INTRODUCTION

Nebraska Department of Roads (NDOR) Material and Research (M&R) Division started an evaluation to determine injurious deleterious lightweight pieces aggregate from a dry pit location, as a result of field observations from a project stock pile. This brief summary presents the field observation and laboratory testing evaluations to determine the percent of lightweight pieces in aggregate.

FIELD OBSERVATION

While visiting a plant site, Materials & Research noticed the aggregate stockpile had large amounts of what appears to be lightweight aggregates (lightweight pieces) on Phase I of the project as shown in Figures 1 and 2. This was a concern due to the large quantities observed in the stockpile.

LABORATORY TESTING

The research in the laboratory was to compare three different test methods of lightweight pieces, as follows:

- **AASHTO T 113**
  - This test method used a high density liquid to separate light weight particles from coarse aggregate. The liquid solution is prepared so density is greater than the light weight particles, but less than the aggregate. When the aggregate sample is placed in the solution the lightweight pieces will float and the coarse aggregate will sink as shown in Figure 3. The floating particles can then be collected to evaluate the quantity as percent by volume.

- **NDOR Modified AASHTO T 504**
  - This test method is used to calculate the percent of clay lumps, shale or soft particles in aggregate samples; this test method is currently being used by the Department. The washed dried aggregate sample is separated into a series of particle size fractions. Each fraction is submerged in a saturated solution of sodium or magnesium sulfate for 16 hours. The fractions are then dried to constant weight. The calculations are based by the mass of the aggregate.

- **Visual Test**
  - This test method was used to identify lightweight pieces by visually selecting the lightweight pieces from the sample, as shown in Figure 4.

LABORATORY TESTING SUMMARY

This investigation compared three different test methods of measuring the percent composition of lightweight pieces in an aggregate sample. The three methods that were examined are Lightweight Pieces in Aggregate in accordance with AASHTO T 113, NDOR Visual Test, and Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate in accordance to Nebraska’s modified T 504. Figure 6 shows the stockpile with large amount of the lightweight pieces and Figure 7 demonstrates the producers change in operation which resulted in a cleaner aggregate.

- The comparison of the results between test methods showed that T 113 consistently had lower values than the Visual test and slightly greater values than NDR T 504. As expected, T113 was more consistent than the other two tests, as the test has less subjectivity.
- The deviation of the Visual Test was expected, as the test is highly subjective with results depending on technician’s visual examination.
- The deviations of NDR T 504 may be attributed to the absorptivity of the soft particles, which may vary depending on the type of soft particles that are found in the sample.
- It was found the percent of lightweight pieces by volume was higher than corresponding percent lightweight pieces by mass. These results correlated with the field observations. In fact, in order to test the samples by volume AASHTO T 113 was modified. The test procedure describing the modification by volume can be found on the Material and Research website as a Modified Nebraska (NDR) Standard Test Method of AASTHO T 113 Lightweight Pieces in Aggregate, as shown in Figure 8 and Figure 9.

SPECIFICATION OF AGGREGATE ACCEPTANCE CRITERIA

Since there was such a large amount of lightweight pieces found on one project and the Departments current specification did not touch on this matter, the Department changed the Nebraska Standard Specifications for aggregates in Section 1033, Paragraph 3.b (2) and (3), to address lightweight pieces in aggregates. Section 1033.02, Paragraph 3.b. (2) was replaced by the following:
(2) The percent of clay lumps, shale, or soft particles shall not exceed the following amounts:

| Clay Lumps | 0.5% |
| Shale | 1.0% |
| Soft Particles | 3.5% |
| Lightweight Pieces | 3.5% |
(3) Any combination of clay lumps, shale and soft particles (all percent by weight values) plus the lightweight pieces (a percent by volume value) shall not exceed 3.5%.

SUMMARY

Samples where collected from the field and evaluated from a project which started out with large amounts of lightweight pieces. The Department found the initial stockpile had an excess of 3.5% of lightweight pieces which impacted the performance of the concrete pavement in Phase I of the project. Therefore, the Department judged the coarse aggregate stockpile to be non-compliant due to injurious quantities of deleterious materials. After the supplier had made changes to the production of the coarse aggregate, the Department showed a reduction of the lightweight pieces to a level that the Department considered acceptable. The pavement construction continued as planned for the 2015 construction season. In an effort to determine a quantitative quality control method to evaluate the effectiveness of lightweight pieces and to develop quantitative acceptance criteria for the second phase of the project, the Department developed the NDR T 113 “Lightweight Pieces in Aggregate” test method and modified the specifications of the current aggregate acceptance criteria. The Department will continue the evaluation of the concrete placed during Phase I of the project which had high amounts of lightweight pieces and verify the long term performance of the pavement with Department’s new specification for aggregate acceptance criteria allowing the following as acceptable material. Clay Lumps 0.5%, Shale 1.0%, Soft Particles 3.5% and Lightweight Pieces 3.5% not exceeding accumulative value of 3.5% for quality testing of coarse aggregate. As well as, the quality of lightweight pieces in the fine aggregate not exceeding 3.5%.