Study on Traffic Jam of The Detour Route after The Noto Peninsula Earthquake Occurrence -The Time Required Prediction that Utilized Probe Car Data-

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By Noto Peninsula earthquake occured on March 25 ,2007, Noto toll road from Kanazawa to Noto and many other roads suffered from it ,so traffic of inhabitants and tourists were confused.

Therefore,when a disaster like an earthquake occur,it is necessary to offer not only a traffic regulation information but also a information of detour route and a traffic jam (the time required)to understand a change of traffic condition and taffic jam more accurately,so I trid to offer such an information by utilizing probe car data.

Key Words :*earthquake,detour plan, traffic jam by disaster,probe car,time estimate*

1. THE BEGINNING

On March 25, 2007, "Noto Peninsula earthquake" of ,M6.9 occurred off the Monzen-town, Wajima-city, Ishikawa and recorded a seismic intensity little over six in Nanao-city, Wajima-city, Anamizu-town, and damaged not only the public houses but also the various public facilities.

Especially the damage of the road was heavy, and suspension of traffic or one side traffic regulation was performed like figure 1 in a lot of roads including "the Noto toll road" which was “the aorta road” binding Noto and Kanazawa.

In particular, it had a great influence on not only the life of the district inhabitants but also the traffic of tourist because the Noto toll road was closed entirely from the earthquake just occurrence .

The Noto toll road Yanagita - Anamizu section was closed in seven hours later, but suspension of traffic became the cancellation partially after that, and it became the cancellation of whole line after an earthquake occurrence on April 27 before “Golden

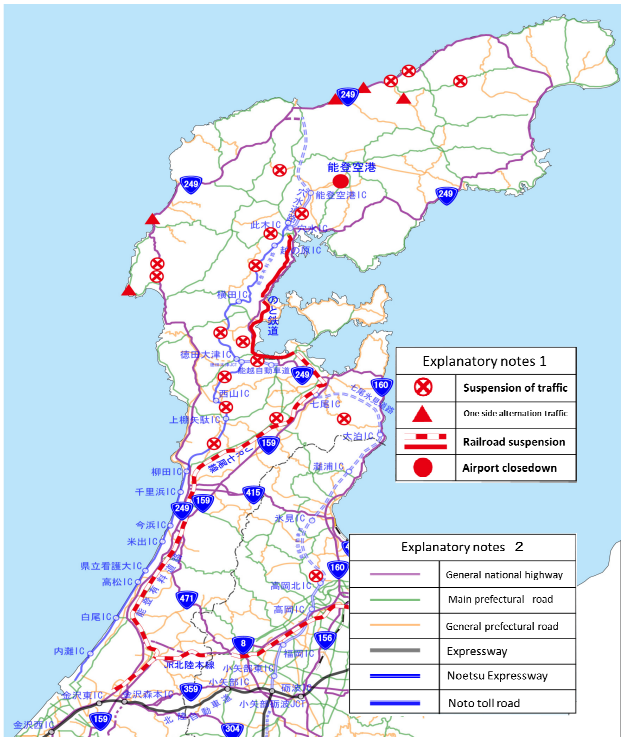

Fig.1 March 25, 2007 17:00 traffic control situation

Week".

However,according to questionnaire about an influence of the road traffic by this earthquake that Takahashi and others [1)] performed for the district inhabitants ,when I compared the time when they used a Noto toll road with the time when they used the detour just after the earthquake for the first time, I understood that the delay for maximum three hours, an average of 30 minutes produced .

Besides, it is expected that confusion occurred just after an earthquake occurrence in particular because the time required vary just after the earthquake(dispersion was big) ,and dispersion becomes small over time.

In addition, the evaluation of the vehicle information the inhabitants received was not as high as they expected its information.

As for the real traffic information, road safety information from Ministry of Land, Infrastructure and Transport or Ishikawa prefecture such as suspension of traffic, the one side alternation traffic was provided just after an earthquake so that the person who wanted the information immediately could use a detour smoothly.

However, according to the analysis that above-mentioned Takahashi and others performed, the inhabitants demanded easy traffic jam information to understand, and the evaluation of the offer of this traffic information was a low result for the inhabitants wanted such an information.

By that, I think that the inhabitants demanded not only its information but also information of detour information and the traffic jam information (traffic information) to understand more real change of the traffic state and jam as well as those information.

Therefore, as one of the basics data collection to offer such a traffic information, I utilized probe car data at this time and tried an offer of detour information and the traffic jam (the time required) information.

A traffic jam reporting system by the private corporation is wide, because the probe car is utilized by a GPS function equipped with a car navigation system, but the systems have begun to spread from about 2007, so I think its usefullness was uncertain just after such a disaster in those days. Therefore,I think what advising this study is ver valuable to prove usefulness of the probe car system.

As a concrete study, I utilized the valuable probe car data measured in chronological order from March 29 to May 13 after the earthquake occurrence, and I analyzed the process when a road traffic condition changed to the process when road suspension of traffic was canceled about the time required, the trip speed of normal route and detour.

In addition, if I could estimate the time required of the detour route,the local inhabitants could choose the most effective detour route ,so I tried the multiple regression analysis by the time required of probe car data as a purpose variable,and by various data such as trip speed as an explanation variable.

2. EXISTING STUDY ON PROVE CAR

About the existing study on probe car data, there is the following study.

At first study on probe car were performed about data handling and precision because the study on probe car data was still immature about prcessing method of them.

Horiguchi and others[2)] considers the record method of probe car data in "Effect of the probe data recording method by the run event unit". When the method to record at regular intervals is short,the quantity of the data becomes enormous. And it is difficult to grasp the correct traffic condition when the method is long ,so a method to record at the time of stop and departure is the best easy to acquire the record for the traffic jam and to distinguish traffic jam section and non-traffic jam section. Therhore they states that it is the best method to record.

Equally, by Horiguchi and others [3)] in " Cleansing handling of probe car data and the service properties analysis according to the car model" ,the removal of loss section of probe car data ,data error and idling car data,and the revision of the data driving at the time of a division road are possible, but they states that we have to be careful because a record range,a time,and a collection efficiency by the kind (a taxi, a bus, and so on) of the probe car is different.

Suzuki and others [4)] states that there is the range and the time when we are hard to acquire if we use taxi data in "Analysis about the link capture rate of the probe car investigation in Tokyo", and we have to examine the action range and time beforehand and locate them beforehand to acquire data.

As an application plan of probe car data, it has been utilized for the precision improvement of the existing traffic data and the reliability improvement about the change of the chronological order of the traffic jam afterwards.

At first, as a study on precision improvement of the existing traffic data, Nakagawa and others [5)] state that It is possible to build a network by using probe car data in the mountains where it is not even got road database data in "Analysis about the road network making of the mountain area using the probe

vehicle" .

Kinuta and others [6] state that they inspect the application possibility for the trip speed of the road traffic general survey by using probe car data ,and it is possible to apply it,but we have to do cleansing of data, and an examination of the number of the acquisition data in "Fundamental analysis about the application to the trip speed investigation of taxi probe car data" .

In "Analysis about change properties of the time according to the route using probe car data", Oneyama and others state that they examine the precision improvement of the OD traffic density according to the time, and there is a problem if there is an unbalance according to the area or according to the car model, and in that case they need further examination about it.

In "Analysis about change properties of the time according to the route by using probe car data", Tamiya and others [8] state that there is a difference in the change rateof the trip time by the kind of the road, and they need to consider the positioning of the network of each route.

In addition, as study about traffic jam,in "Substantial analysis about the evaluation of the service state of the bus by using probe car data", Yasuda and others [9] state that there is a characteristic about a grasp and a cause (time, weekdays/holiday,and so on) of appointed hour characteristics(delay) by using probe bus data, and they need the reviews of the bus schedule accordingly.

In "Analysis of division road passage traffic by probe car data", Kitamura and others [10] analyze the relations between the traffic jam of a main road and traffic condition of a division road,and state that traffic jam condition of a main road before passing a division road have an influence on traffic condition of a division road.

Ishida and others [11] , in "Analysis on traffic jam judgment in consideration of a subjective evaluation" ,utilizes probe car data and compares traffic jam consciousness with the real drive data, and the result approximately agrees and they state that they can make the judgment model at the traffic jam time when a driver feels, but it depends greatly on a prior state.

In addition, as a study on precision improvement of the course choice in the shortest time required of the traffic jam ,in "Substantial study about road choice method and the trip speed estimation by using probe car data" ,Sakai and others [12] state that we can revise them by applying map matching method of the shortest course choice, for example, there is a highway on a public road on two dimensions,and by it,we can build the model of the time required and course choice by using probe ca data.

Recently, to do comparison analysis in an emergency like the snow or the earthquake,the study by utilizing probe car data is performed.Takahashi and others [13] analyzes a change of the trip speed before and after the snow and relations with the traffic density in "Analysis about the trip speed change for the winter season in Sapporo-city by using a probe car" .From the result of the analysis,they clarifies that the recovery effect of the trip speed after the removed snow is very big and that a decline of the trip speed before the removed snow work and a recavery of the trip speed by the removed snow work is remarkable as a section with much traffic density.

In " Analysis of the effect of the traffic speed restraint system based on probe car data " , Hashiji and others [14] state that an increase rate of the average car speed tend to be decrease about the car more than the regulation speed by examining a system increasing the stop number of times with the signal.

In "Problem and the prospects for the offer of the road map which was able to go in Chuetsu offing earthquake of Niigata prefecture and for the realization of reducing a disaster by use of the probe car information", Hata and others [15] point out that we can utilize the navigation system ("navi system") of the private car company, and they can make the map of the road which was able to go, but that there is a problem that we have to weste time because data quantity becomes enormous and that we may offer wrong information because the road canbe closed after it could be opened once if we use random car data.

Like the above examples, about the study using probe car data, at first the principal objective was performed for the precision improvement or data processing at first, but now,studies about a utilization plan particularly of the disaster by improvement of the ICT and the spread of navigator systems increase.

However, about the study utilizing probe data in at the time of disasters, we can collect,analyze,and suggest the data in a phenomenon which can be predicted like snow,but we can not reach the suggestion about the sudden disasters such as earthquakes.

So, about traffic information at the time of a disaster in particular, I think that it is necessary to utilize the characteristic that we can grasp the road situation the car can go in the more real time.

Therefore, in this study, I analyzed a change of the trip speed of each route after the earthquake occurrence,and its characteristics.

In addition, I analyzed a change of the trip speed at

each time at each route by comparing a usual trip speed of the car with a real trip speed of it in detail.

Furthermore, by utilizing the result,I performed the multiple regression analysis by various explanation variables to predict the arrival time by utilizing probe car data in future.

And I calculated the significance and inspected the multiple regression type.

3. SUMMARY OF THE DAMAGE SITUATION OF THE ROAD AND THE TRAFFIC REGULATION AND CANCELLATION

This time,in 271 places of road points that was damaged, what there was the most in the damage situation of the road was the full-scale crack (2 traffic lane) of 119places(43%), the next was full-scale step (2 traffic lane steps) of 40places(14%), and the next was collapsing a fill psrtly of 31 places (11%)(Cf. table 1)

I think that it was difficult and delicate damage to judge which they can pass or not.

And the traffic regulation with the damage were almost of one side closed(one side open)of 166places(61%), so I think the driver hesitate about the judgment.

In addition, about the cancellation of the traffic regulation,there were 195 places(72%) done it on March 25,that day on the earthquake.

If cancellation time increases unidentified 39 places(14%), 86%(approximately 90%) of them were performed derestriction on that day, but the confusion of the road network was still assumed.

From this, just after the disaster occuered accidently like an earthquake,the I think that the driver could not judge which of the road we choose by only traffic regulation information.

Table 1 Road damage point number in the Noto Peninsula earthquake.

Kind of the damage	National highway	Prefectural road	Municipal road	The total	Ratio
Full-scale crack (2 lanes)	0	115	4	119	43%
Full-scale step (2lanes)	0	30	10	40	14%
Collapsing a fill partly	0	18	13	31	11%
Others	13	53	23	81	32%
The total	13	216	5	271	100 %

※ 1 In 271 places, one side is closed (possible 1 traffic lane traffic); 166 places (61%)
※ 2 〃 ,195 places(72%) of 3/25(earthquake day) deregulation

In that department, I think that it is effective to utilize the probe car data which we can judge more easily and which we can offer in more real time.

4. SUMMARY OF PROBE CAR DATA

I used a trip speed data of a probe car for analysis with the 10day in total, for each five days on weekdays and holidays within “Golden Weeks” from March 29 to May 13.

I divided a detour of the Noto toll road which became closed partly until from March 25 to April 27 into ①～⑧ according to figure 2,and I measured about each road.

And about the summary of each route, I showed it in table 2.

①,①',② route showed a detour in the west from Uchihisumi IC to Wajima-city ,and ③,④,⑤ route showed a detour in the east similarly, ⑥and⑦ route showed a detour frpm Anamizu-town to Suzu-city, ⑧route showed Noto toll road (from Yanagita IC to Tokudaotsu IC) that was cancelled to be suspension of traffic after March 29.

About measurement method,I separated by weekday and holiday like table 3,and should let probe car drive in every section where Noto toll road was opened particurally and every approximately one hour from 7:00a.m. to 19:00 p.m.

And I didn’t measure a position with GPS this time, but I measured the time required and the traffic

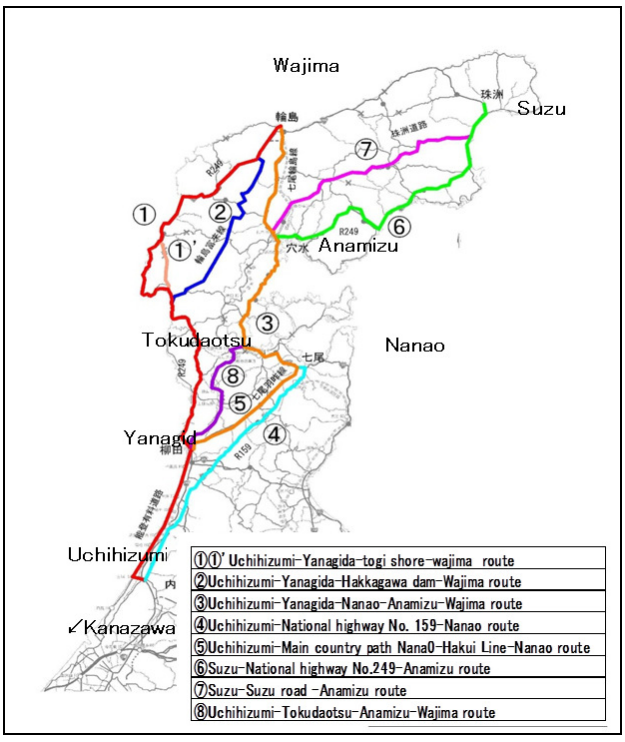

Fig.2 Probe car route (March 29)

Table 2 Summary of the probe car route

route	Distance (km)	Main route	The starting point	the end of line	The number of the general survey
①, ①‘	103.8	National highway No. 249(west)	Kahoku-city	Wajima-city	14
②	95.4	Main country path Togi-Wajima Line	Kahoku-city	Wajima-city	15
③	101.3	National highway No. 249(east)	Kahoku-city	Wajima-city	19
④	45.7	National highway No. 159	Kahoku-city	Nanao-city	12
⑤	46.2	Main country path nanao-Hakui Line	Kahoku-city	Nanao-city	8
⑥	57.1	National highway No. 249	Anamizu-town	Suzu-city	9
⑦	51.3	Suzu road	Anamizu-town	Suzu-city	8
⑧	95.5	Noto toll road	Kahoku-city	Wajima-city	15

Table 3 Measurement time and the situation of the Noto toll road

Date	Contents
March 25	・Earthquake occurrence, Noto toll road suspension of traffic
	18 places of suspension of traffic, one side alternation 5 places
March 29(Weekday)	・The Yanagita IC - Tokuda Otsu IC in-service reopening
	・Measurement
April 1(Weekend)	・Measurement
April 15(Weekend)	・Measurement
April 17(Weekday)	・Measurement
April 20	・The Tokuda Otsu IC - Yokota IC in-service reopening
	4 places of suspension of traffic, one side alternation 9 places
April 24(Weekday)	・Measurement
April 27	・The Yokota IC - Anamizu IC in-service reopening
	1 place of suspension of traffic, one side alternation 9 places
April 29(Horiday)	・Measurement
May 4(Horiday)	・Measurement
May 8(weekday)	・Measurement
May 13(weekwnd)	・Measurement

density of section at the general survey section number spot every approximately one hour from 7:00a.m. to 19:00 p.m by measuring the time probe car passed at the general survey measured point.

Of these, about ③ route, in a study of above-mentioned Takahashi and others [1], traffic density increases in particular to approximately 1.5 times between Tokudaotsu IC and Anamizu IC, and I got the answer that the time required increased more than usual(a traffic jam occurred) from a questionnaire.

5. A TRAFFIC JAM ROUTE AND CHANGE OF THE CHRONOLOGICAL ORDER

The Yanagita - Anamizu interval of the Noto toll road was closed just after the earthquake,so I thought that I detoured in either of the above-mentioned ①～⑧ routes.

In one of those route,as I spoke in the preceeding chapter, a traffic jam was more likely to occur because almost car were concentrated on ③ route as a detour by the result of the questionnaire. therefore, it was like table 3 as a result ,as I counted the section (I suppose a general survey section to be a unit) that average trip speed was under 20km/h in ①～⑧ route from March 29 to May 13 when probe car data were provided.

Like this table,The general survey sections where trip speed was as under 20km/h in ③ route on March 29(weekday) and on April 1(holiday) just after the earthquake occurrence in particular increased.From this, I supposed that A traffic jam was more likely to occur in ③route just after the earthquake occurrence.

In addition, sections which became less than 20km/h about the ④ route occured a lot after April 29, but I thougt that rather the route became nomal condition as a day from an earthquake occurrence because the route originally has a short interval of the signal crossing, and traffic jams usually occur.

6. AVERAGE TRIP SPEED CHANGE IN JUST AFTER THE EARTHQUAKE AND THE TRAFFIC DERESTRICTION

As I spoke in a foregoing chapter,I thought that the probe car data is effective for collecting and analyzing the traffic information in the detours such as earthquake occurance,for comparing a change of the chronological order in particular.

So this time I compared the change of chronological order from March 29 four days after the earthquake occurrence to May 13 that the road network restored, and passed for a while.

At first I calculated the ratio of the trip speed at the time of the observation to the H17 general survey trip speed (the following "trip speed ratio") to see how trip speed changed ,and made the scatter diagram which compared it every H17 general survey trip speed.

(※ trip speed ratio = the trip speed at the time of the observation / H17 general survey trip speed)

And I classified the explanatory notes into at the time to leave for work(to 9:00a.m.),at the daytime(from 9:00a.m. to 17:00p.m.),and at the time to go home (from 17:00p.m.).

In figure 3,the trip speed ratios disperse greatly with 0.5-3.5 at the ③ route congested with traffic in March 29 because the earthquake occurred before four days.

But there is a wide dispersion at the daytime,and at the time of the commuting in morning and evening,the dispersion is between 0.6 and 1.5. In contrast,in figure 4,there is a close dispersion at the ① route not congested so much,theremore most trip speed ratios exceed 1.0,and trip speed at the time of the observation exceeds H17 general survey trip speed.

From this,I think that there were few traffic jams because of earelier trip speed than usual,but I suppose there might not be many data of exceeding trip speed ratio" 1.0 " about this result because we used the observation data at a peak hour about the general survey data.

After that, the change of the trip speed of ① and ③route in April 17 by canceling the suspension of traffic of some sections (Yanagita - Tokudaotsu interval) was like figure of 5and 6.

About route ③ congested just after the earthquake, a total unevenness ,especially the maximum of the trip speed ratio of the low speed range, is controlled to less than 2.5 from 4.0 in March 29.

On the other hand, about ① route,the unevenness had been decreasing ,particularly the difference between the time of the commuting in morning and evening and the daytime had been decreasing,so I think that the estimate of the data for the whole day is easy if we measure trip speed and the time required in morning .

Furthermore, about the change of the trip speed of ① and ③ route after the Noto toll road whole line opening to traffic (April 27) , it became like figure 7 and 8.

About ③ route, unevenness was settled more, and the data of the tim to leave for work and the data of daytime turned out approximately same result.(In

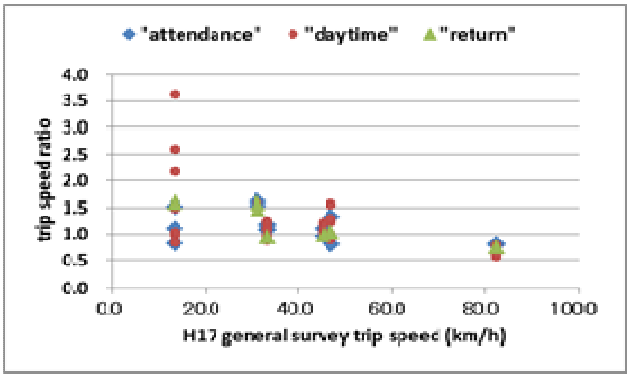

Fig.3 3/29(weekday) National highway No.249 (Nanao→Anamizu) (route ③)
H17 general survey trip speed - trip speed ratio scatter diagram

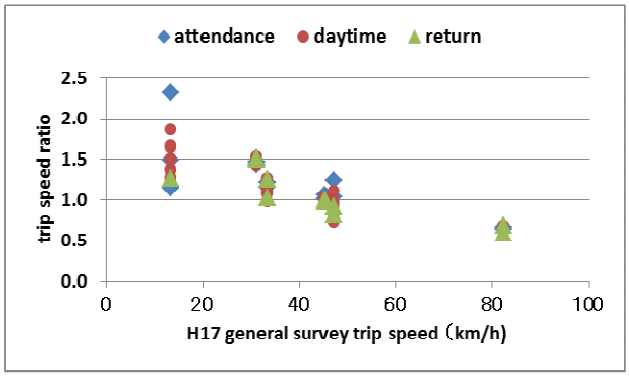

Fig.5 4/17(weekday) National highway No.249 (Nanao→Anamizu) (route ③)
H17 general survey trip speed - trip speed ratio scatter diagram

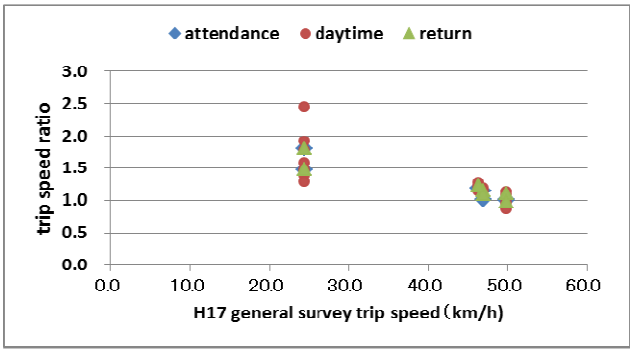

Fig.4 3/29(weekday) National highway No.249 (Yanagida→Togi) (route ①)
H17 general survey trip speed - trip speed ratio scatter diagram

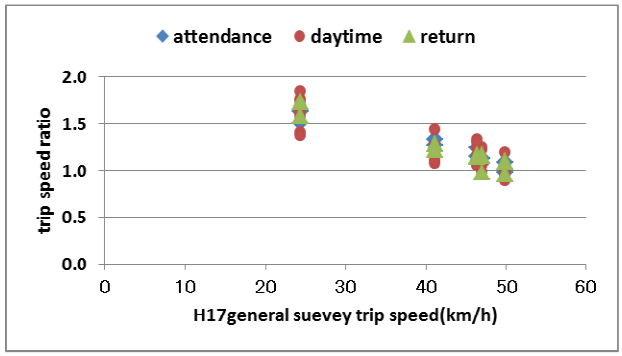

Fig.6 4/17(weekday) National highway No.249 (Yanagida→Togi) (route ①)
H17 general survey trip speed - trip speed ratio scatter diagram

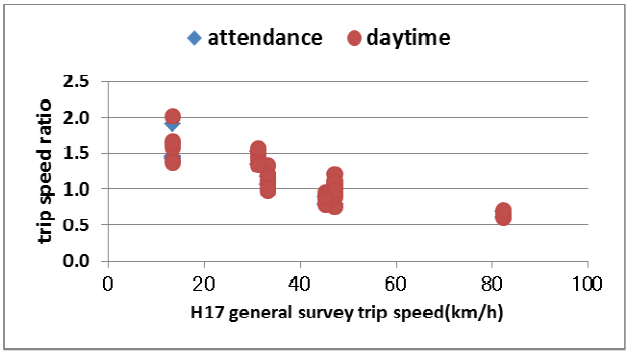

Fig.7 5/8(weekday) National highway No.249 (Nanao→Anamizu) (route ③) H17 general survey trip speed - trip speed ratio scatter diagram

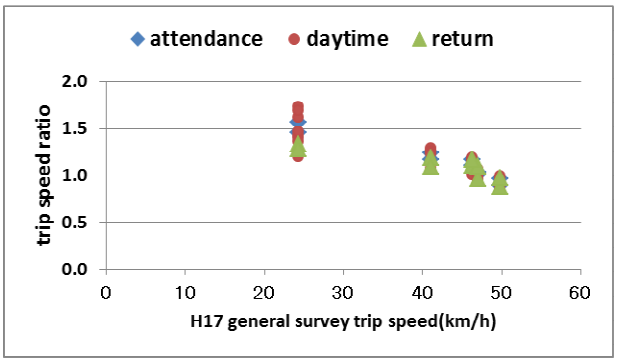

Fig.8 5/8(weekday) National highway No.249 (Yanagida→Togi) (route ①) H17 general survey trip speed - trip speed ratio scatter Diagram

addition, there were not the observation data at the time to go home in these data.)

And about ① route,the data was distributed like the similar straight line with the right shoulder inferiority at the time to leave for work, daytime, and the time to go home.

From the above-mentioned result, the earthquake occurrence had a big dispersion just after that, and, I understood that it tended to appear conspicuously in the route which was congested because it in particular was used as a detour. But as it became converging, I understood that the dispersion tended to be a convergence tendency, and there became to be almost no difference of a detour and the route which were not it.

7. COMPARISON BETWEEN TRIP SPEED RATIO AND TRAFFIC DENSITY

This time,I observed the section traffic density of the general survey section hourly from 7:00 a.m. to 19:00 p.m.

In that, as the hypothesis such as follows tended to be formed about the relations with the trip speed ratio of the foregoing chapter, I analyzed it.

"A hypothesis ": Trip speed tends to fall down to be crowded just after an earthquake occurrence so that there is much traffic density, and on the other hand it tends to go up at the recovery.

The result showed a tendency such as figure 9,10.

About the general way, time traffic density might be lower than most 1,000, so the tendency such as the hypothesis was not extremely seen.

However, as the Noto toll road was recovering, the tendency of the time traffic density and the trip speed ratio became soaring, so the hypotheses was right.And it showed that the trip speed ratio tended to go up (the trip speed became earlier than normal trip speed) so that there is much traffic density.

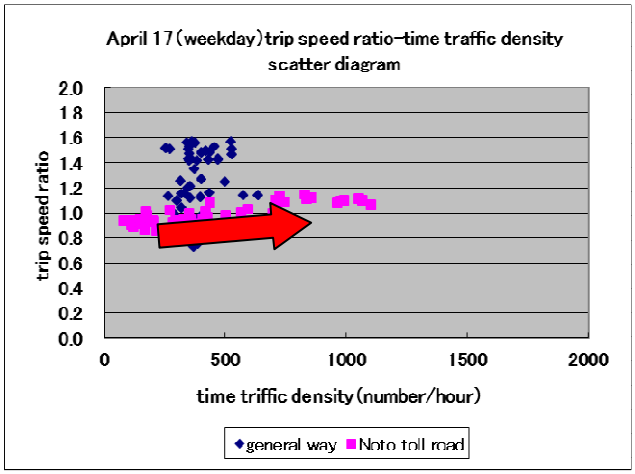

Fig.9 trip speed ratio – time traffic density scatter diagram (just after the earthquake)

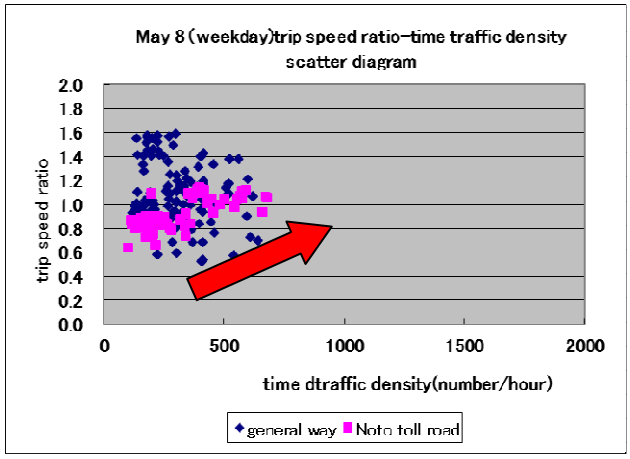

Fig.10 trip speed ratio – time traffic density scatter diagram (convalescence)

8. INSPECTION ABOUT THE SECURITY OF THE APPOINTED HOUR

By the above,a decline of trip speed was showed at the section of National highway No. 249 between Anamizu and Nanao (③ route) particularly just after the earthquake, and the other roads too,but I could not reach to analyze whether a decline of trip speed produced at the all the whole line or Partially.So I made a graph so that where a delay was made, and whether the delay was recovered after that or not.

As a result, like figure 11, a delay occurred in Tadatsu IC, but I understood that the delay was recovered and at the arrival time became same as usual.

In addition, I made delay time a graph like figure 12 to confirm how the spot where a concrete delay occurred changed with progress of the time.

As a result, I understood that ,for example at the section of National highway No.249 (Nanao - Anamizu), a delay occurred at the Tazuruhamahigashi crossing at any time,and whenever if the probe car leave,I understood the tendency was same.

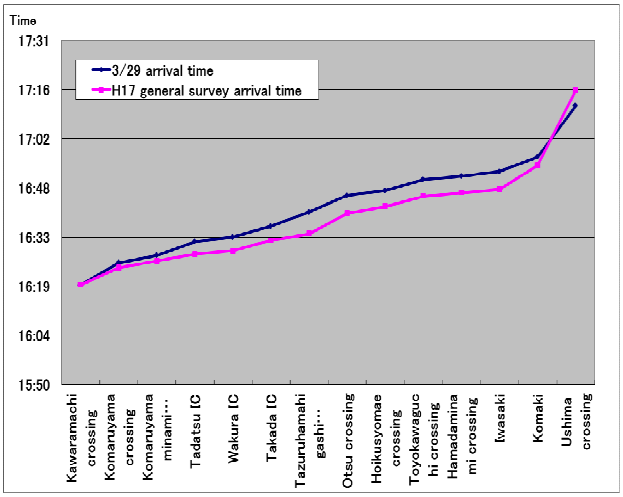

Fig.11 National highway No.249(Nanao→Anamizu) arrival time comparison

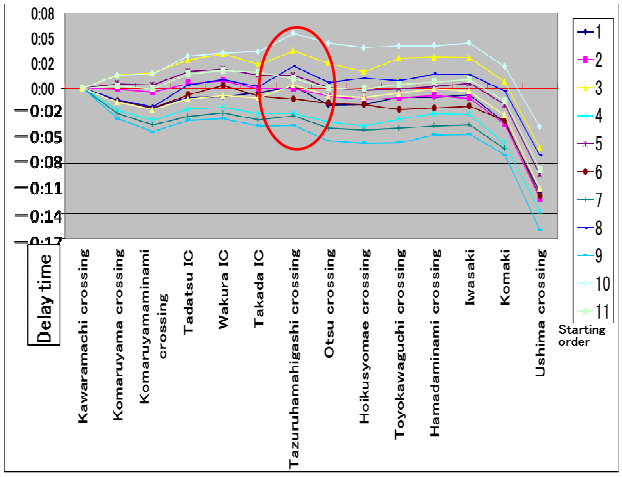

Fig.12 Delay time from a general survey value every crossing

9. TIME REQUIRED PREDICTION UNTIL ARRIVAL TIME

By the past result, I understood that when Noto toll road was closed to traffic, a traffic jam by the Noto Peninsula earthquake was concentrated at National highway No. 249 of the east side, and the traffic jam occurred locally in the vicinity of Tazuruhamahigashi crossing in that.

Therefore I estimated the time required by using a multiple regression analysis this time about whether I could suppose the time required when I used a detour route in such situation.

In addition, about the detour route, I divided it into the eastern route (following "east route") of National highway No. 249 (Nanao→Anamizu) and the western route (following"west route") of National highway No. 249 (Yanagida→Togi), set the time required in a purpose variable (y), and set explanation variable(x_i) like table 4 about each route.

As a result, about the east side route, it became like next page table 5. About the single correlation, No. 1063 trip speed (x2) which was the first general survey section at the time of the departure turned out (the minus number) highest in correlation . From this,I understood that the time required showed a tendency to grow bigger when the trip speed at the time of the departure became slower (smaller).

And, in this coefficient, the trip speed of departure and the arrival (x2～4,6,7) and earthquake occurrence progress days (x8) turned out statistically meaningful in a t value. Furthermore, the multiple correlation coefficient was 0.9252, so I can

Table 4 Attribute of the explanation variable

Explanation variable	Contents		Unit
x 1	Detour route departure time		Time
x 2	Trip speed every general survey section	(East)1063, (West)1089	Km/h
x 3		(〃)1064, (〃)1088	
x 4		(〃)1065, (〃)1087	
x 5		(〃)1066, (〃)1086	
x 6		(〃)1067, (〃)1085	
x 7		(〃)1068, (〃)nothing	
x 8	The earthquake occurrence progress days		day
x 9	Weekdays or holiday		1, 0

Table 5 Multiple regression analysis result (east route)

Explanation variable	Partial regression coefficient	t value	Single correlation
x 1	0.044	1.25	0.19
x 2	-0.213	11.17※	-0.69
x 3	-0.098	3.56※	-0.48
x 4	-0.051	3.50※	-0.3
x 5	-0.005	1.66	0.02
x 6	-0.141	3.66※	-0.54
x 7	-0.511	8.12※	-0.66
x 8	-0.027	2.83※	0.02
x 9	-0.043	0.14	0.43
Constant term	89.066	26.91※	

Note) ※ 5% are meaningful

Table 6 Multiple regression analysis result (west route)

Explanation variable	Partial regression coefficient	t value	Single correlation
x 1	0.001	0.03	0.08
x 2	-0.224	4.24※	-0.76
x 3	-0.112	3.33※	-0.45
x 4	-0.247	3.88※	-0.82
x 5	0.013	0.21	-0.68
x 6	-0.17	4.20※	-0.71
x 8	-0.012	0.61	0.63
x 9	-0.117	0.36	-0.03
Constant term	73.662	22.03※	

Note) ※ 5% are meaningful

that correlation was high about the multiple regression type which I calculated this time.

On the other hand, about the western route the result became like table 6. In this case,like the east route, the trip speed (x2) of No. 1089 of general survey section at the departure, No. 1087 trip speed (x4) turned out to have a high negative correlation.

Therefore, about the western route, in addicion to the departure, the time required indicated to tend to be bigger when the trip speed at halfway point arrival became slower(smaller).

When I watched a t value next, I think that trip speed (x2 ～4,6) at the time of departure and the arrival is meaningful in a t value about east route and west route together. So I think that these explanation variable is meaningful statistically, but I cannot say that only the earthquake occurrence progress days(x8) is not meaningful in west route in comparison with east route.

From this, the main difference about the time required prediction between western route and east route is progress days (x8), so I think that the time required of the route of the east side is associated with the progress days.

In addition, the multiple correlation coefficient of this west route was 0.9039, and the correlation turned out high like the east side.

By the above, I can say that the time required prediction (multiple equation of regression) of the time required is possible by using probe car data.

10. CONCLUSION

By the above, I got the following conclusions.

- A big difference was seen in the situation of the traffic jam by a course just after the earthquake occurance that Noto toll road was closed to traffic in comparison with normal time and many cars tended to pass the ③ routes of the east side, but was disappeared with the progress in the days.
- About the ③ route, unevenness was seen in trip speed after the earthquake occurrence at the daytime in particular on March 29 of the fourth day and became the low speed partially.
- There was not very unevenness for it about National highway No. 249 (Yanagita - Togi) (① route) and was stable.
- And the days passed, and dispersion became small and approximately converged at trip speed of nomal time.
- About the comparison between trip speed and traffic density, just after the earthquake correlation was not seen, but the trip speed did a rise (particularly Noto toll road) as traffic density increased for convalescence.
- At the time of the earthquake, although a traffic jam occurred locally, I observed a tendency to revise the delay by it , I usually showed tendencies to secure the appointed hour characteristics not to almost change as usual.
- The spot of the delay was almost decided and I understood that a delay occurred locally.
- The estimationof the time required(trip time) by the multiple regression type which assumed a the time required as a purpose variable and the trip speed of each general survey section and so on as an explanation variable is possible.
- By the above, I think that we might control the outbreak of the traffic jam if we gave information according to the recovery of the road (cancellation of traffic suspension) precisely.

In addition, the following points are considered as a future problem.

- About the first day that this probe car data was

collected in, four days later was passed from the earthquake occurrence, so it is necessary to prepare the system collecting the necessary data just after an earthquake.

- therefore, it is desirable to utilize the data such as car navigation systems, but the notice is necessary enough for the utilization,because when I utilize the data of the general car ,the data become enormous, and truth characteristics whether or not we can pass in safety are doubtful.
- So,I think that I attach GPS to the patrol car r which a road manager of a city,a prefecture,and a country own, and that it is desirable to process probe car data while judging a traffic condition.

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