Background

Currently over 71 million tons of pulverized coal combustion fly ash is produced annually in the United States, with only about 39% beneficially utilized (American Coal Ash Assoc. 2004). The remaining 61% that is not beneficially utilized represents an expensive solid waste burden to our society. The current single largest source of beneficial fly ash utilization is in the production of portland cement concrete and concrete products, both as a partial cement replacement and as a constituent in blended cements. Utilization in this category accounts for approximately half of the total fly ash utilization, increasing by approximately 12% between 2003 and 2004. Because of the large volume of concrete produced annually, this market represents a significant opportunity for increased beneficial utilization of fly ash.

Coal fly ash has been used in concrete since the 1930's, with the first published results detailing this use appearing in 1937 (Davis et al.). The current published literature on fly ash characterization and utilization is extensive and spans many disciplines, including civil engineering, ceramics, chemistry, materials science, and environmental engineering.

In reviewing the literature, it is clear that existing specifications and tests for fly ash are not adequately serving the transportation industry. In part, this is due to a misunderstanding regarding the purpose of specifications such as AASHTO M 295. This specification is not intended to be a specification to predict performance of a concrete system incorporating fly ash. Rather, it is intended to serve as a material specification to provide a means of quality control of fly ash as provided to the concrete producer. To address the areas of performance and durability, a new specification or changes to AASHTO M 295 are required that address these key issues with respect to fly ash utilization in concrete. The issues facing DOT's regarding fly ash utilization are numerous and within the scope of this project, only selected issues can be addressed in a meaningful manner.

Chemical Classification/Reactivity

- The chemical classification of fly ash based on the sum of the oxides does not adequately characterize the pozzolanic and hydraulic nature of fly ash.
- Related to hydraulic and pozzolanic reactivity, the current test for fineness falls short of providing the information needed to assess the effect of particle size on this important fly ash characteristic.
- The strength activity index has been widely reported to not adequately assess the pozzolanic reactivity of a fly ash.

Effect of Carbon on Air Entrainment

- The LOI test is good at determining the total carbon but does not adequately identify if the carbon will effect air entrainment. The foam index test is useful at determining the interaction of the fly ash with air entrainment admixtures but has not been standardized and is not part of AASHTO M 295 or ASTM C 311.

Prediction of ASR Mitigation

The existing ASTM C 311 ASR test does not provide adequate guidance for developing mixture designs, particularly for Class C fly ash.

Study Objective

The study objective "is to recommend potential improvements to specifications and test protocols to determine the acceptability of fly ash for use in highway concrete." This major objective will be accomplished through a series of tasks that will allow the team to base their recommended changes and improvements on firm scientific information. The specific objectives of these tasks can be summarized as follows:

- To make a thorough study of the existing specifications and classification schemes for fly ash and to recommend changes that provide highway agencies with better criteria for selection of fly ash for a given level of performance.
- To investigate new test methods for characterizing the reactivity of fly ash.
- To investigate new test methods for characterizing the properties of residual carbon in fly ash and to develop strategies that can be used on a day-to-day basis to ensure that air-entraining admixture dosage can be predicted for any given fly ash.
- To make a thorough evaluation of how fly ash can be used to mitigate alkali-silica reaction in concrete and to provide highway agencies with specific guidance on how to select fly ash type and dosage to reach a specified level of field performance.

Research Approach

The objectives of this research program will be met through the execution of eight tasks, grouped in two phases as shown in Table 1.

Table 1. Breakdown of tasks assigned to each Phase of the project.

Phase I	Phase II
Task 1 – Literature Review	Task 5 – Conduct Research Work Plan
Task 2 – Conduct Survey of Current Practices	Task 6 – Develop Recommendations for New Specifications and Tests
Task 3 – Refine Task 5 Work Plan	Task 7 – Document the potential applicability of the recommendations made in Task 6
Task 4 – Prepare and Submit Interim Report	Task 8 – Prepare and Submit Final Report