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REVIEW OF PAVEMENT CAPACITY STUDIES FOR THE MINDEN-TAHOE AIRPORT

January 15, 2008

Mr. Doug. Johnson
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P.O. Box 218
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RE: Capacity of the Minden – Tahoe Airport

Mr. Johnson:

As requested, I have reviewed the various engineering documents prepared between 2000 and 2005 pertaining to the condition and structural capacity of the flexible pavement at the Minden – Tahoe Airport. The details of my findings are contained in the body of my report behind the Executive Summary. A short list of recommended actions regarding pavement use and maintenance has been added at the end of my report.

EXECUTIVE SUMMARY

An Engineer's Design Report was prepared by Shutt Moen Associates in April 2000 in compliance with a FAA AIP-09 Grant for the Rehabilitation and Re-construction of Taxiway Alpha. As part of the design, 8 borings were drilled and sampled along the taxiway alignment by Kleinfelder.

Based upon the geotechnical study, the section of pavement between 30+00 and 50+00 was reconstructed, and the remainder of the 6000 foot taxiway was rehabilitated by recycling, in-place, the existing 3 inches of Asphalt Concrete (AC) and the addition of a 2 inch AC overlay. The reconstructed pavement was to consist of 4 inches of AC on 6 inches of recycled base and 6 inches of cement treated native soil. However, the subbase section was increased to 12 inches because the designers assumed "construction traffic will place the most stress on subgrade."

According to the design form contained in the report (AA Form 5100-1) the basis for design was a 30,000 pound, single wheel type aircraft.

In November 2000, a Pavement Condition Survey and Evaluation Report was prepared for the Minden-Tahoe Airport by Eckrose and Green and Associates, Inc. In that report

the majority of the pavement of the principal Taxiway Alpha, was found to be significantly below the threshold PCI value (Pavement Condition Index). This study confirmed the need to upgrade the taxiway pavement.

In April 2004, Mr. Moen prepared a second Engineering Design Report, this one for the renovation of Runway 16-34. This recommended work consisted of recycling the upper 4 inches of asphalt concrete and topping the reworked surface with a 2.5-inch Asphalt Concrete overlay. No cores or measurements of the existing runway pavement were obtained in preparation of that report. The design criterion for the runway renovation was a dual wheel loading of 50,000 lbs.

The first of the two Pavement Capacity Studies reviewed was undertaken in November 2002 and the second in September 2005. The reason for undertaking these two studies is unclear. According to the two design reports from Mr. Lee Moen, the original pavement designs and renovations of Taxiway Alpha and Runway 16-34 were designed for wheel loadings much lower than was considered in the two Capacity Studies. The pavement cores obtained as part of both the Design and Capacity Studies indicate the pavements of Taxiway Alpha and Runway 16-34 are as prescribed by the FAA design charts (and computer programs) for the 50,000 pound dual wheel aircraft.

Where did the list of expected larger aircraft come from? Some details of the design in both of the Moen reports are curious, but the designed pavement sections are in essential compliance with the FAA Design Charts. The one exception is the section of pavement between Sta. 30+00 and Sta. 50+00 on Taxiway Alpha where the re-constructed pavement is 6 inches deeper than necessary for the design load. The explanation was the need to support construction traffic.

CONCLUSIONS

The two engineering design reports are in essential compliance with design procedures of the FAA. However, the two Pavement Capacity Studies are so badly flawed as to be useless. The investigators apparently do not understand statistical analysis, had little understanding of pavement design and construction, did not follow good engineering practice, and have misused the pavement computer programs provided by the FAA. In brief, the flaws are as follows:

1. There are insufficient data points.
2. The recorded data were not correlated with measured pavement sections.
3. No calibration data for the testing equipment was attached.
4. The back-calculated values of component moduli are not reasonable.
5. The ISM data was not used to segregate regions of the studied "Features."
6. All three of the back-calculated moduli at each test point was included in the data "population," rather than a single representative value.
7. The Arithmetic Mean was used as a central value for each "Feature."

8. No allowance or consideration was given to reduced pavement strengths in the hot summer (reduced AC strength) or times when the frozen subgrade is thawing or the ground water table is high.

The three most critical mistakes listed in the above tabulation are Items 2, 4 & 7. Item 2. The assumed pavement sections used in the back-calculation of the component moduli are grossly different from the recovered field cores. This mistake would nullify the computed values, even if the back-calculated values were reasonable. None of the observed variation in the pavement sections along the Feature alignment was considered. Both studies assumed a uniform and consistent section for each feature analyzed.

Item 4. The array of back-calculated data is so extreme as to defy credibility. Examples are presented in the body of my report. With such extremes ranges, no single central value can be used to represent the population.

Item 7, choosing to represent the feature modulus and therefore the pavement capacity as the Arithmetic Mean of the collected data is the final flaw! Because of the skewed frequency distribution and extreme range within the data sets, 60 percent, not 50 percent, of the test values fall below the reported design capacity as represented by the Arithmetic Mean. While the collected computed data are highly suspect and the wrong methodology has been used in data analysis, the use of an 85th percentile of the study values, as prescribed by the FAA, rather than the “Average Value” would have lead the authors to a completely different conclusion. Their analysis would then have indicated that much of the Airport pavements would be over-stressed with any wheel loading greater than the 50,000 lb. for which the pavement was originally designed. If the 85th percentile value had been used to represent pavement capacity instead of the Arithmetic mean, only 16 percent of the test values would fall below the design moduli.

There are other incorrect statements in the reports, which I have not addressed.

DETAIL REVIEW OF THE PAVEMENT CAPACITY REPORTS (2000, 2002 & 2005)

INTRODUCTION

Before reviewing my critique of the pavement studies, the reader should understand some basic parameters about the design, construction and expected performance of flexible pavements, as well as the relative stresses that are carried by Airport pavements. Because the Capacity Studies are based upon Non-Destructive Testing (NDT), I also have included a brief review of the purpose and use of indirect testing methods.

ASPHALT CONCRETE PAVEMENTS (Flexible pavements)

Asphalt Concrete Pavements are made up of layers of mineral aggregates with a top course of asphaltic stabilized rock. The strength (modulus) of the various layers should decrease progressively from the highest value for the top course to the lowest value for the subbase, which is placed directly on a conditioned subgrade (soil). The various layers

within the pavement can also consists of aggregates that are stabilized with either lime or Portland Cement, but the strength of each layer should be greater than the layer below.

DESIGN

Pavement design is an empirical procedure. The four parameters that enter into the design process are: Subgrade strength; Type of Loading (wheel loads and tire pressure); Expected Frequency of design load application; and Design Life. A number of graphical and computer programs have been developed to assist the engineer with pavement design. These design aids may give the illusion of scientific and / or mathematical precision, but such is not the case. These programs are based upon historical experience collected by the reviewing agency. All such programs must be used with sound engineering judgment and understanding of the properties of the materials that will be used to construct the pavement being designed or studied, as well as the limits of the illusory precision that may be obtained by using these design tools.

The weakest part of the design process is the probable variation of subgrade strength, and especially so if the pavement is to cover a large area. The strength (modulus) of the pavement components should be consistent throughout the project. However, the engineer must consider how the in-place pavement materials will vary because of climatic conditions, (hot summers and cold winters), annual variation of the water table and changes in the engineering properties of the materials due to aging and fatigue.

CONSTRUCTION

Project specifications written by the designer as well as the testing and field observations conducted during pavement construction, as required by reviewing agencies, insure that flexible pavements are constructed to high standards. Materials are supplied from a single source and meet stringent requirements for uniformity and quality (gradation, durability, abrasion resistance, angularity, etc.). During pavement construction the various components are compacted to a specified density. Areas with failing tests are reworked and re-tested. The final result is a pavement of exceptional uniformity. The only significant variables should be the strength of the soil subgrade along the pavement alignment and minor variations in the thickness of the pavement components as allowed by conventional construction tolerances. Typical specifications allow for a 0.1-foot variation in grade for each layer, including the original subgrade and the final pavement surface.

RELATIVE LOADING OF AIRPORT PAVEMENTS

The most highly stressed segments of airport pavements are the apron areas upon which the airplanes are staged while being loaded and waiting to begin taxing. Static loads, and especially heavy loaded wheel groups with high tire pressures, can cause permanent (non-elastic) deformations in Asphalt Concrete pavements.

The next most severely loaded pavement segments are the taxiways. The slow movement of aircraft prevents the transfer of any loads to the wings, and because of the restrictive width of typical taxiways, traffic is more channelized than on runways. The term used by the FAA is a “narrow wander pattern.”

Except for the ends of a runway, where the aircraft will be moving slowly, the greater part of the runway pavement will be the most lightly loaded area within an Airport. As the aircraft gains speed, the load is shifted from the wheels onto the wings (100 % on the wheels at the start of a takeoff roll to 0% at liftoff).

Because of the different loading and wander pattern within an Airport, the structural capacity of an Airport almost always will be governed by the strength of the major aprons and principal taxiways,

NON-DISTRUCTIVE TESTING (NDT)

As discussed above, pavement design involves more than just the consideration of the immediate transfer of surface loads (wheel loads) through the pavement to the existing subgrade. It must also consider the fatigue stresses that are developed within the pavement by repeated loadings, the effect that aging and environmental conditions (cracking and the loss of volatiles) has upon the paving materials, and the annual thermal and freezing stresses that are generated within the pavement and subgrade.

Flexible pavements do not become stronger with time, they deteriorate. In order to prepare a maintenance plan and to budget for major repairs and /or replacement as the pavement transitions along its predicted useful life, the responsible agency or owner of the pavement should know how the pavement is performing. The most cost-effective way to measure (estimate) pavement performance and its deterioration with the passing of time is to use some type of indirect measurements (NDT studies). Such studies are relatively inexpensive and can be accomplished with a minimum disruption to aircraft use of the tested pavement.

The use of indirect measurements of pavement properties requires both correlations of the measured values with some direct measurements of the pavement and subgrade properties, and the use of sound engineering experience and judgement. The principal advantage of indirect testing, besides the savings in cost and time, is the ability to divide the pavement into discrete sections based upon similar NDT measurements. In neither of the two Capacity Studies were the collected data used to define areas or sections within the Airport Features that have similar elastic response to the test loads.

The FAA has prepared an in-depth guideline for the use of NDT studies of Airport Pavements, Advisory Circular 150/5370-11A. During my professional career I can't remember a single NDT study undertaken to establish that an existing pavement had a supporting capacity that was greater than that for which it was designed.

PAVEMENT CAPACITY STUDIES

The 2000 study consisted of a visual evaluation of the airport pavements in which areas (Features) were assigned an index number equating pavement condition (amount of deterioration) with its original “as-constructed” condition. A new pavement is assigned an index of 100. As the pavement ages and becomes weaker the index decreases. The Pavement Index Number (PCI) assigned to various areas of the Airport is based upon the type and amount of cracking observed by the evaluators.

I have no way to check or evaluate the 2000 study, but considering the age of the pavement at the time of the study and reported aircraft traffic, the assigned PCI values seem reasonable. A crack map or site plan locating the more seriously distressed pavement surfaces should have been prepared and included in the report, but was not.

The two Pavement Capacity Studies undertaken by the same firm in 2002 and 2005 are seriously flawed (firm name change for the 2005 report). The reports are incomplete and reach incorrect conclusions regarding the capacity of the Airport pavement. The engineers preparing these studies did not follow the guidelines, methodology or procedures outlined in the FAA manuals or that conform to sound engineering practice. They did not properly use, analyze or characterize the collected field data.

Both reports are voluminous, contain a large amount of tabulated field test and computed data, and use technical jargon. The conclusions reached by the investigators might seem reasonable to a non-engineering reader.

DATA COLLECTION

The first discrepancy that I noted in the reports was the selection of spacing and location of data collection points. When the objective of a non-destructive testing program (NDT) is to estimate the remaining supporting capacity of an aging pavement, the undertaking is classified as a PROJECT LEVEL STUDY. The FAA prescribes the spacing of test points and the offsets of the test lines at a much closer interval than was used in either the 2002 or 2005 reports. For example, the center two test lines should have been spaced along the runway or taxiway at an interval of 100 feet. Spacing of the near center test points for Taxiway Alpha in the 2002 study was at 400 ft intervals, and spacing for Runway 16/34 in the 2005 study was at 200 ft intervals. By increasing the spacing of test points to a distance greater than specified, an insufficient amount of field data were collected and therefore the two studies do not comply with the FAA guidelines.

My second observation was the absence of either calibration or correlation data in the reports. Two very important elements of any NDT study are the calibration of the testing equipment and the correlation of the collected data with actual on-site conditions. Six cores were obtained for the 2005 study of Runway 16/34, but no test sites were located at the points where the cores were taken. Three of the 6 cores indicated the thickness of the pavement was less than assumed in the analysis. In one core, the base thickness was short by 4 inches. Certainly, the structural capacity of this section of the pavement, if the

one thin pavement core is representative of that area of the runway, cannot be represented by some of the extremely high back-calculated moduli of the study.

Not a single core was obtained along the principal Taxiway Alpha as part of the 2002 study, nor was the boring data collected by Kleinfelder in 2000 used. Taxiway Alpha was renovated in 2000 by overlaying the end sections that had a reasonable thickness of base and by re-constructing a central region where there was no base. The base under those areas that were only over-laid consists of a cement treated aggregate, which varies from 4 to 9 inches in thickness. The re-constructed section consists of 4 inches of AC, 6 inches of recycled base and 12 inches of soil cement. Based upon the 2000 Design Report by Mead Hunt, the pavement section of Taxiway Alpha is quite variable. Yet the Taxiway pavement section assumed in the 2002 study is uniform across the entire length and assumed to be comprised of 4 inches of AC on 10 inches of Aggregate Base.

Was the testing equipment frequently calibrated as required by good practice, and if so, why was the calibration data not appended to the two reports? Without direct correlation of the collected and back-calculated moduli with the measured thickness and strength of the pavement components, the magnitude of the computed moduli are not valid.

The design of Flexible Pavements per the FAA guidelines is based upon the strength of the subgrade and yet not one CBR test result was collected for the two studies. I have read of references to numerous CBR tests, but have seen no actual test results except for three that I obtained from Geocon. The tested CBR values reported by Mr. Moen range from 2 to 5, which agrees with the three results that I obtained from Geocon. These are very low values. There are no references in either of the two studies to the low strength of the native subgrade. On the contrary, the back calculated moduli of the subgrade are postulated as being quite high.

The computer program that was used to back-calculate the pavement moduli is very sensitive to the depth and strength of the "Hard Layer" located at some depth below subgrade surface, and yet not one boring was drilled by the investigators to determine this vital information. A few of the cores should have been obtained at borings that were deep enough to define the depth and composition of the deep soil zone underlying the subgrade, and to collect samples for laboratory testing. Some of the 2000 Kleinfelder borings were extended to a depth of 6 feet, but data from these borings were not considered.

DATA ANALYSIS

I have scanned all of the tabulated data in the two Pavement Capacity Reports, but my detailed review has been limited to two Features on the Airport: a portion of Runway 16/34 (Feature 6105) and a portion of Taxiway Alpha (Feature 105). A cursory review of the collected data for the other Airport Features in both studies suggests that my observations and comments are also valid for the remainder of the collected data.

As prescribed by FAA guidelines, each test point was impacted with three progressive loads. While many of the test points behaved with an expected elastic response (surface compression), a great number did not. There is no explanation in the studies for these many anomalies. Does a non-linear increase in the measured pavement deflection with an increasing load suggest the existence of voids, or a disconnection between pavement layers? Does an inverted deflection response to an increased test load suggest the subgrade soil is load sensitive? Or is the explanation simply inaccurate test data?

Back-calculation of material properties (elastic modulus) requires engineering judgement. The FAA Advisory Circular 150/5370-11A contains a lengthy discourse on the process (pages 24 through 31) and discusses the 14 major factors that can influence the computed value. To quote the Circular *“It is important to understand that a unique solution is not obtained during a back-calculation process. Rather, one of many feasible solutions is obtained based on the set of constraints that exist or have been defined in the back-calculation setup.”*

Apparently the investigators assumed their computed values were unique, accepting the computed result as absolute. Many of the back-calculated moduli at the same test point for the AC surface vary by more than 100,000 psi, and at several test points by more than 400,000 psi . I found one test point where the computed modulus varied from a low of 500,000 psi to a high of 900,000 psi, or a difference of 400,000 (a change of 80 %) at the same test point. The computed moduli for the pavement base layer also are extremely variable and suspect. For example: At station 5400, line “A” on Feature 6105, the computed strength of the granular base is only 14,000 psi as compared to the AC strength of 800,000 psi and a subgrade modulus of 15,500 psi. This extremely lopsided distribution of pavement strength is not credible. One further example: At a number of locations for other Features the computed modulus for the AC was the default maximum 2,000,000 psi. How can a 20-year-old pavement with an original AC surface so badly checked and cracked that it required in-place reworking and an application of a 2-1/2 inch overlay have such a high modulus? One wonders how high a modulus would have been calculated and accepted by the investigators if the computer program not had a default limit.

Another example of questionable back-calculated values occurs at stations 300 and 700 on Taxiway Alpha. At both stations the computed subgrade modulus is 30 percent larger than the Aggregate Base. How could this be? The first principal of pavement design is violated. The modulus of a layer must be higher than the layer below.. The base modulus should be at least 100,000 psi. and the value for the subgrade lower then computed by at least 10,000 psi.

Good practice requires the determination of a representative value for the ISM (Impulse Stiffness Modulus) for each test point, the sectioning of each Feature (runway, taxiway or apron) based upon the developed modulus and then the assignment of a representative modulus value for each section. The ideal is to have relatively consistent values (a limited range) across the assigned Feature segment. A reasonable central value can then be assigned for each section and the modulus of pavement components then back

calculated. With a proper correlation of the computed values with measured pavement geometry and strength, the Arithmetic Mean, Standard Deviation, Coefficient of Variation and 85th percentile value of the pavement moduli for each section of the Feature should be reasonable values, and therefore useful in estimating pavement capacity. As I stated earlier, this sectioning of the pavement based upon dynamic testing was not attempted for any of the tested Airport Features.

DETERMINATION OF PAVEMENT CAPACITY

Before discussing the back-calculated values obtained in the studies for pavement moduli, the reader should know the theoretical range of an AC modulus. It can vary from a low of 70,000 psi to a maximum of 2,000,000 psi, but typically an AC layer will have a tested value ranging from 100,000 to 300,000 psi. The FAA's default modulus for the design of new pavement is 200,000 psi., which is based upon historical testing of flexible pavements. Any tested values much higher than 500,000 should be suspect, or at least questioned by the technician or engineer performing the back-calculation.

Not only did the authors of the two studies not divide the Features into discrete sections, they used each of the three load tests at each point as an individual test. Pavement moduli for each test was back calculated and analyzed as one relatively large population. Without regard to the excessive range between both the measured ISM and back-calculated moduli at the individual test points, the data were analyzed as a population three times larger than actual test points. If the analysis had been properly conducted, the study would have been based upon a population only 1/3 as large as was actually used. The total number of computed moduli (three at each test point) was represented by a central value (Arithmetic Mean) and a computed Standard Deviation. For example the range of the AC modulus for 6105 (Runway 16/34) was from 1,380,000 psi to 480,000 psi., a difference of 900,000 psi. The AC modulus range for 105 (Taxiway Alpha) was from 646,000 psi to 153,000 psi., a difference of 493,000 psi. These ranges are much too large to represent the array by a meaningful single central value.

Even if the ISM and back-calculated data had been used to divide the Features into pavement areas with relatively consistent physical properties, the use of the arithmetic mean is wrong. Assuming a normal distribution of test results, the use of the "average test value" for assignment of pavement capacity would mean that 50 % of the pavement (represented by the lower computed values) would not carry the assigned load. The actual situation is much worse. Because of the extremely high computed values included in the array, the distribution curve is skewed to the right side of the frequency distribution curve, resulting in the Arithmetic Mean being higher than the Medium value. The central value used in both reports to represent pavement strength and therefore capacity, represents only the stronger 40 % of the tested feature. About sixty percent (60 %) of the back-calculated values are less than the value used to represent pavement capacity. In other words, even using the unreasonably high computed moduli, 60 % of the tested pavement would be over-stressed if the heavier wheel loadings considered in the Capacity Reports are applied to the Feature.

The proper value that should be used to gage pavement capacity (assuming the array of collected data is reasonably consistent) is one Standard Deviation less than the Mean, as prescribed by the FAA. Using this criterion, only about 16 % of the pavement would have strength values less than the Standard, and with a normal frequency distribution, these lower values would be close to the established Standard.

One last comment on pavement capacity. When one considers the pavement capacity of the Airport, the results of the runway tests (2005 study) should have been compared with those of the taxiway (2002 study). The 2005 study of Feature 6110 uses the value of 766,163 psi for the representative modulus of the AC surface, 51,854 psi for the Base, and 10,213 psi for subgrade. The 2002 report uses a modulus of 227,607 psi for the taxiway AC surface, 33,777 psi for the Base, and 15,165 for subgrade. How can the investigators conducting the 2005 study classify the structural capacity of the Airport on the basis of their evaluation of the Runway, when the taxiway moduli are so much less?

CONCLUSION

The two Pavement Capacity Studies are badly flawed. The investigators do not understand statistical analysis, have little understanding of pavement design and/or construction, have not followed good engineering practice, and have misused the FAA's pavement computer programs. In both reports the authors speak of reduced pavement strength during a typical year. Yet no consideration or downward adjustment was made in their capacity analysis to accommodate such seasonal reduction in pavement strength.

In addition to the questionable back calculation of moduli and the mishandling of data as I have discussed, the authors of the two reports failed to comply with two critical FAA directives. The following quotations are from the FAA Advisory Circular 150/5320-6D Airport Pavement Design and Evaluation. The first quotation is from Chapter 6, paragraph 602. *"Evaluation of flexible pavements requires, as a minimum, the determination of the thickness of the component layers and the CBR of the subgrade."* As I have pointed out in the body of my report, neither of these two requirements were met. The second quotation is from Chapter 7, paragraph 702. This chapter discusses the use of the Layered Elastic Pavement Design computer program and explains that its primary use is for the design of pavements that are expected to support heavy aircraft with Triple Dual Tandem main gear. It is a useful tool, but the second last sentence in the paragraph reads as follows: *"Pavement designs for traffic mixes that do not include aircraft with TDT main gear must conform to the minimum pavement sections defined in Chapters 3 and 4."* These two referenced Chapters use the basic graphical charts for pavement design.

Using the pavement design criteria defined in these two chapters and the measured sections of the thinner pavements in Taxiway Alpha and Runway 16/34, the design aircraft is a 50,000 pound airplane with dual wheels. Conclusions contained in the two reports regarding an increase in the Airport pavement capacity are based upon faulty analysis and are incorrect.. Use of the Airport by aircraft heavier than the designed

50,000 lb. dual wheel, or 30,000 lb single wheel loading will most probably result in excessive pavement distress and a much shortened design life.

The 85th percentile value of the collected ISM data for Features 105 & 125 (Taxiway Alpha), is about 200,000 psi for the AC surface, 25,000 psi for the Base and 12,000 psi for the subgrade. While I seriously question the validity of the studies and the back-calculated moduli, I evaluated the capacity of the Taxiway using this data. Besides the major discrepancy between the assumed and measured pavement sections, the base course modulus should be higher and the subgrade modulus lower. However, putting all of this aside and using the study data for the 85th percentile value to represent the taxiway pavement in the LEDFAA computer program, we still reach a conclusion that is markedly different from that of the two studies. Using the overstated moduli, and the 85th percentile values of those moduli to estimate pavement capacity, the Airport can not support the heavy aircraft tabulated in the two Capacity Reports. This same data suggest the Airport pavement should be able to support the 50,000 and 30,000 lb. design aircraft with a modest increase in the assumed number of annual departures, but not heavier wheel loadings.

If the subgrade modulus drops from the study value of 12,000 psi to a more realistic value of 6,000 psi, the pavement with design loads will be slightly overstressed. To carry the design loads the subgrade of the taxiway section must have a modulus of at least 7,500 psi. This is 1500 psi greater than the average 6000 psi CBR strengths that have been measured on the Airport. If the 6000 psi. value is in fact the more realistic representative modulus for the Airport subgrade, the design 50,000 dual wheel load will theoretically result in a slight overstress of some sections of Taxiway Alpha.

There are times during the year when pavement strength is so reduced that even the design aircraft with their heavy wheel loading and high tire pressures will overstress the existing pavements and thereby either increase required maintenance or foreshorten the useful life of these pavements. During the hottest part of the summer, when the AC surface is softened due to heat, and during the spring thaw or time of high ground water levels when subgrade strength is reduced, the supporting capacity of the Airport pavements will be lower than its maximum value..

As I have noted elsewhere, except for surface wear and abrasion, lightly loaded General Aviation airplanes will not subject the Airport Pavement to undue stresses during times of reduced subgrade strength.

RECOMMENDATIONS

1. Lacking any data to substantiate the capability of the Airport Pavement to carry wheel loads above the Design Aircraft without significant pavement distress and greatly shortened useful life, the present Aircraft weight limits should be maintained.
2. If the heavier fire bombers are to use Runway 16/34, limiting them to their taxiway and having them depart south on Runway 16, consistent with wind conditions, will

limit pavement distress. The north end of runway 16 appears to be one of the strongest pavement sections of the Airport. Separating air traffic using both runway 30 and 34 at the same time the bombers are using Runway 16 should be feasible with a temporary control tower in operation during fire bomber operations. Fully loaded bombers should be discouraged from using Taxiway Alpha.

3. The Airport flexible pavement will continue to decline in strength with time. In order to develop budgets for maintenance and repair, pavement performance should be measured with a new NDT study conducted within the next five years. However, the next study must be undertaken by a qualified local engineering firm and the study receive peer review throughout the testing and analysis phases of work.
4. The critical pavement areas are the taxiways. Annual inspection and records of performance (cracking) should be made and recorded. In addition, I suggest the installation of two deep borings to measure soil parameters and install permanent piezometers. The piezometers will be used to measure seasonal fluctuation in the local water table. These special borings should be at least 25 feet deep and installed as soon as practical. Readings should be made monthly except during the winter and spring months when the water table elevation may change rapidly. The recording interval can be adjusted to intervals consistent with fluctuations of the water table.
5. Historical engineering data pertaining to the Airport should be collected and plotted on an Airport layout plan. The engineers designing the next pavement renovation or replacement, as well as those conducting the next NDT study should have all relevant information.
6. A site specific Air Freezing Index should be developed for the Airport as prescribed by the FAA. It is a relatively simple task requiring a review of historical weather records for the past 30 years and the compilation of the number of degree days the air temperature falls below 32 degrees. Pavement designers in the past have assumed the 500 degree days default value contained in the computer program F805FAA.XLS I suspect that a more appropriate value for the Airport will range between 800 and 1000 degree days

Respectively submitted,

Wayne E. Ferree
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