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SITE SURVEY AND ANALYSIS OF HIGHWAY TRUCKS OVERLOADING STATUS QUO IN ANHUI

HANG Wen
Graduate Research Assistant
Transportation College
Southeast University
Si Pai Lou 2, Nanjing,
210096 China
Fax: +86-25-83795384
E-mail: zeal-hw@sohu.com

LI Xu-hong
Professor
Transportation College
Southeast University
Si Pai Lou 2, Nanjing,
210096 China
Fax: +86-25-83793685
E-mail: lixuhong@seu.edu.cn

JU Peng
Bachelor of Arts
High School Affiliated to
Nanjing Normal University
Jiangning Campus
Jiang Ning, Nanjing,
211102 China
Fax: +86-25-52724605
E-mail: wajp@sohu.com

HE Jie
Associate Professor
Transportation College
Southeast University
Si Pai Lou 2, Nanjing,
210096 China
Fax: +86-25-83795384
E-mail: hjie1@263.net

Abstract: In 2004, with the increasing requirements of restriction upon overloading in Anhui, a province-wide comprehensive overloading transportation survey has been conducted to evaluate the overloading status quo and enforcement efficiency with the support of the World Bank. A total of six site surveys were conducted at Hefei, Fuyang, Luan, Wuhu, Huainan and Huangshan Areas with four main contents: traffic volume, axle load, freight information and registration information.

Via statistical analysis on the survey data, conclusions were reached as the following: vehicle overloading is very universal and serious at arterial highways in Anhui nowadays. The traffic loads have far exceeded the designed bearing capacity of highways and have caused prevalent premature pavement damage, especially for rigid pavements. Actually, the overloading trucks are now engaged in highway freight transportation due to the disordered overloading enforcement strategies and the deficient inspecting technologies.

Key Words: overloading, over-limit, site survey, percentage distribution of axle load, overloading enforcement

1. INTRODUCION

1.1 Background

Evaluated by the transport development theory, China is still under its metaphase or anaphase of industrialization. The leading industries of society are pertained to the style of intensive resources, and more scale freight transportation methods are needed to reduce the production cost. With the increasing economic activities and the absence of effective load regulations, the heavier trucks are now rapidly multiplying on the primary highway routes. At present, overloading transportation has become more and more prevalent in Anhui Province. Except some special trucks, almost all trucks are attached themselves to overloading transportation in different degree.

While uncontrolled growth in loads and volumes of heavier trucks may be beneficial to truck owners, it could bring structural deterioration to bridges and lead to premature pavement damage. As an example, partially because of the oversight of universal overloading situations in highway design, serious premature pavement damages have occurred on many primary highway sections in Anhui under the overwhelming traffic load. Several arterial highways even require thorough rehabilitation within two or three years after their opening to traffic. On the other hand, overloading transportation causes highway-related tax revenues to lose due to "higher operating loadage with lower registered tonnage" behavior and other social problems such as traffic safety and environment pollution.

1.2 Objective

In 2004, with supporting the highway constructions in Anhui province, the World Bank put forward the "Overloading Study for the Proposed Anhui Highway Project II". This project aims at recommending strategies for the improvement of overloading enforcement by evaluating the current state of overloading in Anhui. It also tries to identify ways in which vehicle inspection systems can be deployed to enhance the highway services for both the user and government.

A province-wide comprehensive survey has been developed to conduct this evaluation. Firstly, traffic and axle load site surveys on arterial highways of Anhui were conducted, which is also the focus of this paper. Secondly, a user survey was developed at the survey sites where the institutional interviews were conducted. Finally, an institutional survey was developed and would be used to assess the institutional perspective of overloading enforcement. This three-tiered survey should help provide a nearly complete and clear picture of the current overloading transportation system and all its major characters in Anhui.

The purpose of this paper is to present a statistical summary of Anhui highway traffic load survey (2004) data and to sum up the significant characters of overloading transportation system in Anhui. We expect this paper to lay a foundation for further investigations.

1.3 Study Range

In China, ministry of communications and ministry of public security are both responsible for the management and enforcement of the highway freight vehicles, and their criterions of overloading identification are entirely distinct. The former defined overloading as "over-limit transportation" which means the length, width, height, gross weight or axle weight of the vehicle engaged in highway transportation exceeds the legal limit value (table 1) of "*Management Stipulation for Highway Over-limit Transportation Vehicles*" stipulated by ministry of communications in 2000. But the latter department affirms "overloading transportation" by the "*Load Traffic Safety law*" (2004) which means the operating loadage of freight vehicle exceeds the registered tonnage on the user's certificate.

Table 1. Legal Limit of Freight Vehicle (Mg=Megagrams)

GVW upper limit	Single-unit truck, Single-trailer truck and Multitrailer truck	40Mg
	Single-trailer truck carrying container	46Mg
Axle weight limit	Single axle with two tires	6Mg
	Single axle with four tires	10Mg
	Tandem axle with eight tires	18Mg
	Tridem axle with twelve tires	22Mg
Size limit	Omit	

In order to distinguish the discrepancy of the two aspects, two sets of indices will be specially described for later analysis in accordance with the upper two criterions. The first set of index are related to overloading, which basically compare the actual loadage of trucks to there registered tonnage, e.g. the overloading ratio (OLR) means the ratio of the part that operating loadage exceeds the truck's registered tonnage to its registered tonnage. Another set of index is related to over-limit, which basically compare the actual gross vehicle weight (GVW) or axle weight of trucks to the legal limits, e.g. the over-limit ratio (OLtR) of GVW is the ratio of the part that operating GVW exceeds the truck configuration's legal GVW limit (i.e. sum of axle limit) to GVW limit. In places where no distinct discrepancy should be made, the two kinds of problems will be uniformly called as "overloading" for the convenience of expression.

2. DATA AQUISITION

2.1 Survey Approach

In China, the transportation surveyors estimate traffic-volume and vehicle GVW data according to vehicle's apparent registered tonnage (e.g. single-unit truck is classified into three types, i.e. light, median and heavy trucks) and load degree (e.g. non-loaded, half-loaded and full-loaded) which are more commonly available than axle-load data. This method is widely used to estimate the equivalent single axle loads (ESALs). Therefore, the vehicle classification is ambiguous and the subjective estimation of load magnitude is inaccurate because of serious overloading problems. So, the project team developed a province-wide comprehensive site survey to collect traffic data according to our requirements without adopting history statistics.

The site survey was composed of three subentry surveys: traffic survey, vehicle weight survey and hauler questionnaire survey. Many types of data were gained such as traffic volume, vehicle configuration, axle load, cargo types and registration information and so on. Though many different sensing techniques have been used to collect these data, with such techniques including pneumatic road tubes, radar, microwave, ultrasonic, video imaging, and piezoelectric cables, there are few available in Anhui. So, large numbers of surveyor were temporarily enrolled to acquire and record the data and the platform-types scale and portable WIM system were used to weight vehicles.

A total of six site surveys were conducted at fixed or temporary vehicle inspecting stations in highway sections of Hefei, Fuyang, Luan, Wuhu, Huainan and Huangshan Area. These six highway sections involve five major highways and one local highway which represent the most common situation of overloading transportation in Anhui. For convenience of statistical analysis, they were divided into three types according to highway technical levels, pavement type and truck volumes as shown in table 2.

Table 2. Highway Sections of Overloading Survey in Anhui

Highway Section	Pavement type	Technical level	No. of lanes	Designed years	Designed ESALs	Description
Type one						
Hefei-Anqing	flexible	express-way	4	15	2.4E+7	major arterial
Wuhu-Xuancheng	flexible	express-way	4	15	2.4E+7	inter province
Type two						
Luan-Hefei	rigid	first class	4	30	1.1E+7	minor arterial
Fuyang-Yingshang	rigid	second class	4	30	1.4E+7	major collector
Huainan-Hefei	rigid	second class	4	30	1.5E+7	major collector
Type three						
Xiuning-Jingde Town	hot mix	third class	2	8	1.0E+6	minor collector

2.2 Traffic Survey

24-hours-traffic-volume-surveys on vehicles classified by their configuration were conducted to be assorted with vehicle weight survey. With reference to the thirteen-class vehicle sorting system established by the Federal Highway Administration (FHWA) of U.S., a twelve-class category, as shown in table 3, were presented based on the experience of experts from Anhui Department of Communications (APCD). Particularly, trucks classes were subdivided into loaded and non-loaded status respectively to minimize the influence of different sampling ratio of weighing survey imposed by surveyors.

Table 3. Vehicle Classes

Class	Description	Abbreviation
1	passenger cars	PC
2	buses	Buses
3	other two-axle, four-tire, single-unit vehicles	Pickup
4	two-axle, six-tire, single-unit trucks	SU2
5	three-axle, single-unit trucks	SU3
6	four-axle, twelve-tire, single-unit trucks	SU4
7	three-axle, single-trailer trucks	2-S1
8	four-axle, single-trailer trucks	2-S2
9	five-axle, single-trailer trucks	2-S3
10	five-axle, single-trailer trucks	3-S2
11	six-axle, single-trailer trucks	3-S3
12	four-axle, multitrailer trucks	2-F2

2.3 Weight Survey

It is widely accepted that the vehicles with more than two axles and four wheels should be mostly responsible for pavement deterioration due to there heavier axle load. So, vehicle weight survey was concentrated upon trucks from Class 4 to 12 in table 3. The gross vehicle weight and per axle weight for each truck were obtained and recorded semi-automatically by the WIM equipment deployed on the road side or platform-types scale inside inspecting stations. At survey sites with low traffic, volumes effort was made to weigh all trucks. At high traffic volume locations, however, loaded and unloaded trucks were selected intermittently to avoid long queues in terms of stated sampling ratio.

2.4 Questionnaire Survey

At the same time, vehicle information, plate number, goods category, freight OD and other information of weighted trucks were inquired and collected by questionnaire surveyors at the roadside to provide data for operating investigation of overloading vehicle. In addition, with the cooperation of APCD, large numbers of transportation trade questionnaire surveyors were assigned to transportation management divisions, vehicle title and registration divisions and garages all over the Anhui province to gather the source data of freight organization, vehicle operating cost and vehicle life.

3. DATA ANALYSIS

The comprehensive site surveys were developed synchronously in six areas at the middle days of April, 2004. A total of 1182 vehicles were properly weighed in one week and 2547 “trade questionnaires” were collected in two months. Based on these latest source data and substantive history statistics offered by APCD, a comprehensive analysis was developed with multivariate analysis programs. Comparisons and contrasts were made across vehicle classes and highways, which leads to the formation of generalized estimation regarding overloading transportation in Anhui.

The following aspects were analyzed or estimated with a brief discussion of each:

- ✧ Traffic volume,
- ✧ Vehicle overloading characteristics,
- ✧ Vehicle over-limit characteristics and ESALs, and
- ✧ Operating characteristics.

3.1 Traffic Volume

The percentage of each vehicle class in all lanes at each highway is shown in Table 4 with average annual daily traffic (AADT) data derived from *transportation statistics of Anhui* (2003). We assume that the traffic proportion of vehicles in recent survey is consistent with the average proportion of a year.

Actually, heavy vehicles with more than four wheels were infrequently seen at Xiuning-Jingde Town so as to overloading vehicles. Further more, though there are some differences among sites in the proportions of vehicle classes making up the total volume, e.g. the proportion of 2-S2 varies from 0.18 percent at highway of Xiuning-Jingde Town to 16.31 percent at freeway of Wuhu-Xuancheng, however, one conclusion was reached that four vehicle configurations, SU2s, SU2, SU3, 2-S2 and 2-F2 (as shown in figure 1), are the most common heavy vehicles.

Table 4. AADT and Composition of Highway Traffic (Two directions)

Highway Section	Hefei-Anqing	Wuhu-Xuancheng	Luan-Hefei	Fuyang-Yingshang	Huainan-Hefei	Xiuning-Jingde Town
AADT (unit/day)	8873	7390	9614	13275	9157	2972
Vehicle Class	Traffic composition (%)					
1	45.52	32.69	52.28	40.87	49.93	66.61
2	15.04	7.08	14.51	8.40	14.36	10.34
3	3.43	1.29	6.39	7.43	1.07	8.71
4	26.27	28.83	21.43	36.16	25.23	14.16
5	3.04	7.80	0.82	4.23	1.61	0.00
6	0.16	1.93	0.00	0.00	0.00	0.00
7	0.70	0.43	0.34	0.07	1.34	0.00
8	5.69	16.31	2.77	1.25	2.55	0.18
9	0.08	2.72	0.19	0.14	0.00	0.00
10	0.00	0.29	0.11	0.00	0.13	0.00
11	0.08	0.36	0.00	0.00	0.00	0.00
12	0.00	0.29	1.16	1.46	3.76	0.00
Total	100.0	100.0	100.0	100.0	100.0	100.0

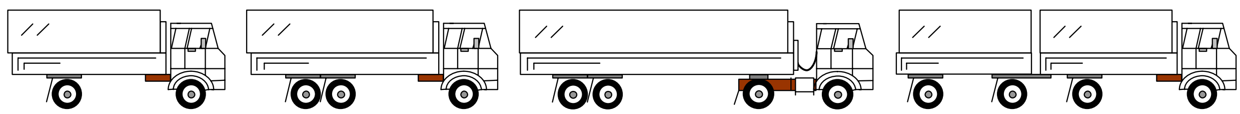

Figure 1. Illustrative Configurations of Broad Trucks in Anhui

3.2 Overloading Characteristic

Table 5 shows the characteristic statistical data of three highway section types with three kinds of indices. Thereinto, *overloading proportion* (OLP) means the proportion of overloading vehicles to all operating vehicles, *average overloading ratio* (AOLR) describes the mean value of overloading ratio of every loaded truck and *maximum overloading ratio* (MOLR) means the overloading ratio of the most seriously overloading truck.

It is obvious that OLP and AOLR of the third type highway are both much lower than those of type one and type two highways, namely the *arterial highways*, and heavy vehicle traffic volume of type three highway is correspondingly ignorable as mentioned previously. Sequently, in further study, attention is focused on the four broad truck configurations at five arterial highways which account for the worst, at least the most representative, load effects.

Further more, it is obvious that the overloading degree is extraordinarily serious at arterial highways. The OLPs of broad trucks all exceed 50 percent, i.e. operating loadage of more than half broad trucks exceeds its registered tonnage at arterial highways in Anhui. And the AOLRs of loaded broad trucks fluctuate from 290 percent to 358 percent which means the registered tonnage can't be used for representing the actual operating loadage. The vehicle tonnage management is proved to be unefficient in other words. Among the four truck configurations, SU2 seems to have more superiority in overloading capacity possibly because of its convenience of refit and easiness of disguise.

Table 5. Truck's Overloading Characteristics in Anhui

Index	Highway Types	SU2	SU3	2-S2	2-F2
OLP (%)	type one	60.3	75.6	76.5	91.3
	type two	50.6	70.9	51.9	67.2
	type three	18.6	-	-	-
AOLR (%)	type one	240.8	306.0	272.0	357.6
	type two	189.9	336.3	250.4	328.6
	type three	87.7	-	-	-
MOLR (%)	type one	769.2	700.0	750.0	653.1
	type two	1106.2	778.6	689.6	712.0
	type three	700.0	-	-	-

3.3 Over-limit Characteristic

Without the influence of non-loaded vehicles, the loading distribution of broad trucks are found to be independent of arterial highway sections by comparing the GVW distribution of loaded broad trucks at different arterial highways. Accordingly, hypothesis was made that the traffic loads imposed on pavement by a given truck configuration is the same among all arterial highways in Anhui which will be explained in institutional estimation subsequently. Based on this hypothesis, over-limit characteristics of a given truck configuration can be expressed as a whole that are shown in table 6.

Table 6. Truck's Over-limit Characteristics in Anhui

Vehicle Class		SU2	SU3	2-S2	2-F2
GVW	Legal limit (Mg)	16.0	24.0	34.0	36.0
	Mean (Mg)	16.29	33.23	48.27	41.24
	Std (Mg)	8.06	10.49	19.42	21.35
	OLtP (%)	43.5	71.9	58.3	61.5
Front axle (two-tire)	Legal limit (Mg)	6.0	6.0	6.0	6.0
	Mean (Mg)	4.41	6.08	4.48	3.35
	Std (Mg)	1.87	1.57	1.56	0.55
	OLtP (%)	11.4	28.5	8.4	4.8
Single axle (four-tire)	Legal limit (Mg)	10.0	-	10.0	10.0
	Mean (Mg)	11.90	-	14.79	12.63
	Std (Mg)	6.51	-	5.84	7.24
	OLtP (%)	43.5	-	64.2	66.8
Tandem axle (eight-tire)	Legal limit (Mg)	-	18.0	18.0	-
	Mean (Mg)	-	27.14	28.77	-
	Std (Mg)	-	9.72	13.19	-
	OLtP (%)	-	70.3	58.6	-

Some characteristics can be found from the statistical results:

- ✧ The mean GVW values of all broad truck configurations have exceeded the GVW limit, which indicates that more goods have been transported with over-limit trucks.
- ✧ The OLtPs of GVW have all exceeded 50 percent except SU2 in respect that SU2 is more likely to be used for carrying a small quantity of goods in short distance locally.
- ✧ The front axle barely exceeds axle limit except SU3 possibly because this configuration is used to manufacture dumpcart, cement mixer or civil engineering vehicle and has lower requirement for highway steering maneuver performance.
- ✧ The single axle and tandem axle of broad trucks both have egregious degree of limit exceeding which means serious impact on pavement and invalidation of axle enforcement.
- ✧ The over-limit proportions and especially the extend to which the mean values exceed legal limit of tandem axles are higher than those of single axles. It indicates that more severe impacts will be imposed on highway pavement by tandem axles possibly.
- ✧ The 2-S2 seems to be the most dangerous truck configuration as it has more axles and the mean values of its driving single axle and rear tandem axle are preponderant higher than corresponding axles of other truck configurations.

(1) Axle Weight Distribution

In the present study, it is assumed that the sample of trucks weighed may be fully representative of the certain vehicle population with respect to GVW and axle weight, since the sampling quantities are sufficient at 95 percent degree of confidence and the percentage distribution of GVW and axle weight were both adjusted by the non-loaded proportion (table7) of each truck configuration.

Table 7. Non-loaded Proportion (%)

Highway / Vehicle class	Hefei-Anqing	Wuhu-Xuancheng	Luan-Hefei	Fuyang-Yingshang	Huainan-Hefei
SU2	32.8	19.9	46.9	32.8	40.9
SU3	8.2	2.8	27.3	8.2	25.0
2-S2	38.9	2.2	21.6	38.9	31.6
2-F2	23.8	-	25.8	23.8	25.0

Figure 2 illustrates the axle weight/load percentage distribution of the four broad truck configurations using the adjusted source weighting data. Thereinto, *legal limit* means the axle weight limit and is of the same color with the corresponding axle load distribution. And the percentage distributions of front axle, single axle and tandem axle are divided at intervals of one Mg, two Mg and four Mg respectively.

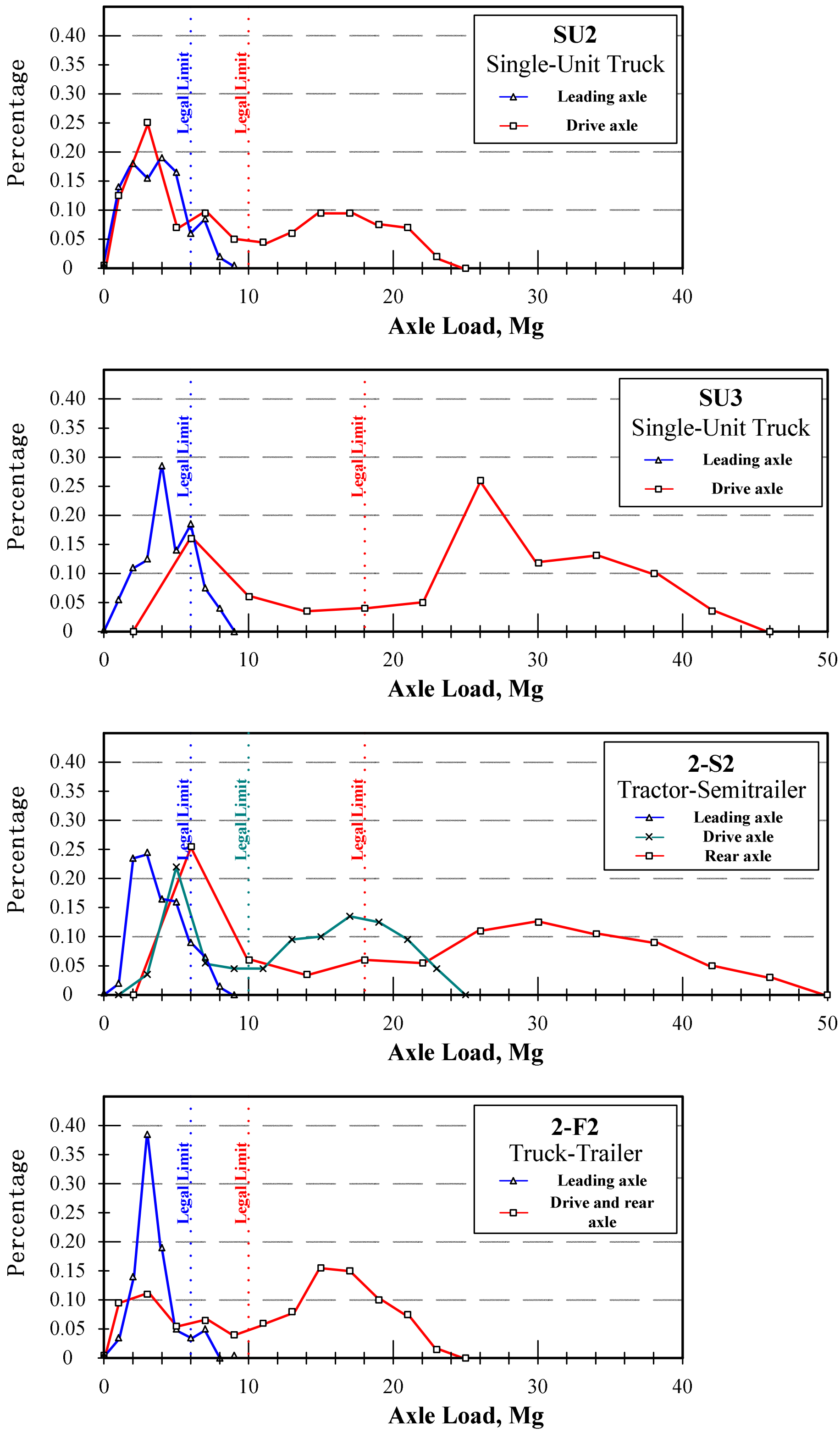

Figure 2. Axle Load Percentage Distribution of Broad Trucks (Mg=Megagrams)

(2) ESALs per Vehicle

The average ESAL factor per vehicle of a given vehicle class is used to convert vehicles per day to ESALs per day, even per year. ESALs calculated by the AASHTO procedure have a fourth to fifth-power relationship to axle loads, but ESALs calculating procedure used in the present study have approximately an eight to nine-power relationship for flexible pavement and a sixteen to seventeen-power relationship for rigid pavement proposed by Changan Transportation University. These indices consider such factors as pavement types, axle types, axle weights and tire pressures and are applicable to middle area of China.

Table 8 shows the average ESALs per vehicle of broad trucks and buses using probability calculating method. The value of standard axle load used is 100 kilo-newton which equals to 10 Mg.

Table 8. Average ESALs per Vehicle in Anhui

Flexible pavement	SU2	SU3	2-S2	2-F2	Buses
Front axle	0.25	0.76	0.17	0.02	0.07
Single axle	-	-	223	-	-
Tandem	132	180	343	173	0.87
Per vehicle	132	181	566	173	0.94
Rigid pavement	SU2	SU3	2-S2	2-F2	Buses
Front axle	0.55	2.15	0.18	0.00	0.01
Single axle	-	-	190711	-	-
Tandem	101000	35950	166743	112530	1.77
Per vehicle	101,000	35,952	357,454	112,530	1.78

Results were obtained that all broad truck configurations, especially the 2-S2 trucks, have prodigious probability ESALs per vehicle in contrast to buses whose ESALs seem acceptable.

(3) Cumulated ESALs

The cumulative ESALs at a site depend on the traffic volume and ESALs per vehicle which may both vary by the day of the week and season of the year. It is assumed in subsequent cumulative ESALs analyses, however, that the actual traffic-loading regime is accurately represented by the event survey data. In order to reveal the traffic loads of overloading transportation in Anhui as a whole, annual cumulative ESALs at a given highway were calculated approximately by summing the annual cumulative ESALs of broad trucks with buses and brought into comparison with designed annual cumulative ESALs (table 9).

Herein, flexible pavement seems to be more adaptable than rigid pavement to serious highway overloading traffic because of its lower axle relationship power. This can be proved by the worse status at rigid pavement compared to flexible pavement in Anhui.

The statistic results also indicated that the actual ACESALs greatly exceed the designed ACESALs of each highway even without more vehicles increasing. It corresponds with the phenomenon of ubiquitous premature pavement damage in Anhui excluding the possibility of construction quality. And then, tremendous losing of both highway owners and users was caused by pavement rehabilitation and maintenance, vehicle maintenance and poor traveling conditions.

At lest two problems need to be solved: axle weight enforcement should be more efficient and pavement design should be more practical.

Table 9. Annual Cumulated ESALs (ACESALs)

	Highway	SU2	SU3	2-S2	2-F2	Buses	Actual ACESALs	Design ACESALs
Flexible	Hefei-Anqing	1.12 E+08	1.78 E+07	1.04 E+08	0.00 E+00	4.58 E+05	2.35 E+08	6.40 E+06
	Wuhu-Xuancheng	1.03 E+08	3.81 E+07	2.49 E+08	1.35 E+06	1.80 E+05	3.91 E+08	6.40 E+06
Rigid	Luan-Hefei	7.60 E+10	1.03 E+09	3.47 E+10	4.58 E+09	9.06 E+05	1.16 E+11	1.47 E+06
	Fuyang-Yingshang	1.77 E+11	7.37 E+09	2.16 E+10	7.96 E+09	7.24 E+05	2.14 E+11	1.87 E+06
	Huainan-Hefei	8.52 E+10	1.93 E+09	3.05 E+10	1.41 E+10	8.54 E+05	1.32 E+11	2.05 E+06

3.4 Operating Characteristics

(1) Goods Categories

As an important national base of energy sources and agricultural products, Anhui kept its economic development depending on relatively lower cost of bulk freight transportation including highway transportation. So, almost all goods have been transported by overloading vehicles more or less except some *speed freight* such as first-order instrument, IT products, fresh foods, mail, etc. Table 10 shows the overloading characteristics of different goods categories. The most likely goods for overloading are coal, steel, building material, chemical materials, foodstuff, etc.

Table 10. Goods Overloading Characteristics

Goods category	Proportion of freight volume (%)	Proportion of truck traffic (%)	Average GVW (Mg)	OLtP (%)	OLtR of laden trucks (%)
Coal	19.12	10.98	33.3	100.0	70.6
Metal ore	2.87	0.43	12.7	0.0	0.0
Steel	5.10	6.41	36.2	86.7	68.0
Building material	27.98	29.19	21.0	77.0	43.7
Nonmetallic ore	2.97	0.00*	-	-	-
Chemical material	9.82	13.25	20.2	80.0	49.6
Foodstuff	10.35	9.83	20.2	77.3	58.9
Farm byproduct	2.98	6.41	15.6	41.7	51.2
Daily industrial product	2.08	15.81	17.2	67.6	47.3
Other industrial product	5.92	5.98	16.6	38.5	51.1
Other goods	10.81	1.71	13.1	50.0	24.3

Note: the survey data about trucks carrying nonmetallic ore is not available.

(2) Organization Framework

The highway freight vehicles operating in Anhui are mainly constituted of private individual vehicles and individual vehicles contracted with state-owned transportation enterprises in virtue of which haulers can derate some taxes. Since superintendence cost is very high, generally, the enterprises pay little attention to operating management of vehicles but collecting a certain quantity of administrative fee. Therefore, it is very difficult to implement overloading enforcement via the transportation enterprises, saying nothing of private vehicle's owners.

(3) Vehicle Types

The most familiar single-unit truck types in Anhui are constituted of Jianghuai series manufactured locally, Dongfeng series and Jiefang series out-of-province. And the most popular articulate trucks belong to Dongfeng, Jiefang, or Steyr series. Even then, because the detailed types of many trucks haven't been marked with uniform technical standards, not to speak of numbers of trucks refitted or reinforced to enhance the ability of overloading, it is nearly impossible to identify the registered tonnage and other laden information from the vehicle types.

(4) Route Choice

As mentioned above, the overloading problems at high-grade highways seem to be more serious than low-grade ones because of the greater truck traffic. Besides, the overloading vehicles at province-wide highways seem to be more prevalent than expressways because of the lower road tolls except in some crucial overloading punish periods when a portion of overloading trucks convert to run via expressways duo to the injunction of blocking vehicles on expressways.

4. ESTIMATION OF ENFORCEMENT

Owing to the relatively fixed freight origin-destination and transportation routes of overloading vehicles, it seems easy to block the main arterial highways to head off overloading vehicles. But, in practice, overloading enforcement has been very knotty to be carried into execution due to many long standing issues.

4.1 Social Conditions

As a whole, China is still in a climactic phase of highway infrastructure construction, especially for those underdeveloped provinces such as Anhui. There are all kinds of social issues existing in the course of highway maintenance and management. It is an ingrained prejudice for most part of the people including numerous highway managers that highway overloading problem is only a departmental problem or even an individual problem. In their opinions, the only thing government should do is to punish the road haulers and their proponent concerned with overloading severely. Therefore, there are countless impractical approaches and projects constituted for amercing the overloading vehicles regardless of the total cost of operating the highway system. There is no detailed definition or examining criterion about overloading vehicles in the law the rather that practice. There are substantive capitals devoted into highway construction repeatedly and prodigally with wretchedly few spent on overloading correlated study. It is painful to distinguish which is more miserable to us between overloading and improper measures of overloading enforcement.

4.2 Vehicle Registration

There is neither direct relationship of interest nor legal restriction in existence to motivate the vehicle titles and registration division, namely the traffic police in China, to develop more effective and impartial estimating and examining mode of vehicles registered tonnage, though the phenomenon of "higher operating loadage with lower registered tonnage" has been ubiquitous, reflected by the indices of overloading characteristics above-mentioned, and has caused a mass of taxes losing to highway management divisions.

4.3 Vehicle Inspection

On schedule, two over-limit inspecting stations superintended by APCD located in Yangxiaodian and Caoan have been put into use in 2003 and more inspecting stations will be established in the near future. But owning to understaffing and unreliability of weighting equipment, the inspection can't be kept in operation all day long effectively. Further more, equity, impartiality and publicity can't be ensured due to low maneuverable policies in course of truck heading off, penalty, vehicle unloading, etc. With more and more overloading vehicles choosing to detour the inspecting stations, drive during the night or other off-inspecting time, plug up the highway lanes purposely and even rush to get across, the abnormality of truck traffic badly deteriorate the circumstance of highway transportation and commodity circulation synchronously.

Besides the tipstaff of transportation management division, a mass of small-scale mobile inspecting groups dispatched by the police have actively executed on highways frequently to engage the vehicles overloading enforcement via mobile WIM equipment or even with eye-measurement. Without effectually surveillance, these enforcement actions were converted to profitable means egocentrically sometimes instead of overloading preventing measures.

5. CONCLUSIONS

Some of the important conclusions of the analysis and estimation presented in the study are:

- Vehicle overloading is very universal and serious in Anhui at the present time. The operating loadage of almost all of the highway trucks exceed their registered tonnage except that some speed freight trucks and the axle weights of broad trucks have a large proportion of over-limit to the similar extent.
- The traffic loads calculated by recently surveyed data have far exceeded the designed bearing capacity of highway structures and have caused prevalent premature pavement damage, especially for rigid pavement.
- Due to the absence of effective highway management strategies and monitoring technologies, the enforcement or regulations about truck payload and axle weight can't be put into practice actually and trucks overloading behavior can't be under control.
- Dynamic coherence of overloading management policy need to be taken into account based on comprehensive overloading investigations, and more effective monitoring methods or technologies should be brought forward.

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