TRUCK WEIGHT SHIFTING METHODOLOGY FOR PREDICTING HIGHWAY LOADS

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One important element in the assessment of impacts due to change in legal truck weight limits is the prediction of the shifting of future truck weight distribution as affected by the change. A number of methodologies have been developed for this purpose. However, with the availability of more recent truck weight data, most of the methodologies have been proven inadequate. A new methodology, known as the average GVW factor methodology, was developed. Both the development and the application of this methodology are discussed explicitly in Report 241-5.

The shifting methodology can be applied either automatically by computer software or manually with the aid of pocket calculators. For the former case, a series of computer programs was developed for immediate application. The shifting methodology, in general, can be divided into two phases: one phase to predict the average weight for the truck type under the proposed weight limits and another to shift a typical truck weight distribution curve to a new position so that the mean of the shifted curve is compatible with the average truck weight obtained in the first phase.

In predicting the average truck weight, a regression model can be constructed using the historical data and estimation can be performed thereafter. However, for a prediction of average truck weight affected by changes in legal weight limits, the expected value obtained from the regression model may be purely an estimate.

Based on extensive analyses of historical data and their relationship to past changes in legal weight limits, a ratio was found to remain quite stable regardless of the weight limits. The ratio is defined as the average GVW factor. It is the ratio between the current average GVW and the maximum practical GVW. An average GVW factor for each type of truck can be found. Once the maximum practical GVW is derived from the proposed weight limits, it is possible to find the expected average vehicle weight for the truck type. By applying this expected value to the proposed shifting methodology, it may be possible to precisely predict the weight distribution for each truck type.

Another significance of the finding is the relationship discovered between the steering axle, tandem axle, and GVW distributions. For two representative types of trucks, 3A and 3-S2, it was found that the relationship of the three weight distribution types can be represented by the axle configurations. In other words, the tandem axle weight distributions for 3A can be constructed by the algebraic subtraction of the single (steering) axle weight distribution from the GVW distribution at the specific percent intervals. It was observed that the steering axle weight distributions for most of the truck types did not undergo significant changes in the past years. Based on these findings, it becomes possible to predict tandem axle weight distribution patterns for vehicles such as 3A and 3S-2. One may obtain a precise GVW distribution curve for either 3A or 3-S2 from the average GVW factor and the proposed shifting methodology. Then, by algebraic subtraction, one may obtain a precise tandem axle distribution for the truck type.

Although the methodology was developed by analyzing Texas data only, the priniciples behind the methodology can be applied to other states. Compared to other methodologies, the proposed one required analysis of more historical data and is more time-consuming. However, with available computer software, this shortcoming can easily be overcome.

While developing the shifting methodology, several new concepts were introduced to facilitate more precise predictions.

(1) Extensive use of historical truck weight data in projecting future weight distribution — All available truck weight data in Texas were used in the analysis. Several computer programs were written to facilitate the analysis and statistical modeling. In the prediction of future truck weight distribution, two sets of the latest available weight distribution data were used. This practice can accurately capture the latest weight distribution trends in the forecast of future trends.

(2) Extensive use of statistical methods in ana-

lyzing historical data — Statistical methods such as using mean and variance to predict a normal distribution curve are the main theme of the shifting methodology. Statistical test methods, such as the chi-squared method and student t-tests, are used extensively in the procedure. Computer statistical packages such as SPSS and MINITAB were used in sorting and analysis of data.

(3) Computer application in conducting the shifting procedure — Due to the large amount of historical data and a large number of required input parameters, computer application became a necessity in performing the shifting procedure. Computer programming has facilitated the procedure by integrating analysis, statistical testing, regression modeling, and forecasting into one single package. It thus reduces the time required in step-by-step manual shifting procedures.

(4) Concept of using a mean and a variance to predict future distribution — Both the means and variances for the weight distribution curves usually suggest specific trends over a period of time. These trends can be represented by regression models. By using these models, one may predict the two parameters for future truck weight distributions. With the suggested shifting procedure, one may obtain a future weight distribution curve with desirable precision.

(5) Concept of using an average GVW factor for projection of average GVW under proposed limit — The average GVW factor is used to relate a known parameter to an unknown parameter, such as the future maximum GVW to the future average GVW. From the proposed truck weight limits, one may derive the future maximum practical GVW for a certain type of truck. By multiplying the future maximum practical GVW with a given average GVW factor, one may obtain an average

GVW for the truck type under the proposed weight limits. Once the future average GVW is obtained, one may project a future truck weight distribution by using the suggested shifting methodology.

Recommendations

Although the main data structure concentrated on the Texas Interstate highway system, the shifting procedure can be used for other types of highway systems, and is applicable to other states. If facilities such as computer hardware and FORTRAN language compilers are available, the AGVWF shifting methodology is recommended.