Easing Traffic Load through Increasing Total Floor Area
-Special Incentive Zoning applied in Ginza District, Central Tokyo -

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Abstract
Trip generation patterns such as peak time differ by floor use categories. Considering this fact, it is rational to reduce peak time traffic load on specific infrastructures by operating floor area quantity through zoning regulation, and further more, there is a possibility to reduce peak traffic load even with total floor area increase by special incentive zoning which operates floor area supplies by use categories. A new type incentive zoning of this kind called “Efficient utilization district of urban renovation type” was actually introduced in Ginza district in central Tokyo in 1998. Unique characteristic of this zoning is applying different floor area ratio (FAR) by office use and commercial use, and giving FAR bonus to commercial use in order to be encouraging renovation of attractiveness as top-brand downtown, if the office floor occupation is less than one third of the building. Does it really effective to ease terrible overcrowding in morning peak hour of commuter trains? This paper makes it clear the rationality of this special incentive zoning that applied to the specific area of Ginza district in central Tokyo, where has traditionally fashionable downtown characteristics as well as concentrates many lines of commuter railways.

Keywords: Incentive Zoning, Floor Area Ratio, Trip Generation Rate, Ginza District, Tokyo, Efficient Land Utilization District, Urban Renovation

1. Purpose

It may be seemed that attempting traffic load reduction by measure of incentive zoning which induces increase of total floor area is somewhat contradiction. It is true that there is a proportional relation between quantities of trip generation and floor area. But trip generation patterns are differed by floor use categories, and peak time load is the most crucial issue for capacity of infrastructure.

In other words, peak time load on infrastructure is largely depends on land use categories. In this context, by mixing different floor use categories with different peak time patterns, it is theoretically possible to reduce the crucial peak time load on traffic infrastructure, even if it

would be resulted in increase of total floor area.

In reality, new type incentive zoning called “Efficient Land Utilization District of Urban Renovation Type” which designated in Ginza District in central Tokyo in 1998 was based on this theory. This paper is to clarify the rationality to adopt this type of incentive zoning on the specific district of Ginza from the perspective of compatibility with promoting urban regeneration and easing traffic problem, and to estimate the potential effect and sub effect of this zoning regulation to the traffic loads on the relevant infrastructures.

2. Traffic Situation and Land Use Location

Traffic congestion of commuter railways, which means overcrowding trains in morning peak time, has been one of the most crucial problems of Tokyo metropolitan area. It is caused by its distinctive land use structure which huge amount of office floor concentrates excessively in the central business districts around Tokyo central station.

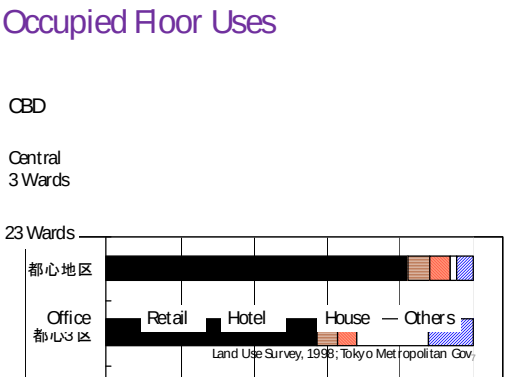
In central Tokyo, daytime population is 2,349 thousand while residential population is only 326 thousand (Central 3 wards, 2005). This fact suggests that more than two million trips is concentrated into the central Tokyo every morning. Figure 1 shows that about 30% of commuter’s destination is central 3 wards and one third of it is the Central Business District around Tokyo central station. These facts tell that the terrible congestion of commuter railways in Tokyo is largely caused by huge accumulation of work place in central Tokyo.

In view of land use proportion by floor area, about 60% is occupied by office use in central 3 wards area, while more than 80% is office floor in Central Business District (Figure 2). These facts indicate that land use condition in central Tokyo is strongly imbalanced, and this excessive concentration of office floor in the centre is the primary cause of dysfunctional warp of urban structure in Tokyo metropolitan region, which means that imbalanced land use location brings imbalanced traffic flow.

Therefore, the principle planning policy has been to facilitate dispersing office accumulations by strengthen sub centre districts such as Shinjuku, Shibuya, ikebukuro,

Figure 1 Commuter’s Destination

Figure 2 Occupied Floor Uses



Ohsaki and Waterfront Sub-centre in Tokyo wards area as well as Yokohama Minato-Mirai, Chiba Makuhari and Saitama New-centre which locate 30 km radius around central Tokyo.

Figure 3 shows the relationship between designations of higher floor area ratio (FAR) in use zone (primary zoning designation) and railway networking in Tokyo wards area. Coloured areas are 500% or more FAR designation. According to the map, 800% or more designation are principally located at the connecting points of multiple railways, especially, central Tokyo area around Tokyo central station and major sub-centres such as Shinjuku, Shibuya and Ikebukuro. This map is telling that relationship between location of intensive land use and railway network has been major concerns of primary zoning in Tokyo. It also describes that the dispersing policy of intensive use to the sub-centre zones has been reflected on the primary zoning designation.

At the same time, the idea that planning on land use intensity of central area should be restrictively operated has long been kept basically by planning authority as a fundamental consensus to avoid excessive accumulation of office floor in the centre. However, this consensus seems to be fading out under the recent urban renaissance policies.

Figure 3: Floor Area Ratio Designation (500% or More) and Railway Network

Source: Tokyo City Planning Maps (Use Zone), 2004

3. Situation of Ginza District

Recent problems on Ginza district are quite various. The most popular problem is supposed on townscape issue including building height. However, this paper is going to focus on the issue about floor area ratio regulation and traffic loads.

In central Tokyo including Ginza district, there are a lot of buildings which were constructed before forty years ago such as 1950s and 1960s. Most of them are being required to get into major renovation or reconstruction in order to update the old fashioned facilities, or to fit with current statutory building standards including seismic, and often to enlarge floor area to having space which is to adapt the current needs and trends. In addition, especially in Ginza district, there was another problem that old commercial buildings, such as department stores which were built before FAR designation in 1964, are in nonconforming condition with excessive floor area than current FAR limit. These buildings were in serious condition because they were actually unable to do reconstruction and major renovation unless it would decrease current floor area.

To solve these sorts of problems, it was sure that national laws and circulars provided some incentive systems with FAR bonus. But they all requires as basic condition to provide open space in the site of the buildings such as plaza or setback. The reason is considered that providing open space is principle mitigation against environmental loads to surroundings by taking the density up.

However, providing open space such as setbacks does not make sense for such cases that there is a sufficient broad pedestrian pavement in front of the buildings as well as streetscape with the buildings orderly stand in a line. In other words, providing open space occasionally turns to be negative and harmful in townscape design aspect for a certain case such as Ginza Central Street. In addition, that is no relief method for nonconforming buildings with excessive floor area to renovate them..

On the other hand, amendment of basic floor area ratio limit designated by use zone (primary zoning) was not good choice for planning people because designated value of 800% to Ginza district is recognized as a kind of landmark in hierarchical order of whole zoning designation. If extra floor area ratio would be required, it should be solved by other method such as overlay zoning than amendment of primary zoning.

Therefore, more appropriate theoretical ground for FAR incentive without open space needed to be investigated.

4. Trip Generation by Timeline

Trip generation by timeline and means of transport in central Tokyo is unique and distinguished.

Left side graph of figure 4 shows trip generation by timeline on each means of transport in central business district of Tokyo. First of all, number of trips by trains in morning peak time (8 o'clock hour) is prominently large. Number of trips on automobiles seems very small comparing to on trains. Trips on foot are observed small peak around lunch time. Anyway, trips generated in this area clearly depend on trains and it can be said that commuter trips by trains are evidently observed as the most critical load on infrastructure in this district.

Right side graph of figure 4 also shows another important fact that the prominent peak is caused by office floor. But more important point than that is that commercial floor generates only few trips on 8 o'clock hour. Considering timeline, characteristic of trip generation by commercial floor is totally different from that of office floor.

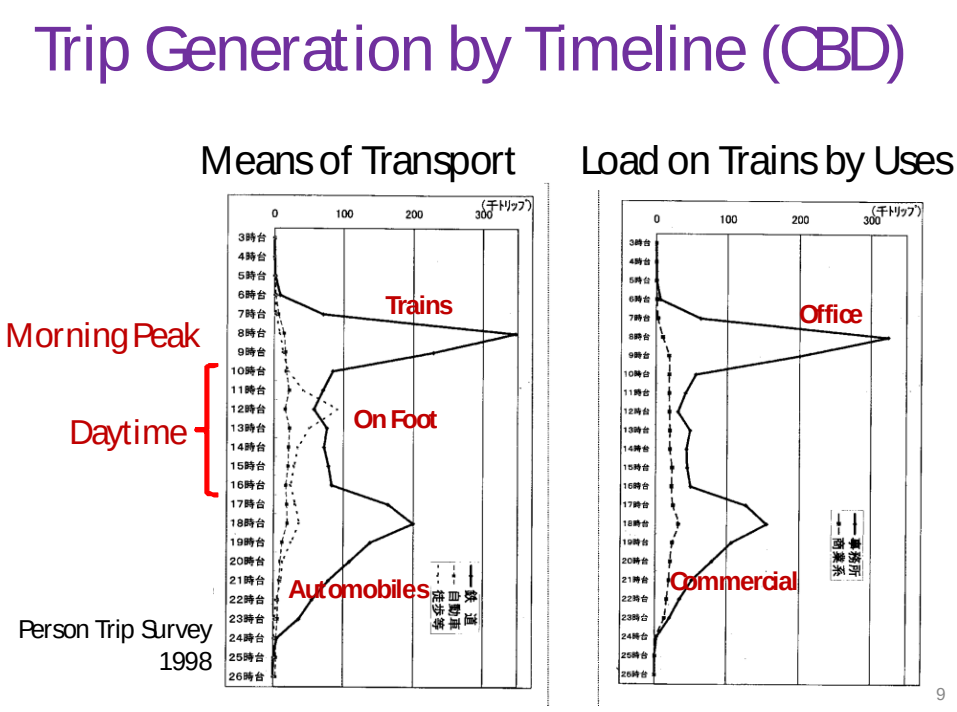
These facts lead to the following findings.

A) Morning peak of trip generation on trains is prominent and huge, which is the most critical load on infrastructure in the area..

B) The critical load is apparently caused by huge amount of office use floor which is concentrated in the area. Thus, the total quantity of office use floor should be controlled in the area.

C) On the contrary, commercial use floor does not affect the peak load. Rather than that, it can be said that commercial floor has potential contribution to efficient use of infrastructure (railway network in this case) on off peak and holiday.

Figure 4; Trip Generation by Timeline and Means of Transport in Central Tokyo



5. Planning Policy

The planning policy based on above findings could be sum up to the following two points.

1) Office development should be dispersed to other areas than central Tokyo to avoid concentration of commuter trip destination. Because peak time traffic load generated by office floor accumulation in central Tokyo is significantly crucial.
2) Contrary to this, redevelopment to commercial use should be stimulated in central Tokyo in order to facilitate good urban renovation. Because commercial floor does not affect the peak load.

On this perspective, the specific approach that to deregulate the FAR limit for commercial floor is thought to be possible if this deregulation links with actual reduction of office floor area. Accordingly, giving right to extra floor development of commercial use for buildings which have small rate of office floor occupation is said to be rational as long as it is in the specific district of central Tokyo. Moreover, in this case, there is no need to establish open space in the building lot for FAR deregulation as long as there is sufficient pedestrian pavement in front of the building instead, because validity of deregulation is justified by floor use change.

6. Special Incentive Zoning applied to Ginza District

Ginza District is known as one of the most popular and sophisticated commercial centre in Japan. It locates south east side in the central Tokyo, neighbouring to Marunouchi District as business headquarter, Nihonbashi and Yaesu District as trade and financial centre and Kasumigaseki District as national government centre. Along the streets, various kinds of shops and stores stood in a row including long established departments, fascinating shops with decent or innovative design, variety of restaurants, bars, cafes and showrooms. But looking to the area size of building lot, most of them are rather small.

However, one thing that should be mentioned is that the proportion of office floor to total floor area is reached to 68% (1998). In fact, office use occupation is surprisingly large portion by floor area regardless of the popular image as brand commercial downtown.

In 1997 to 1998, an epoch making event on planning was happened to Ginza District. As mentioned above, all the existing method on floor area ratio bonus requires establishing open space in the building lot such as setback, which sometimes negatively affects to such specific townscape design as Ginza Central Street, as well as it does not make sense to major renovation of the existing nonconforming buildings. This problem was picked up on the table of national government that is making the urgent economic stimulation program, which was one of the government initiative measure to overcome the long term recession after the bubbled economy. As the result, Ministry of Construction wrote up the circular as operational direction on Efficient Land Utilization District, which is one of the statutory overlay zoning categories with floor area ratio bonus. Chuo Wards Government immediately wrote up the

draft of the planning decision and started negotiation with the landowners and local organizations in Ginza District. The planning decision including Efficient Land Utilization District of Urban Renovation Type as introducing new type incentive zoning with floor area ratio bonus and District Plan as introducing height limitation to protect townscape were promptly authorized through approval of Tokyo Metropolitan Government. Then, they had officially validated in October, 1998.

On Ginza Efficient Land Utilization District's case, requirement for the building is that 1) office use floor occupation is required less than 1/3 of the total floor area and 2) promoted use floor occupation such as retail, restaurant, theatre, hotel and so forth is required more than half of the total floor area. The limit of the extra floor area ratio is from 100% to 300% according to sidewalk width in front of the building (Figure 5). Maximum case is 1,100% (that is 800% base plus 300% bonus) in front of Ginza Central Street or Harumi Street with more than 5.5m width of sidewalk (Figure 6).

Pictures on Figure 7 are the buildings applied the new incentive zoning. Most of them have unique and fashionable facade.

By the way, height limitation designated by District Plan at that time has been played more significant role in partnership planning activities involved with landowners. However, this paper intends to focus on the FAR and traffic issues instead of townscape design control.

Figure 5 Contents of Incentive Zoning

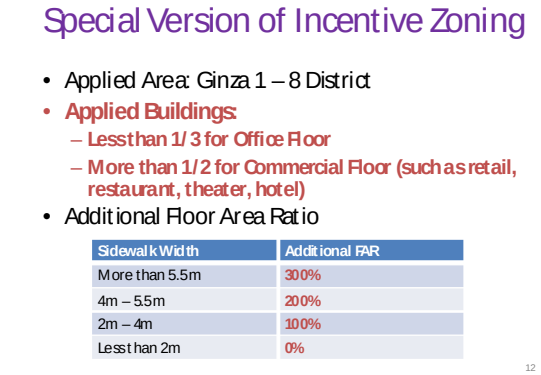


Figure 6 Application of Incentive Zoning

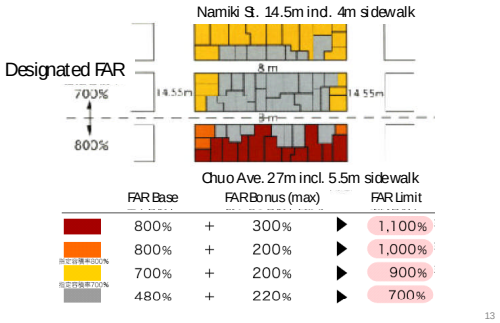


Figure 7 Buildings by New Incentive Zoning

7. Theoretical Studies

Every policy has negative sub effects more or less as well as positive effects. In this case, positive effect is reduction of overcrowding trains in morning peak hour, whereas negative effect on traffic might be increase of automobile trip generation in daytime hours.

Figure 8 is the trip generation rates by floor use in central Tokyo. It is calculated in relation to the data of Person Trip Survey 1998 and Current Land Use Survey 1988 using the smallest zone of Person Trip Survey as samples. According to these results, traffic loads on trains in morning peak are 211 trips/hectors by office use floor, 43 by retail and restaurant floor, 13 by hotel floor where as on automobiles in daytime hours are 10 by office, 34 by retail and restaurant, 5 by hotel. Actually, by change of floor use from office to commercial, morning peak load will surely be reduced, but on the other hand, daytime automobile load will be increased.

In general, it is assumed that relation between trip generation and floor is followings;

$$T = f_{of} \cdot t_{of} + f_{cm} \cdot t_{cm} + f_{ot} \cdot t_{ot} \qquad \cdots(1)$$

T : Total trip generation in the district

f_{of}, f_{cm}, f_{ot} : Total floor area by Office, Commercial and Other uses

t_{of}, t_{cm}, t_{ot} : Trip generation rates by Office, Commercial and Other uses

Hereafter, ($f_{ot} \cdot t_{ot}$) is omitted because it is rather small comparing to office and commercial in this district.

Now we attempt to consider an incentive zoning regulation that to give extra floor area to commercial use according to reduction of office use floor area from average occupation rate in the district. Assuming that all buildings in the area would be reconstructed by this rule, total trip generation in the future is;

$$T' = (k f_{of} - \Delta f_{of})\, t_{of} + (k f_{cm} + a \cdot \Delta f_{of})\, t_{cm} \qquad \cdots(2)$$

T ' : Total trip generation in the future

k : Increasing rate of future total floor area by trend

= (Future / current effective rate of FAR regulation

Δf_{of} : Floor area reduction on office use

a : Multiple coefficient for commercial floor

Proportion of future to current on total trip generation is;

$$\frac{T'}{T} = \frac{(k \cdot f_{of} - \Delta f_{of})\, t_{of} + (k \cdot f_{cm} + a \cdot \Delta f_{of})\, t_{cm}}{f_{of} \cdot t_{of} + f_{cm} \cdot t_{cm}}$$

$$= \frac{k(1 - p + q\cdot r + a\cdot p\cdot r)\, f_{of}\cdot t_{of}}{(1 + q\cdot r)\, f_{of}\cdot t_{of}}$$

$$= k\{1 - p\cdot(1 - a\cdot r)/(1 + q\cdot r)\} \qquad \cdots(3)$$

$p = \Delta f_{of} / k f_{of}$ (Reduction rate on office floor)

$q = f_{cm} / f_{of}$ （Proportion of commercial to office on current total floor area）

$r = t_{cm}\, t_{of}$ (Proportion of commercial to office on trip generation rate by floor area)

For the purpose of estimating positive effect and negative effect on traffic issue, proportion of future trip generation to current situation each on trains in morning peak hour and on automobiles in daytime hours ($v_m = T'_m / T_m$、 $v_d = T'_d / T_d$) is;

$$v_m = k\{1 - p\cdot(1 - a\cdot r_m)/(1 + q\cdot r_m)\} \qquad \cdots(4)$$

$$v_d = k\{1 - p\cdot(1 - a\cdot r_d)/(1 + q\cdot r_d)\} \qquad \cdots(5)$$

r_m、r_d : Proportion of commercial to office on trip generation rate by floor area (trains in morning peak hour, automobiles in daytime hours)

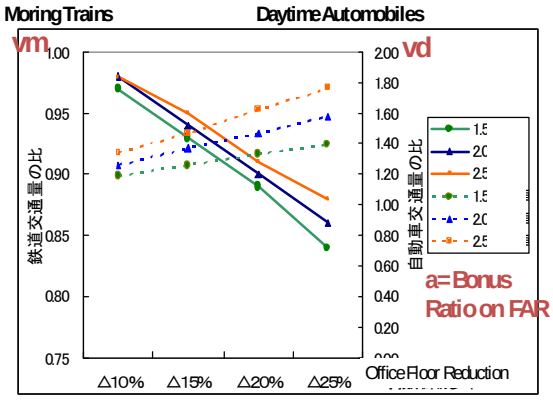
On the simultaneous equations above, p (= reduction rate on office floor) and a (= multiple coefficient for commercial floor) are the variables decided (but not directly) as specific requirements of incentive zoning system whereas k (=1.055), q (=0.141), r_m (=0.127) and r_d (=1.731) are invariables which depend of current situation.

Figure 9 shows the results of estimation that is expected future traffic loads to current situations by applying different variables which are decided by incentive system of zoning. For instance, if you set value of “a” (multiple coefficient for of commercial floor area to office reduction) is 2.0 and would succeed in 20% office floor reduction to current total, trip generation on morning peak trains would be reduced by 10% whereas daytime automobile trip generation would be increased to 147%. However, one thing that should be noticed is that on the premise of this calculation, there is an assumption that total floor area in the future

Figure 8 Trip Generation Rates

		Trip Gene. Rate (Trip/ ha)	R^2	t
Trains Peak Time (8–9am)	Office	211.5	0.72	9.2
	Retail & Eat	43.3	0.50	5.8
	Hotel	13.2	0.61	7.2
Automobiles Daytime Ave (10–16)	Office	10.4	0.82	28.7
	Retail & Eat	33.6	0.71	14.1
	Hotel	5.1	0.58	9.3

Fiture 9 Estimated Future Traffic Load



would be expected to increase 5.5% (k=1.055) by trend, which means trip generation level would also be assumed to increase by 5.5% in the future.

8. Expected Future Traffic Load in Ginza District

Lastly, I'm going to try to estimate how the new incentive zoning work on traffic load in Ginza District using data of building certificate file.

On current situations in Ginza District, office use occupies 68% of total floor area in the district whereas commercial floor occupies 27% so that q=0.39. As mentioned above, this fact is surprising in consideration of the popular image of Ginza as distinguished commercial centre,. According to the building certificate data, 17 projects out of 45 were applied FAR bonus of the new incentive zoning from November 1998 to October 2001. Average of FAR values after the project is 930%, which is 25% increase than without bonus case. Average proportion of commercial floor to total floor area of these projects is 76%. According to the trend on FAR effectiveness, value k is estimated to 1.074. Using these values, it is calculated that a=1.49 and p=0.30, which means that 30% of office floor area will be reduced in the projection of the current trend in the whole district whereas 1.49 times floor area for commercial use to reduced office will be established in the future.

The effect and sub effect on traffic load are estimated as v_m =0.82、v_d =1.39, that is morning peak load on trains will reduced 18% to current crowded situation whereas daytime automobiles generation will be increased to 1.39 times larger than the current. The result means that overcrowding rate of the subways in 8 o'clock hour will be down by 2.7 points whereas automobile generation load on the surrounding road will be back to the level of 89% compared to the peak year of 1988. Actually, according to the person trip survey, automobile trip generation in central 3 wards area was evidently decreased so that it could be thought that this level of sub effect is not so serious condition than we had experienced in the past.

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