Using Reclaimed Asphalt Pavement in Tabriz Runway

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***Abstract*—These instructions give you guidelines for The runway of TABRIZ required a fundamental reformation. For the change of runway from asphalt to concrete a great amount of chip was produced, and the reuse of these materials was studied under a research. In this research, the use of chip of asphalt with cement was studied which will be done by the WR device and the creation of a fixed and resistant layer. The resistance and penetrance of these materials are controlled. The CBR experiment was done for the layers of pavement which are built from basic materials and the materials for recycling the asphalt with different percentages. It is obvious that, this number is not constant for a specific kind of soil and it is dependent on the condition of consolidation and moisture of that soil.**

The penetration of the materials of chip of asphalt is pretty high and can be used as a layer in the condition of appropriate bearing and this action will be done by mixing new materials. Also the reduction of penetration of these materials in the condition of fixing with cement was studied in the research and after density and fixing, the experiment of penetration was done and the results are almost equal to a basic layer.

***Index Terms*—Reclaimed asphalt pavement, concrete pavement, runway, stabilized base and sub base.**

I. Introduction

A great amount of RAP materials are produced in the world each year that the US is the first in the world. This amount is more than ten tons. To recycle this amount of the materials with high quality can have an important effect on the environmental improvement and economic efficiency in each country. RAP materials are pavement materials which are exfoliated or recycled containing tar and stony materials. The materials that are used for asphalt pavement are usually produced from fragmentizing aggregate or deep exfoliation of old asphalt. Fragmentizing materials requires picking up the asphalt layer from pavement surface that is done by fragmentizing device. This machine can pick up to ten inches of that surface with one time crossing over the pavement, in this way it is possible to lathe, fragmentize and soften asphalt pavement in the place of executing the project and optimize its quality by recycling the materials and mixing with granular or prepared materials to carry out this job in the place of executing the project reduces the cost of further transferring materials to factory of preparing materials and transferring prepared materials to the place of constructing the project. This research proceeds recycle materials and stabilizing it with cement as a basic sub basic layer.

Manuscript received April 10, 2013; revised June 17, 2013.

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RAP materials are used as basic and sub basic materials in many project. Almost all states as basic and sub basic materials lawful Table I presents the status of using asphalt chip materials as a base in twelve states of US [1].

TABLE I: USING RAP MATERIAL IN USA

State	Rap	Max%	Processed	Testing
Florida	No			
Ilinois	No			
Montana	Yes	50-60%	No	Corrected nuclear gouge
New jersey	Yes	50%	Yes-Gradation	Corrected nuc. Gauget sample
Minne sota	Yes	3%	Yes-Gradation	Dynamic cone penetrometer
Colorado	Yes	50%	Yes-Max agg.size	Roller compaction strip
Utah	Yes	2%	Yes-gradation	Nuc.gauge or breakdown curve
Texas	Yes	20%	Unknown	Various(includingnuc.gauge)
California	Yes	50%	Unknown	No special testing procedure listed
New mexico	Yes	UNKNOWN	Unknown	Corrected nuc.gauge
Rhode island	Yes	UNKNOWN	Yes-gradation	Unknown
South dakota	No			

Column one shows whether using RAP as a base in foresaid state is lawful or not. The second columns shows acceptable rate of RAP in mixing with other materials and using these materials increased from 50% to 100% in Newberys and Colorado. The third column shows the way of grading proportionate with foresaid state and the last column shows the type of test which is used for asphalt materials for its workability [2].

In research center of US many studies were done about asphalt chip materials and the result was presented in the format of some articles.

Table II presents the status of accomplished studies on asphalt chip materials and technical results.

TABLE II: SOME REPORT ABOUT RAP MATERIAL

Report	Blended	Dry density	Moisture content	Permeability	CBR	Resilient modulus
Cooley (2005)	Yes	Decreased	Decreased		Decreased	
Carg & Thompson (1996)	No	Decreased	Increased		Decreased	
Macgregor (1999)	Yes			No change		**Increased**
Bennert &mahr (2005)	Yes	Decreased	Decreased	Decreased		**Increased**
Papp (1998)	Yes	Decreased	Decreased			**Increased**
Sayed (1993)	No		Decreased		Decreased	
Taha (1999)	Yes	Decreased	No change	Increased	Decreased	
Trzebiatowski (2005)	No	Decreased		increased		

DOI: 10.7763/IJET.2013.V5.621

In the second column, RAP materials were mixed with other materials. The third column explains the effect of dry density with increase in RAP of mixture. And according to the results we can say that dry density decreases with increase in RAP of mixture. Next column shows the effect of optimum moisture with increase of RAP in mixture which is variable but it often decreases. The fifth column shows the rate of changes in penetration and its results are variable, the next column shows relative rate of bearing of CBR with increase in RAP of mixture which has reduction, the last column shows resilience module which is decreased with increase in RAP of mixture [2].

From all the above results we can conclude that the asphalt chip materials with suitable materials decreases resistance, dry density and resilience module are decreased [3].

Tabriz airport rehabilitation has started since 2012 and project client is Iranian Airports Company also Consultant Engineer is Baniandimas Co. and Contractor is Khanegostaregil Co.

II. The Characteristics of Reclaimed Asphalt

One of the important characteristics of the mechanic of the soil is grading which is usually used for categorizing different materials of bulwark. Grading is an important factor that effects on executing bulwark and pavement such as stability, drainage and sensitivity to freezing. Since the regulation of required layered grading that the recycled lathed layer of asphalt was superseded. The tests were done according to the group four of sub basic grading and the RAP materials should give the sub basic Characteristics according to FAA journal the above characteristics are explained below:

The liquid and plastic limit on the materials which were passed from number 40 sift, according to AASHTO method T-89 and T-90 shouldn't be more that 24% and 60% fabulous value on the materials which were passed from number four sift, according to the AASHTO method T-176 shouldn't be less than 30% which is 47.5 for asphalt chip material with the same fabulous value that is more than standard [4].

Abrasion percentage on gravel materials with Los Angeles method (AASHTO T-96) should not be more than 50. The percentage of gravel abrasion about RAP is 29% which is 37.5 about asphalt chip materials that are place in defined characteristics with a few changes. The grading of usable materials should be according to the below characteristics whose content can be compared with chart which shows sub base value, abrasion percentage, sat rant bearing tolerance, tar percentage and the curve of grading for usable materials:

100 percent of weight of materials should be passed from 1.5 inches sift and 100 to90 percent of weight of materials should be passed from 1 inch sift which are passed about 98% also 55% to 88% of materials should be passed from 9.5 millimeter sift which is shown in chart one, the percentage of weight of materials which are passed from number 4 sift should be between 40 to 60 which is about 40% in chart one, the material which are passed from number 10 sift is 28% which should be between 28 and 48, the percentage of weight of materials passed from number 40 should be between 28 to 48 too that the used materials were placed in this range. The percentage of weight of materials passed from number 200 sift is less that 10% which means 0 to 10% in the standard range.

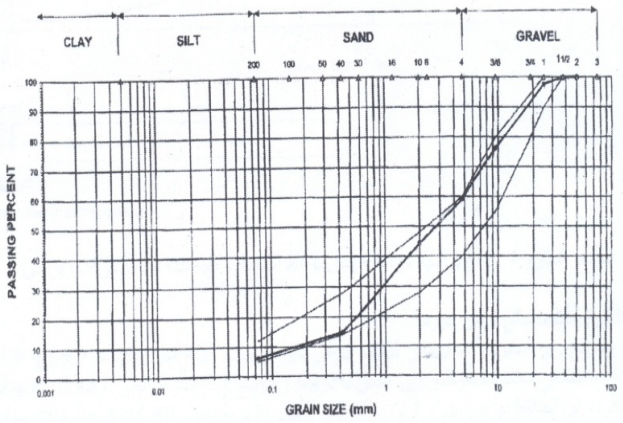

Fig. 1. RAP material grading.

1). Tar percentage = 4.11%
2). C.B.R = 37.69%
3). Abrasion with Los Angeles method = 29%

III. The Variants of Mixing of Lathed Materials Reclaimed

Different variants were studied with use of lathed asphalt for providing sub base materials and the way of mixing asphalt chip with different amount of sub basic materials with high quality was presented for optimizing the quality of RAP and increasing in its bearing and sub base was noticed with 4% of moisture as you see the percentage of the mixing in Table III [5].

The CBR test was applied for attaining the optimum percentage of materials as you see the percentage of California (CBR) decreases with increase in amount of asphalt chip, moisture percentage of samples were noticed 4% during the CBR test [6].

TABLE III: The Results of Mixing Different Amount of Materials with Lathed Asphalt

CBR%	Pressure in 0.1 inch after modification (Kg/cm2)	Force at the en penetration of 1.5 inch (Kg)	Mixture percent
13.06	9.18	324	**35%asphalt+65%mixture**
12.17	12.83	589	**50%asphalt+50%mixture**
9.25	9.75	445.5	**65%asphalt+35%mixture**

Another way of increasing CBR is adding cement to the asphalt chip material which is more expensive than previous way, because of that different percentages of cement were added to a constant amount of reclaimed materials and the CBR test was done with 2% moisture for comparing.

As you see in above tables, the amount of CBR of stabilized RAP asphalt with 5% of cement is equal to 64% which is more than need of base and sub base [7].

In Table IV, the results of mixing asphalt chip material with cement were studied as we expected the California bearing ratio CBR increase with increase in amount of cement. Now with comparing the Table III and the Table IV, we can conclude that stabilization of asphalt materials with cement has more effects on soil bearing capacity but it is

more expensive way, In another case adding cement increases the rigidity of layers and decreases plasticity but because the pavement is rigid and the general goal of this research is the maximal use of asphalt chip materials RAP so the way of stabilization with cement was selected the pavement was done according to calculation, the 50% CBR is necessary[8].

TABLE IV: THE RESULTS OF DIFFERENT AMOUNTS OF MIXING THE ASPHALT CHIP MATERIALS WITH CEMENT

$CBR_{\%}$	Pressure in 0.1 inch after modification (Kg/cm^2)	Force at the end of penetrations of 1.5 inch (Kg)	percent
36.4	25.9	1318.5	**Asphalt+2.5%cement**
45.81	32.21	1521	**Asphalt+3%cement**
50.92	35.80	1705.5	**Asphalt+3.5%cement**
58.75	41.31	1890	**Asphalt+4%cement**
64.68	46.68	2232	**Asphalt+5%cement**

IV. DENSITY AND DETERMINING OPTIMAL MOISTURE TEST

The density and determining optimal moisture test D-1557 was done at lab and the rate of necessary moisture was between 5.5 to 6% and the maximal dry density was attained 2.14 to 2.19

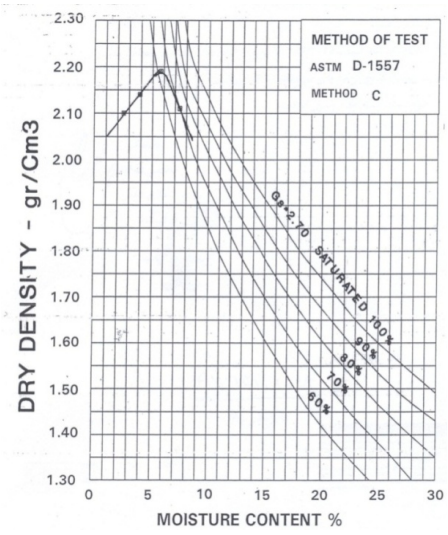

Fig. 2. The chart of density and determining optimal moisture test on lathed asphalt materials.

The density test consists of reducing soil content under the effect of bringing out the air with force and this manner the friction between dust increases and this weight is soil density criterion. The existence of water facilitates this operation. To attain this content of moisture and maximal special dry weight after applying certain amount of compression energy is the important goal of the density test. When water is added to dry soil, the dusts of soil penetrate a thin layer of water (film) shallowly. By adding more water, this thin layer becomes thicker and it allows dusts to slither on each other easily until the thickness of this thin layer of water over the gravel is not remarkable in comparison with diagonal of dusts, water effects on fine aggregate solely and causes more density. But if the amount of water increases the water will bear the load admission instead of soil and it undergoes a cut so the maximal amount of water is important which is attained 5.7% in the chart two [9].

The density and determining optimal moisture test was done at the place and the amount of optimal moisture was attained between 5 to 6% and the maximal dry density between 2.14 to 2.22.

TABLE V: RELATIVE DENSITY AT THE PLACE

Number of test	Place density		Lab density			Percentage of relative density
	Dry density (gr/cm^3)	Moisture percentage	Maximal dry density gr/cm^3	percentage		Thickness (cm)
1	2.14	6	2.14	6	100	**22.5**
2	2.22	4.8	2.14	6	100	**25**
3	2.14	5.7	2.14	6	100	**19.5**

V. STABILIZATION WITH CEMENT AND DETERMINING THE OPTIMAL MOISTURE

For making a stabilized, immediate under the concrete and according to the standards of stabilization with cement, some samples were provided with the rate of 3 to 7 percent and the UCS test was done and was broken at the age of 7 days and the attained strength was equal to final 70% which is shown below and finally according to this test and the results of test of mixing asphalt with cement, the rate of 4% cement was noticed for stabilization whose final strength is equal to 3900 Kg/cm2 that the number 25 Kg/cm2 is absolutely enough for building roadways and freeways according to normal standards [10].

TABLE VI: THE RESULTS OF 7 DAYS STANDARD TEST USC ON ASPHALT CHIP MATERIALS WITH STABILIZING CEMENT

SAMPLE	Diameter (cm)	Height (cm)	Density (gr/cm^3)	Compressive strength(kpa)
3%	15.2	11.3	2.04	**2162**
4%	15.2	11.3	2.06	**2721**
5%	15.2	11.3	2.10	**3176**
6%	15.2	11.3	2.12	**3540**
7%	15.2	11.3	2.13	**3730**

VI. THE RATE OF PENETRABILITY OF MOISTURE IN RECLAIMED ASPHALT MATERIALS (RAP)

Some researchers were done in the US on the rate of penetrability of moisture in lathed asphalt materials RAP that all of them show the high rate of penetrability of above materials. There is a table below to show the results for traditional materials also the moisture penetration test was done on asphalt chip materials in granular soils D-2434 to examine the workability of drainage of these materials in comparison with basic and sub basic materials and finally the rate of penetration is equal to 0.000816 Cm/sec or 70.5024 Cm/day and almost equal to penetration of a basic materials [11].

TABLE VII: LUFRAN DESERT PERMEABILITY TEST RESULTS

TEST	Diameter (cm)	Segment length (cm)	Discharge (cm^3/sec)	K=permeability coefficient (cm/sec)
1	9	21	2.3	1.034*10^-3
2	9	25	9.1	3.283*10^-3

TABLE VIII: THE RESULTS OF RATE OF MOISTURE PENETRABILITY FOR TRADITIONAL MATERIALS

Permeability coefficient, K (cm/sec)	Permeability coefficient, K (feet/day)	Relative permeability	Soil type
$<10^{-7}$	<0.00028	Impervios	**clay**
10^{-7} - 10^{-5}	0.00028- 0.0283	Very low	**silt**
10^{-5} - 10^{-3}	0.0283- 2.83	Low	**sand, dirty**
10^{-3} - 10^{-1}	2.83 - 283	Medium	**sand, clean**
$>10^{-1}$	>283	High	**coarse, gravel**

VII. PLATE LOADING TEST

By using plate loading test, we can determine lawful bearing capacity according to the considerations of subsidence. This test has been standardized according to ASTM-D 1194 or T-222 AASHTO. The bearing plate can be a circle plate with 6 to 30 inches diagonal or a square plate with 12×12 inches dimensions.

At first a hole should be dug for the test, width of the hole should be minimum 4 times bigger than loading plate. Then the plate for test has been placed on the soil and loads little by little. After each increase in loading, enough time is given for occurrence of subsidence. When the subsidence of plate was stopped, the amount of load and subsidence was recorded and the amount of load increases. By recording the amount of load and subsidence load will be attained [12].

Since the base of rigid pavement design of airport is the WESTERGAARD method and the final control of stabilized layer with cement for concrete slabs is plate loading test, this method of relation of stress in the unit of content is the base of calculating theory and the test which gives this rate directly is T-222 AASHTO test that Ks has been attained directly according to the method of subsidence rate upon attained strength and in this way this rate is controlled and the numbers are attained K=430 PCI and actually they attained several times bigger than the postulated number for primary pavement the postulated number for primary pavement designing (K=330 PCI).

TABLE IX: PLATE TEST RESULTS

Test	Plate area (Cm^2)	Natural wet density of soil (GR/cm^3)	Humidity (%)	Max pressure (kg/cm^2)	Ks (PCI)
1	4560	2.21	3	5.2	**551.4**
2	4560	2.11	3.2	5.2	**448.8**
3	4560	2.25	3.8	5.2	**436.3**
4	4560	2.23	3.3	5.2	**355.0**
5	4560	2.1	2.4	5.2	**377.6**

VIII. CONCLUSION

Regard for total rebuilding one of the runways at Tabriz airport and large amount of asphalt chip that was remained after destruction, it is necessary to use this chip economically and environmentally.

Thus the materials should be used for a process adequately until having properties such as penetration, strength, plasticity and durability beside adequate technical characteristics.

To attain this goal, the stabilization of chip materials should be applied with adequate percentage of cement. Many tests were done such as the relation of California bearing ratio CBR, penetration with stable load and plate loading PLT. Finally using these materials with 3% of cement in a layer on the bed and 4% of cement in the layer of sub slabs of pavement contained acceptable results from calculating the pavement.

IX. ACKNOWLEDGEMENT

At the end, should appreciate Iranian airports holding company Specially Mr. H. Sadeghi Deputy of Airport Operation for giving the information of this project and Baniandimas consulting engineers company for cooperating in doing the tests and providing the article also Y. Safavi for do The Tests.

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