated during the 2 hours.

On the other hand, the number of vehicles passing through in the 2 hours is equal to the traffic capacity of 5,400 per 2 hours per 2 lanes. Therefore, the excess rate would be only 13%.

(2) Congestion Inbound on Streets

According to the material provided by the Metropolitan Police Agency, inbound traffic congestion of about 3.5 km long occurred from the Yodobashi Nichumae intersection on Ome-kaido, near JR Shinjuku Station during the two and a half hours from slightly before 7:00 a.m. to 9:30 a.m. in one morning.

Using the value measured by the traffic detector of the police agency installed at the intersection of Nakano Sakaue, the traffic volume, speed, and density were observed. From this estimation, the excess demand of the Yodobashi Nichumae intersection was estimated, and the excess rate was only 3%. Another calculation was made based on the travel speed survey along this same section, and the excess demand rate was estimated at 5%. The actual excess demand would be most probably halfway between 3% to 5%.

3.2 Measures against Daily Congestion in Urban Areas

We observed, as a case study, intersections that daily cause bottlenecks in the urban areas inside Loop 6 of Tokyo, as shown in Fig. 2 and Table 1, with the help of the patrol staff of the Japan Automobile Federation.

(1) Removal of On-street Parking near Intersections

Of the 193 intersections, 152 intersections have vehicles parked on-street all the time. If there is even one vehicle parked near an intersection, one traffic lane out of the 2 to 3 lanes existing for the same direction will be unavailable, and traffic capacity will be decreased by a half or one third. This decrease in volume is substantial compared with the 2 or 3 to 10 or 20 percent imbalance between demand and supply. Therefore, in this kind of intersection, the congestion could be well eliminated by removing the vehicles parked on the streets.

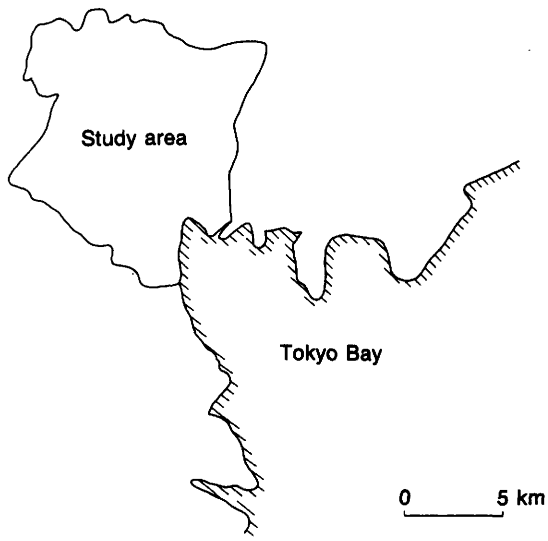


Fig. 2 Study area (8 wards within Loop 6)

Table 1 Countermeasures at the study area

Measures	Number of intersections
Removal of on-street parking	152
Adjustment of traffic signal	33
Improvement of intersection configuration	6
No short-term countermeasures	2
Total	193

Of the bottleneck intersections inside Loop 6, the number of intersections that need to have parked vehicles removed was 152, and the number of approaches, 206. If the vehicles parked on the streets were to be removed from the 50 m section from the stop line on these approaches, the number of vehicles removed would total 1,500.

On the other hand, based on the 1985 Road Traffic Census, we estimated that approximately 190,000 vehicles were parked on the roads inside Loop 6 at the peak period. As the removal rate is only about 0.8%, there would be hardly any impact on the traffic activities in the center of the city, but this would have a substantial improvement on the capacity of the intersection.

(2) Signal Control Adjustment

Of the remaining 41 bottleneck intersections inside Loop 6, 33 intersections had congestion in only one direction. In such intersections, signal control adjustment is an effective measure. As shown in Fig. 3, suppose that the time period of 50 seconds is allocated for the green light in each direction at an intersection, and then a period of 5 seconds is taken from the direction with no jam and given to the direction with a jam. With just a simple procedure of this kind, the traffic capacity in the direction of the congestion can be increased by as much as 10%.

Fig. 4 shows an example of the intersection improvement achieved by the combination of a signal control adjustment and traffic regulations at the Yahara intersection. Since the green time was previously assigned for traffic coming from Fuji-kaido, sufficient green time could not be assigned for Mejiro Street which was more congested. Therefore, a new signalized intersection was facilitated at a little before the Yahara intersection so that the traffic from Fuji-kaido can flow into Mejiro Street from that intersection.

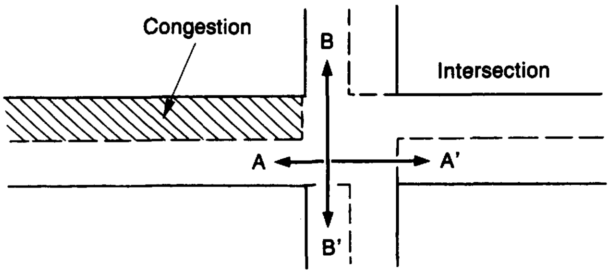
To compare the signal split of the Yahara intersection before and after this measure, we can see that while 11% of the total green time was assigned to the traffic from Fuji-kaido, the 8% of the green time has shifted to the Mejiro Street side. The traffic capacity in this direction can be considered to have been improved by 8% divided by 42%, which means it was enhanced by approximately 20%.

(3) The Improvement of Intersection Configuration

In the remaining 8 bottleneck intersections inside Loop 6, not much on-street parking was found, but still there was congestion both ways. At such intersections, structural measures such as improvement of intersection configuration or grade separation may be necessary.

We therefore studied these 8 intersections more closely and found that there was room for improvement in six of them. However, in the remaining two, no simple measure seemed to prove effective.

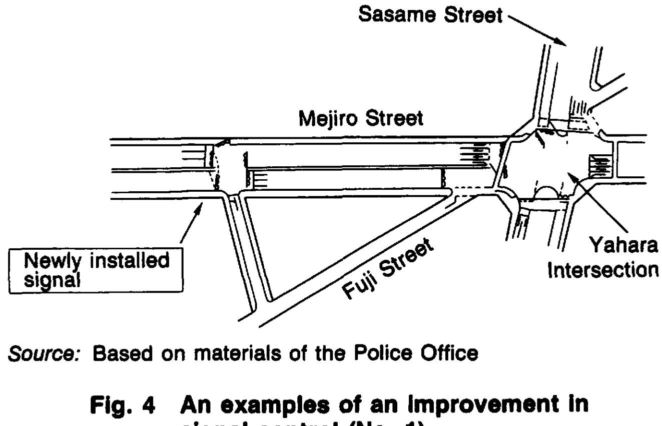
Fig. 6 shows an example of an improvement in the Ichigaya intersection. Before the measures were implemented, there were 3 traffic lanes in the direction toward Iidabashi and 2 lanes in the direction toward Shinjuku, and there was also a large traffic island installed by markings. After the measures were taken, the width of the lanes was slightly narrowed by repaint-



	A—A'	B—B'
Present status	50 seconds	50 seconds
After adjustment	55 seconds	45 seconds

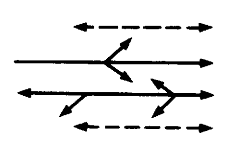
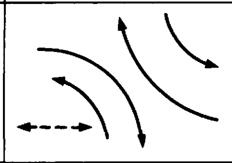
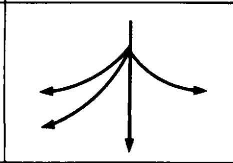
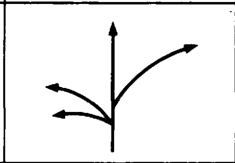
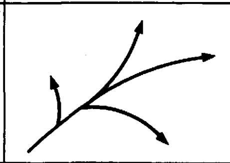
(10% increase in capacity)

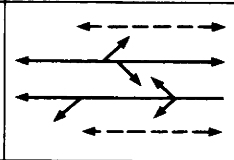
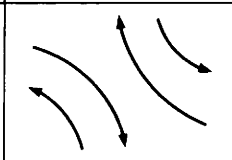
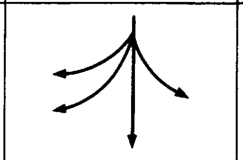
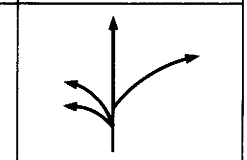
Fig. 3 Signal control adjustment



Source: Based on materials of the Police Office

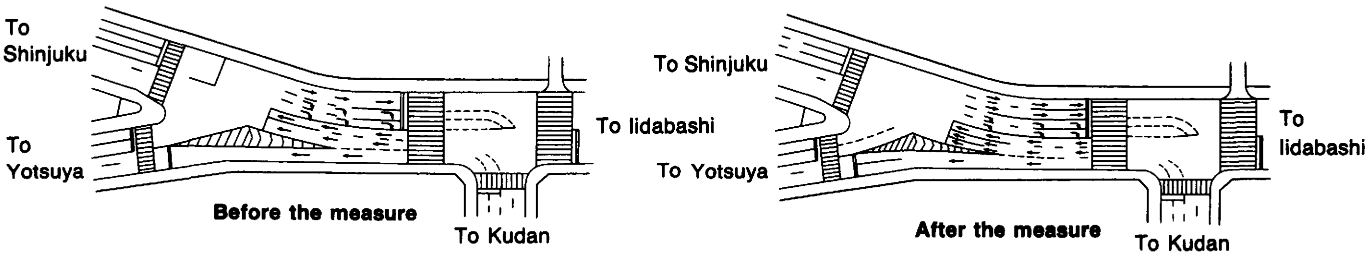
Fig. 4 An examples of an improvement in signal control (No. 1)

	Phase	First phase	Second phase	Third phase	Fourth phase	Fifth phase
Prior	Flow chart					
	Split	42%	20%	18%	9%	11%

	Phase	First phase	Second phase	Third phase	Fourth phase
New	Flow chart				
	Split	50%	20%	21%	9%

Source: Based on materials of the Police Office

Fig. 5 An example of an improvement of signal control (No. 2)



Source: Based on materials of the Police Office

Fig. 6 An examples of improvement in the geometric structure of an intersection

ing the lane markings, and the traffic island was made smaller so that one lane in each direction was added.

By increasing the number of traffic lanes by four thirds, or by three halves as in this example, the capacity can be increased by 30% or 50%. In fact, traffic congestion was eliminated after the measures were taken.

(4) Removal of On-street Parking during the Night in the Suburban Area

During the morning rush hour, virtually no vehicle is parked on the streets, and the traffic signals for the inbound traffic in the morning have already been adjusted in an elaborate manner. Therefore, removal of parked vehicles and adjustment of traffic signal control are no longer effective measures.

So what we can think of is the containment of driven-home vehicles which the employees drive back home in the evening, park them in the suburban areas during night time, and drive into the center of the city the next morning for business use. To prevent this, they should be oriented toward securing a garage in the center of the city, by prohibiting on-street parking during the night in the suburban areas.

The number of vehicles flowing into the area inside Loop 6 is estimated to total 190,000 in the three hours of the morning rush hour. Of these, the number of vehicles used for business at least once during the day is estimated at 100,000, and of these, the number of vehicles parked on the streets outside Loop 6 during the night is estimated at 11,000, accounting for approximately 6% of the total of 190,000 vehicles.

At the Yodobashi Nichumae intersection of Omekaido previously mentioned, the excess demand in the inbound direction during the morning rush hours was about 3 to 5%. Therefore, if half of the 6% stopped driving their vehicles back home, the congestion would ease substantially. Furthermore, if on-street parking is removed after 9:30 a.m., the congestion during the daytime would be eliminated.

(5) Induced Demands

If traffic congestion is eliminated or reduced, some of the people who have used railroad traffic previously will shift to vehicles and a new demand will be induced. If this is not strictly controlled, the situation will prove none the better.

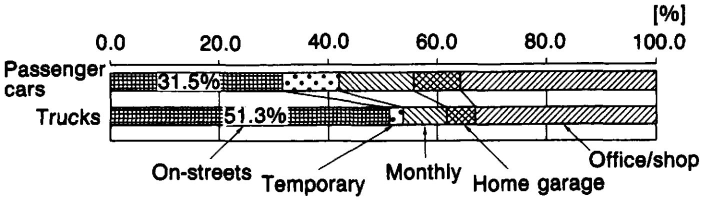
As shown in Table 2, the capacity of off-street public parking places totals about 40,000 for the 23 wards of Tokyo. On the other hand, in the area inside Loop 6, which is an area smaller than the whole 23 wards, the number of vehicles parked on streets at the peak period is estimated to reach approximately 190,000, as previously mentioned. From Fig. 7, we can see that a considerable number of trips toward the center of the city result in vehicles parked on streets. Therefore, we believe that if on-street parking is controlled properly, new demand can be contained effectively.

Table 2 Parking capacity of off-street parking places
(unit: 10,000 vehicles)

	Monthly	Temporary	Total
Tokyo City	60.5	4.7	65.2
(Component ratio)	(93%)	(7%)	(100%)
Within 23 wards	43.9	3.9	47.8
(Component ratio)	(92%)	(8%)	(100%)

Note: Off-street parking places accommodating more than 10 vehicles.

Source: Survey by the Traffic Department of the Police Office (1987).



Source: Road traffic census (1985, Ministry of Construction)

Fig. 7 The component ratio of number of trips by parking places in the 8 wards within Loop 6

4. CONGESTION CAUSED BY LEISURE TRIPS

Traffic congestion on holidays can also be eliminated if proper measures are taken. To prove this, we have conducted field surveys at typical resort areas in the metropolitan region, Hakone and Nikko, and have examined measures for traffic congestion based on the surveys.

4.1 Traffic Congestion Around Hayakawaguchi, Hakone

(1) Morning Congestion

Fig. 8 shows the rough outline of the congestion during the morning near Hayakawaguchi, Hakone. The traffic from the Tokyo area flows in from the top right of the figure, mainly over the Odawara Atsugi Highway. Of the traffic flowing in, the traffic heading for Hakone gets off at the Odawara Nishi Interchange, which is at the end of the Odawara Atsugi expressway, merges with the traffic from Seisho Bypass on the ramp, and merges with the traffic from National Road Route 1 at Intersection E. On the other hand, the traffic heading for Izu and Atami gets off at the Odawara Nishi Interchange, turns to the right at Intersection H, and moves onto Route 135 (Manazuru Highway). At Intersection H, traffic from the Seisho Bypass as well as Route 1 comes straight in.

On the day the survey was conducted (Sunday, August 28, 1988), the congestion on the Odawara Atsugi Expressway started around 7:30 a.m. and reached a maximum length of about 3 km around noon. The con-

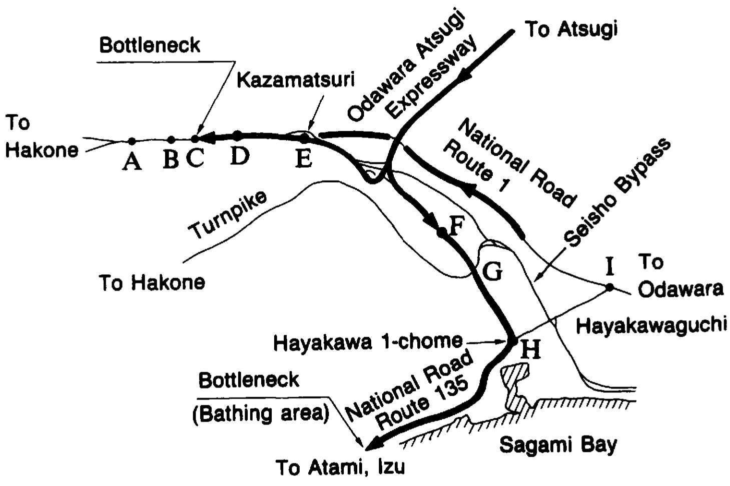


Fig. 8 Morning congestion near Hayakawaguchi, Hakone

gestion vanished around 4:00 p.m. The congestion along Route 1 also reached a length of about 800 m from intersection E around 11:00 a.m.

The starting point of this congestion in the morning was not the merging point of the 3 routes, which was presumed to be the bottleneck, but was about 650 m downstream. In the section from the merging point to about 1.3 km downstream, traffic signals were installed at 5 places, and one of them had been the bottleneck. The traffic capacity of a signalized intersection depends heavily on the saturation flow rate shown by the maximum number of vehicles that can pass the stop line during an hour of green time. The saturation flow rate actually measured at this point was about 1,430 [vehicles/hour of green time/lane], which is at least 10% lower than normal values even by taking into consideration the lane width, the heavy vehicle mixture and the vertical grade. The main reason for this reduction of saturation flow rate would be due to the timing of the green light indication (the offset) among the consecutive traffic signals. Since the timings were not coordinated properly, a vehicle started under the green signal was obliged to stop at the next downstream intersection under a red signal and this phenomenon was repeated in this section.

Fig. 9 shows the time fluctuation of the congestion delay (extra time needed) which was estimated from the observed queue discharge rate and the length of the congested section. The solid line shows the observed delay, and the delay has reached more than 20 minutes at 9:00 a.m. The broken line shows the delay when the saturation flow rate was increased by 10% by adjusting the offset. Compared with the situation before the improvement measures, the congested period is reduced, and the amount of delay itself is expected to decrease substantially.

On the other hand, with regard to traffic congestion in the direction toward Atami, Izu as well, we have found that the bottleneck did not exist at Intersection H where a right turn is made, as we thought, but further downstream near the bathing resort area. The congestion was caused by a few vehicles that had protruded by 20 to 30 cm onto the road from the parking lot of the bathing resort, and was stagnating the flow of passing vehicles by that place. We also calculated the traffic volume heading toward Atami, Izu, on Route 135 at Intersection H and found that it was about 1,200 vehicles per hour until 8:30 a.m., but then the value began to fall because of the effect of these parked vehicles protruding into the traffic lanes, and at 10:30 a.m. the flow was halved to approximately 600 vehicles per hour.

Fig. 10 shows the estimated delay caused by the traffic heading toward Atami, Izu. The solid lines show the observed delay (on the day of the survey), and we can see that the delay at noon is nearly 1 hour. The broken line shows the estimated delay assuming that the reduction of traffic capacity is avoided by removing the vehicles that were parked protruding into the traffic lanes. Although the congestion cannot be com-

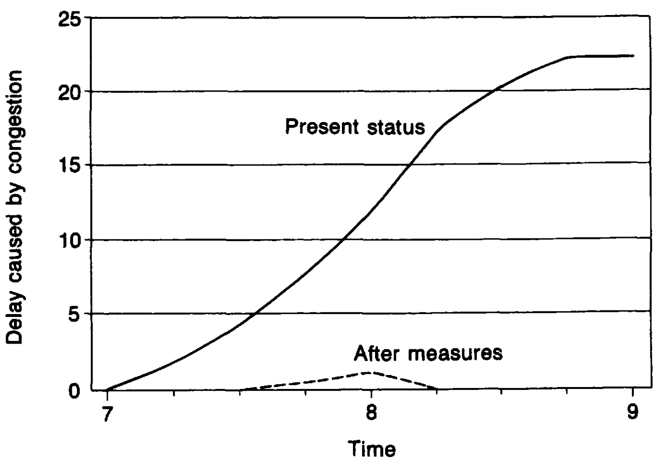


Fig. 9 Delay caused by congestion heading for Hakone

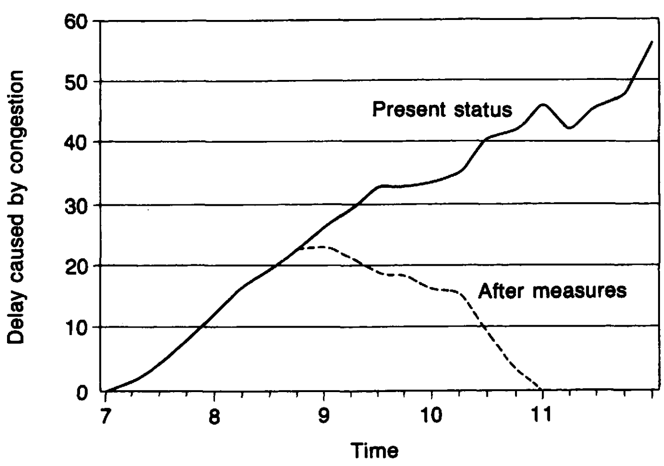


Fig. 10 Delay caused by congestion heading for Atami, Izu

pletely avoided even after the improvement measures, the maximum delay could be reduced to a little over 20 minutes, one third of the present time delay, and the congestion is expected to disappear by 11 a.m.

(2) Afternoon Congestion

Fig. 11 shows the outline of the congestion observed in the afternoon around Hayakawaguchi, Hakone. At 4:00 p.m. on the day of the survey, traffic congestion of 12 km long formed on Route 135 for Tokyo (source: Japan Traffic Information Center). At the Hakone Turnpike, as well, congestion of 5 km long formed. The traffic heading toward Tokyo from Atami, Izu, via Route 135 merges with the traffic from the Hakone Turnpike at Intersection G, but the bottleneck of the congestion was further downstream. Vehicles going into and out of the parking lots of souvenir shops and restaurants along the road, pedestrians getting out of their vehicles and crossing the road, or tourist buses parked on streets occupying one of the two lanes set for both directions have impeded through traffic and reduced the traffic capacity at this point. According to the observation, the traffic capacity around 1:00 p.m., the lunch period, was found to be less than 500 vehicles per hour. This kind of bottleneck can be found near the Hakone Yumoto station, and also in other tourist and resort areas.

Measures that have to be taken in principle for such bottlenecks, are the access control to and from facilities along the road. That is, to improve the conditions of the off-street parking by rearranging the position and structure of the entrance and exit so that it will have sufficient capacity and that the vehicles entering and leaving them will not obstruct traffic on the main road, or by restricting on-street parking or removing the parked vehicles. However, in order to oblige them to make improvements, revision of legal restrictions will be necessary, and in reality securing parking spaces is also a difficult problem. It is therefore not a measure that is feasible in the short run.

In Figs. 12 and 13, two detour proposals are shown as alternatives. The proposal in Fig. 12 lets the traffic demand exceeding the capacity of the bottleneck detour to Route 1 by proper guide signs, and flow

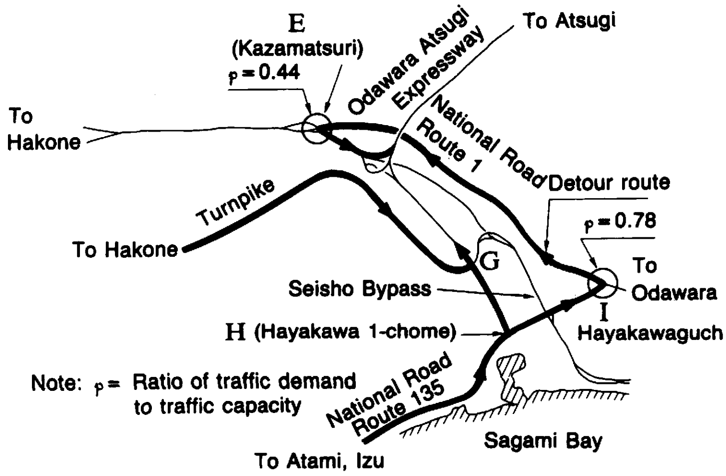


Fig. 12 A proposal for detour (1)

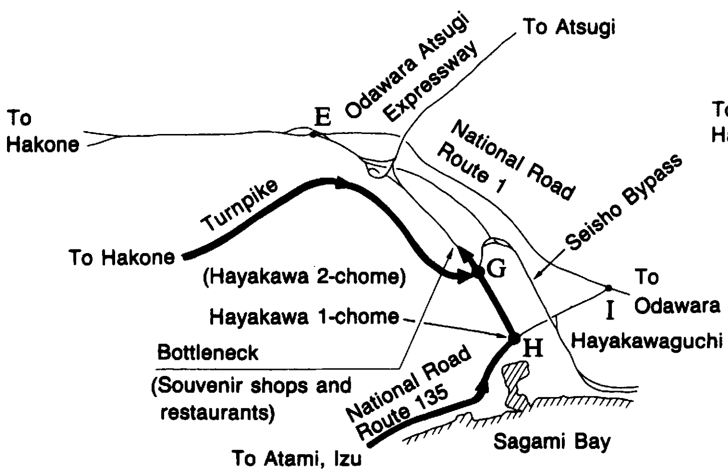


Fig. 11 Afternoon congestion near Hayakawaguchi, Hakone

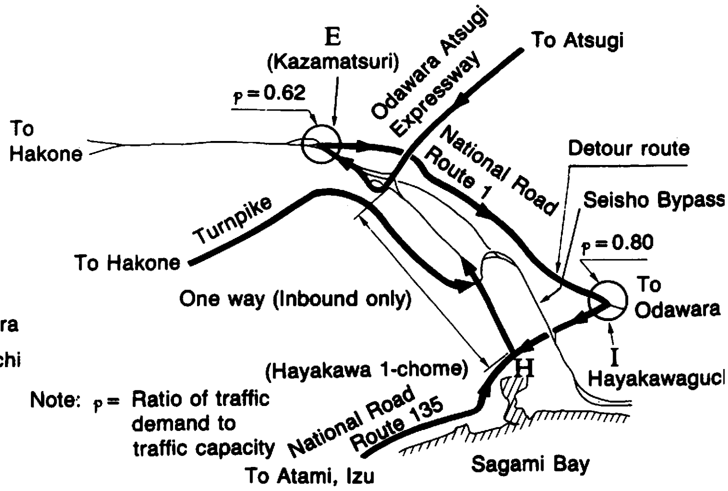


Fig. 13 A proposal for detour (2)

onto the Odawara Atsugi Expressway from the on ramp on the Hakone side. It has been made clear from the survey that the rate of the traffic turning left from Route 1 and flowing onto the Odawara Atsugi Highway increases sharply around 12:30 p.m., when the congestion of the afternoon begins. From this a volume of traffic seems to be actually making the detour mentioned above. At the two intersections E and I shown circled in Fig. 12, detour traffic volume must be also handled in addition to the present traffic. However, these traffic volumes are estimated to be only 44% and 78% of the capacities of the intersections respectively.

The second measure, shown in Fig. 13, proposes a one-way scheme for Tokyo between Intersection H and the on ramp of Odawara Atsugi Highway during proper time zone in the afternoon. If this is done, the number of traffic lanes will be doubled from the present situation for traffic going back to Tokyo, so the traffic capacity will more than double. Reversely, as the traffic volume heading toward Atami, Izu, from Tokyo falls considerably at this time zone in the afternoon, the traffic can be channeled into Route 1 from the exit for Hakone on the Odawara Atsugi Expressway, and led into Route 135 from Intersection I. It is calculated that even by adding the detour traffic, Intersection E and I shown circled in Fig. 13 has only to handle traffic volumes which meet 62% and 80% of the intersection capacity. In addition, along the one way section, there are a number of small branch roads on both sides, and reverse way roads can be secured for the people living in the area to travel.

4.2 Traffic Congestion in Nikko

The outline of the traffic congestion in Nikko is shown in Fig. 14. Around this area, the Shinkyo intersection, which is adjacent to the Nikko Toshogu Shrine, and the Iroha Slope, which has steep slopes and sharp curves, are the bottlenecks of traffic. On the day of the survey (Sunday, November 6, 1988), regarding morning traffic heading for Lake Chuzenji from Utsunomiya, congestion over a maximum distance of about 1 km formed at Shinkyo and at the terminal point of the Second Iroha Slope. On the other hand, regarding afternoon traffic in the reverse direction, congestion of more than 4 km long formed at the entrance of the First Iroha Slope and also at Shinkyo, as shown in Fig. 14.

(1) Morning Congestion at the Second Iroha Slope

Fig. 15 shows the geometry and signal indication of the three-leg intersection in which the traffic driving up the Second Iroha Slope from Shinkyo turns left toward Lake Chuzenji, or turns right to the Kegon Waterfall and the First Iroha Slope. If the traffic demand heading toward Lake Chuzenji increases, the traffic driving up the Second Iroha Slope becomes jammed.

The traffic turning left at this intersection heading toward Lake Chuzenji is stop controlled, and all the vehicles were made to stop before turning to the left regardless of the existence of vehicles proceeding straight into the intersection from the direction of the Kegon Waterfall. If this left turning traffic is controlled by the signal together with traffic from other directions, a larger volume of traffic can be disposed of. In the example in Fig. 15, it is calculated that with this improvement in signal control, the volume of left turning traffic can be increased by 40%, to 830 vehicles per hour. Then no congestion will form.

(2) Afternoon Congestion at Shinkyo

The geometric structure and the signal indication of the Shinkyo intersection is shown in Fig. 16. The traffic heading for Utsunomiya from Lake Chuzenji approaches the intersection from the left side of the figure, turns right and flows out toward the bottom. The signal at this intersection is operated by traffic-actuated control, and the allocation of the green time on the day of the survey was roughly as shown in the same figure. The split adjustment according to the afternoon traffic demand from all directions would be an effective measure.

The observed and estimated delays caused by the congestion is shown in Fig. 17. At the time of the survey, a delay of more than 35 minutes was observed, but if the afternoon signal control is to be improved as shown in Fig. 16, hardly any traffic congestion would appear.

As the traffic demand of tourist traffic varies considerably depending on such factors as season, weather, and time zone, the traffic conditions should be monitored constantly and the signal parameters should be adjusted to the traffic demand. Thus, high performance signal equipment will become necessary. This will lead to a substantial improvement in traffic congestion, as seen in this example.

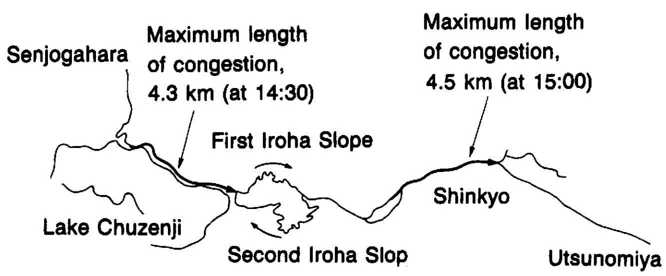
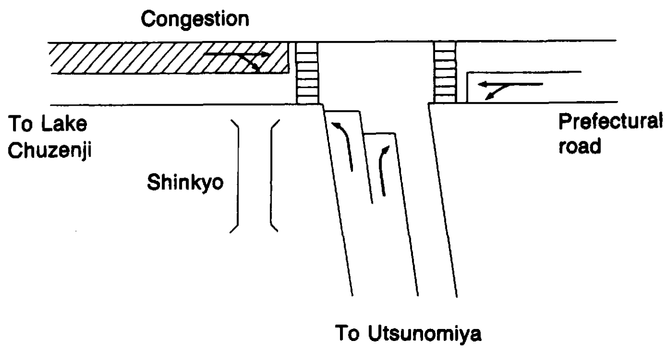


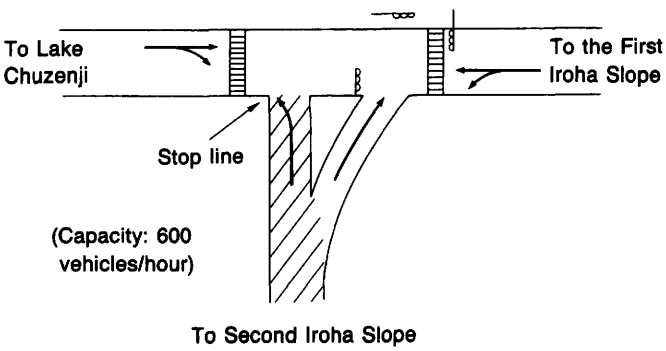
Fig. 14 Outline of congestion in Nikko



	First phase	Second phase	Third phase
Green light phase			
At the time of survey	25 seconds	95 seconds	40 seconds
Improvement proposal	29 seconds	106 seconds	25 seconds

Cycle length = 160 seconds

Fig. 16 Improvement of signal control at Shinkyo Intersection Congetion



	First phase	Second phase	
Observed			Cycle length 135 sec.
	65 sec.	70 sec.	
	Third phase	Fourth phase	Fifth phase
Proposed			
Split	35 sec.	65 sec.	35 sec.

Fig. 15 Improvement of signal control around Lake Chuzenji (Countermeasures for morning congestion heading for Lake Chuzenji)

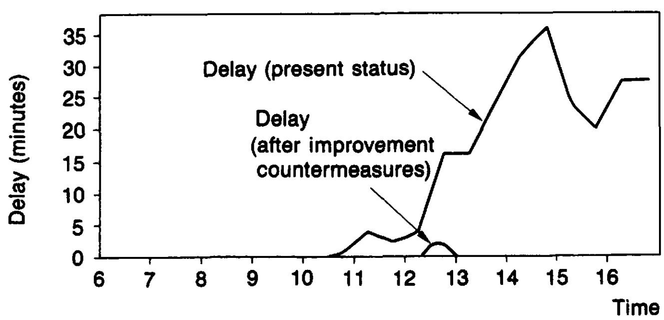


Fig. 17 Delay caused by congestion at Shinkyo Intersection

(3) Congestion around Lake Chuzenji

Fig. 18 shows the distribution of afternoon traffic around Lake Chuzenji. The bottleneck of the traffic going down toward the First Iroha Slope from Lake Chuzenji in the afternoon, was intersection A where Route 120 and C Street meet and where the entrance and exit of the parking lot for the Kegon Waterfall was set. The reason for the low capacity of this intersection was that the vehicles waiting for a vacant place in the parking lot of the Kegon Waterfall were stagnated on Route 120, and they were obstructing the through traffic for the First Iroha Slope.

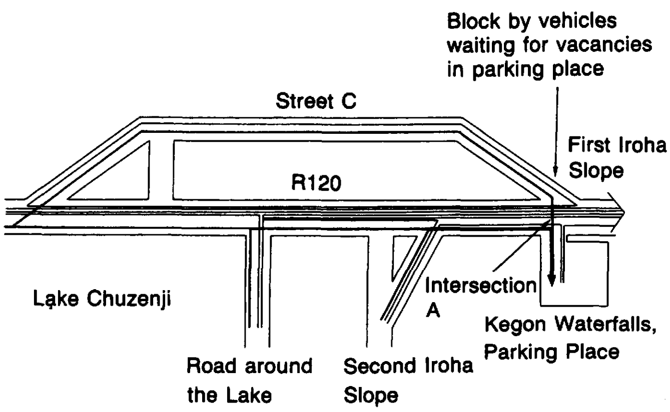


Fig. 18 Traffic flow chart around Lake Chuzenji: Present status (1:00 p.m. - 2:30 p.m.)

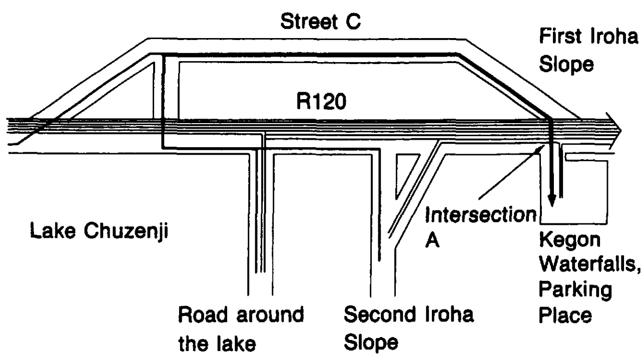


Fig. 19 Traffic flow chart around Lake Chuzenji: After improvement measures (1:00 p.m. - 2:30 p.m.)

Fig. 19 shows the estimated traffic volume when the vehicles were prohibited from entering the parking lot by turning right from Route 120, and instead, were made to detour to C Street, (a parallel street of Route 120) and to approach the parking lot straight through intersection A. This can be carried out by proper detour guide signs, and by this the vehicles waiting for vacancies at the parking entrance and the traffic heading for the First Iroha Slope can be separated. It is calculated that approximately a 15% increase in passing traffic volume can be disposed of. Fig. 20 shows the delay caused by the congestion, and through this measure almost no congestion will form.

A situation in which vehicles waiting for a vacant place in a parking lot obstructs passing traffic and forms a bottleneck, is a phenomenon found commonly in various tourist spots and resort areas. If enough off-street parking places to meet demand cannot be designated at appropriate places, temporary parking places should be secured at places like public offices even if they might be somewhat far from the destination. Also, we should control the number of vehicles entering parking places by issuing tickets. Shuttle bus services to and from parking places should be planned as well. In this way the vehicles waiting for a vacant parking place and passing traffic can be separated.

5. CONCLUSION

We have shown that most of the traffic congestion we experience in our daily life is caused by trivial reasons

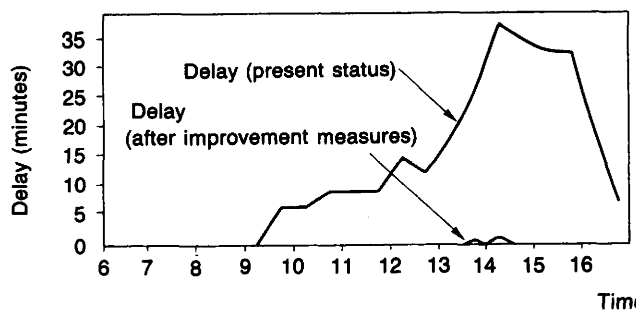


Fig. 20 Delay caused by congestion at Lake Chuzenji Intersection (Way back: Heading for First Iroha Slope)

indeed, and can be eliminated by simple measures. The problem is that so far, no system by the administration for the monitoring, planning, study, design, or implementing of such measures against congestion has been drawn up.

It is almost impossible, in the immediate future, at least, to arrange and fix roads that have the capacity to meet the traffic demand of city areas as well as resort areas. It is most important in the future as well, to make full use of the road facilities that we now have. The way the roads are used in Japan, is, on the contrary, inferior to the way the motorized western countries use their roads, which are far better developed.

In carrying out either of the measures for congestion mentioned here, a huge amount of labor as well as special knowledge will be required considering the size of the road network addressed. Therefore, without the endorsement of budget, labor, and organization for this purpose, no continuous policy can be promised. A common understanding on this matter among the government, the public, and the private sector is a priority.

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