❖ Questions on Design Inputs

1. ***How do I measure slab-base friction?***
   - By performing a push-off test (see question 2).

2. ***What is a push-off test?***
   - A push-off test is a procedure to measure the friction, bearing, adhesion, and bonding conditions at the slab-subbase interface. This test consists of casting a slab with an approximate thickness of the projected pavement on top of the same subbase type. A range of slab sizes have been used in the past, but we have generally used a 3 x 5' slab. A horizontal force is applied on one side of the slab with a hydraulic jack and a load cell is used to measure the applied load. Dial gages are installed at the opposite side to measure the slab movement. The friction force per unit area is determined from the applied force divided by the area of the test slab. The testing history of friction force and slab movement during the push off procedure is recorded and the friction force at free sliding is evaluated.

3. ***What value of strength do I use - the spec value?***
   - HIPERPAV requires the mean values of strength and modulus of elasticity. The 28-day laboratory measured values should be input in HIPERPAV. Construction specification values should not be used here since they are often much lower than mean values at 28 days. ASTM specifications C31 or C192 should be used in defining the curing conditions for the 28-day strength and modulus values required by HIPERPAV.

4. ***What if I have only flexural or compressive strength?***
   - Many correlations for estimating the tensile strength from flexural or compressive strength are available and may be used with caution in HIPERPAV. A good correlation from a number of studies is that the tensile strength may be predicted by taking 72% of the flexural strength. Also, tensile strength (f_t) can be obtained from compressive strength (f_c) with the following relationship: $f_t = 0.72 * 2.3*(f_c)^{2/3}$.
     Many engineers use the ACI Building Code Formula for predicting the tensile strength from the compressive strength, but it should not be used since it under predicts the flexural strength. However, given that the primary mode of failure during early-age behavior is tensile stress, consideration for implementation of tensile strength tests is highly desired since it would yield significantly more reliable results.

5. ***What if I don't have information on the modulus of elasticity?***
   - The sensitivity of the stress calculations due to the modulus of elasticity is relatively low as compared to most other variables for most concrete coarse aggregates used in the field. However, coarse aggregates such as lightweight, high calcium contents, or high silica contents may have significantly different values. If the modulus of elasticity used in HIPERPAV is higher than the actual modulus of elasticity of the concrete, the stresses calculated would be slightly higher than the actual stresses developing in the concrete, thus, a conservative high value of modulus of elasticity (I. e. 5,000,000 psi) may be used if a preliminary analysis is desired.

6. ***How is reliability considered?***
   - The stress and strength internally computed by the HIPERPAV system are mean values. Based on these mean values HIPERPAV uses a probabilistic approach to calculate a critical stress and critical strength as a function of the variability associated with the materials and construction procedures for a typical concrete placement as well as the reliability or level of risk selected.

As the selected reliability level increases, the critical stresses will be higher, and the critical strength will be lower.

7. Why is reliability an input for the user?

- A large reliability has higher associated construction costs due to the additional precautions that must be taken to minimize early-age damage. Therefore, reliability is an input for the user to give the option of the level of risk the user is willing to take based on the importance of the project and regional policies. Generally, the higher the risk, the higher the reliability the user should assign.

8. Why do I get an error when I enter a 24' slab width, and is the analysis output accurate?

- The analysis output is still accurate, but the software is telling you that the 24' is out of range of typical slab widths (after longitudinal sawcut). If you are simulating a slab 24' wide before longitudinal saw cut, we recommend running two scenarios. Run one with a 24' wide slab (dismiss the validation error). Then run a second scenario with the slab width after longitudinal sawcut (eg. slab width=12'). Evaluate your results looking at the corresponding chart depending on when your longitudinal sawcut occurs. For example, if your longitudinal sawcut occurs at 20 hours, and you want to evaluate stress-strength at 10 hours look at the first scenario. If you want to evaluate stress-strength results at 40 hours, look at the second scenario.

❖ Questions on Mix Design Inputs

9. Does the program check for mixture proportions?

- The current version does not verify the adequacy of the mixture proportioning. The user has to ensure that the mixture proportions entered will yield the design strength entered in the "Design Inputs". Future versions of HIPERPAV will most likely include a Mix Design Module for mix proportioning.

10. How are chemical admixtures accounted for since there are no inputs for dosage rates?

- Only moderate adjustments to the hydration of the cement are considered in HIPERPAV when chemical admixtures are selected. This adjustments are based on average dosage rates. Online help is provided for the use of admixtures in HIPERPAV which describes the primary effects that are considered when chemical admixtures are used. Future versions of HIPERPAV will better characterize the effect of chemical admixtures as ,pre accurate models become available.

11. Can differences in cement chemistry from the default cement types be modeled?

- Yes, HIPERPAV allows the user to enter a different chemistry in terms of the Bogue compounds by selecting the "Cement Chemical Composition Data" option within the "Mix Design Inputs" Module. In recent years, the chemistry of cements has changed to produce a more rapid strength gain for use in expediting construction.

12. Does the program consider cement grind (fineness)?

- Not in the current version, although there are plans for including this parameter in future versions. Suppliers have developed finer grind cements in recent years also for producing higher strengths at early ages.

13. Why is cement type IV not included in the default cement types?

- Type IV cement is not considered as a common cement type for paving applications, although it may be easily included in a future version if a potential demand for this cement type is observed.

14. Does the software consider blended cements like cement type IS?

- The current version of HIPERPAV considers the use of blended cement type IP only. It does not have an option for Type IS or other blended cements. A percent replacement of Fly Ash, Silica Fume, or Slag admixtures may be entered to approximate blended cements. As more information on the hydration of other cement types is available, it will be incorporated into HIPERPAV.

15. ***Could concrete heat of hydration information from adiabatic calorimetry tests be used as input for the software?***
    - Yes, but not in its current form – a more advanced user input screen may be incorporated in a future version of HIPERPAV.

16. ***Is air entrainment considered in HIPERPAV?***
    - Not in the current form, however, it may be added in a later version of HIPERPAV.

17. ***Can the program consider shrinkage-compensating cements?***
    - The models in HIPERPAV are applicable for any cement type, however, in its current form only cements type I, IP, II, III and V are considered. As more information is gathered on the properties and performance of other cement types they will be included in HIPERPAV.

❖ Questions on Environmental Inputs

18. ***Can the wind speed be varied over the 72 hour period?***
    - This is being considered as an improvement to the HIPERPAV software in the future.

19. ***Where should wind speed be measured?***
    - It is recommended to measure wind speed as close to the surface as possible. The height and location where wind speed is measured is important since it varies significantly depending on height from the pavement surface and proximity with obstacles to wind patterns. However, the weather information provided by local weather stations may be used with reasonable results. The user should recognize that the Weather Bureau generally measures the wind speed approximately 10 feet (or more) above the ground.

❖ Questions on Construction Inputs

20. ***What would be the best time of placement based on ambient temperature conditions, noting that early placement during the day might be a dangerous time for hot weather concreting?***
    - The answer depends on the specific value for all the inputs including cement type, thickness, base type, etc. HIPERPAV has the ability to integrate all these concepts for specific situations.

❖ Questions on the Analysis

21. ***Why is the program limited to 72 hours of analysis?***
    - It has been found from experience that most of the potential problems associated with early age behavior occur within the first two or three days after placement.

22. ***Why doesn't the stress drop when it shows that it cracks?***
    - The software in its current form does not actually model the distress development. Instead, it provides a warning for potential damage to the pavement structure. Due to the associated variability of materials and construction procedures, HIPERPAV indicates the chances of excessive stresses in the pavement. It does not necessarily indicate that a failure <u>will</u> occur.

23. ***Can HIPERPAV determine what the pattern of cracking would be for any given concrete age at saw cut?***
    - The current version of HIPERPAV predicts the potential for early-age cracking – it does not predict the optimum patterns or timing of saw cutting operations.

24. ***Is the strength value predicted by the program actually reached after the time of simulation, or does it vary with conditions?***
    - It varies according to the field conditions based on the inputs selected by the user.

25. Why did the predicted strength not change when I increased my Cement Content?

- HIPERPAV adjusts the strength gain curve based on the 28-day design strength provided by the user. If the mix design inputs are changed, the 28-day design strength determined from lab tests for the new mix has to be modified by the user as well.

26. Why don't the program results change significantly with different curing compound dosage rates (single, double, triple)?

- A small change is considered by HIPERPAV based on the heat loss estimated for single, double, or triple compounds. However, at the present time there is little information available on the effect of moisture loss as a function of curing compound application. HIPERPAV can be easily modified to account for such effects as soon as validated research results are available.

❖ Questions on Modeling

27. How does HIPERPAV consider the effect that air temperatures have on the development of strength?

- HIPERPAV uses maturity models (Arrhenius Method) to take into account the deviations in strength development from specimens cured at normal curing lab temperatures.

28. What reference is taken for the temperature differential considered in the model for computation of stresses?

- Temperature at final set is considered as the reference temperature since it is at set time when the concrete changes from a plastic to a hardened state and stresses start to develop.

29. At what point geometrically is the strength predicted by the program?

- The strength predicted is the average strength through the slab thickness.

30. Is bleed rate accounted for in HIPERPAV?

- Not in the current version, a more robust moisture model is being developed and may be added in a later version.

31. Before the joint sawing, what is the slab length considered by HIPERPAV in the analysis?

- Before joint sawing, HIPERPAV considers an infinite slab length to simulate the restraint conditions. If time at saw cutting is entered as zero, HIPERPAV will simulate the development of stresses for a slab with the length entered in the design inputs. In this form, it is assumed that joint sawing is performed at a time before excessive stresses develop (optimum time). On the other extreme, if it is desired to know what is the latest that joint sawing can be performed, the sawing time can be entered as 72 hrs and the moment at which stresses exceed the strength will indicate the latest time for joint sawing.

32. What is the maximum thickness that can be modeled?

- Since most of the models in HIPERPAV are of a mechanistic nature and the core of the program is a 2-D finite element model, the maximum thickness that can be modeled depends mainly on the limitations of the model. Currently, HIPERPAV has been validated for thicknesses of up to 12 inches and it is believed it would provide good results for thicker pavements although further validation may be needed if significantly thicker pavements are to be modeled.

❖ Questions on Software Interface

33. Is it possible to input mixed U.S. and Metric units?

- Yes, the software gives the flexibility to use any combination of both units systems.

34. Is there online help?

- There is limited online help for some of the more sensitive parameters such as cement chemistry, mineral and chemical admixtures, and curing methods. An improved online help system will be developed in the next HIPERPAV version.

❖ Questions on Availability

35. When will HIPERPAV be available?

- Now! Check the hiperpav.com website for details.

❖ General Questions

36. Why should I trust this software? It seems like a black-box?

- HIPERAV has undergone through an extensive validation of all its models during a recent validation consisting in the instrumentation of real construction pavements throughout the US to monitor the early age pavement behavior in terms of strength and stress development. During this validation effort, the software proved to provide reliable results for a range of design, environmental and construction conditions. In addition, a number of experts including academics and practitioners have reviewed the software for its validity.

37. Can HIPERPAV predict cracking of my bridge-decks?

- Some modification would be required for this purpose, but basically the core of HIPERPAV can be used in many other concrete applications such as bridge-decks.

38. Is aggregate shape or size considered?

- Currently none of the models in HIPERPAV requires the shape or size of the aggregates as an input, however, this may be considered in future versions.