

studying the properties of the debris and their use in paving layers of roads and concrete construction

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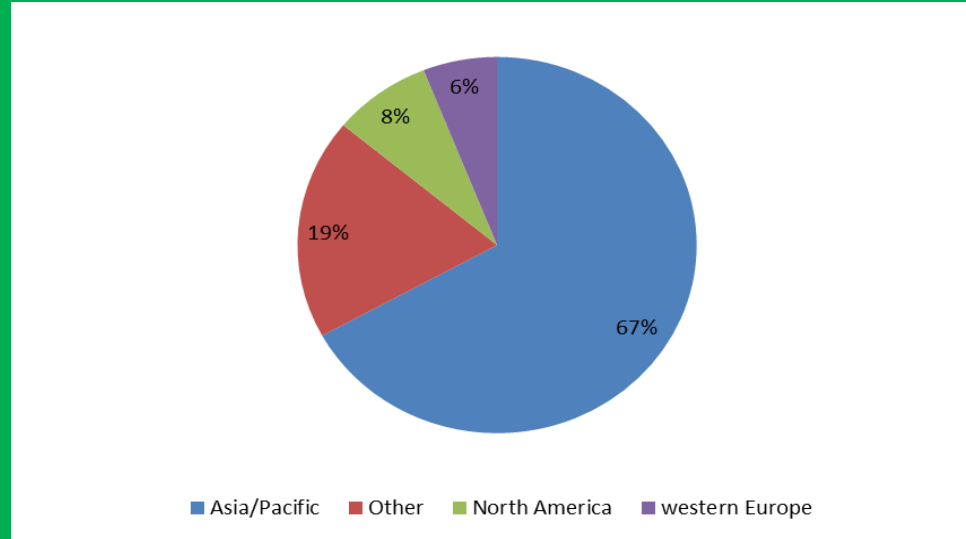
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Introduction

- The Rapid population growth has led to an increase in the demand for infrastructure which leads to an increase in the demand for aggregates, which represent 70-80% of the total concrete volume .
- in 2015 the consumption of aggregate in all world reached 48.3 billion metric tons as shown bellow



- In this research we studied all the debris of demolish building materials such as
 - concrete slab
 - Columns
 - brick and rock walls
 - foundations
 - Gypsum
 - concrete blocks and soil and use it in base or sub base layer of roads

Case study

- Anbar province with population of two millions population.
- There are three destroyed regions . They are :
 - **middle region:** which include ramadi center, tameem , al-tash,sofia, jazeera , sujariya , khalidia and 5km area .
 - **East region :**which include falluja .ameriat al-falluja , saqlawiya and al qarma city .
 - **west region :**which include Ana city , rutba city , kubaisa city ,
heet city , . rawa city and al-qaim city .
- In this research I studied the debris of Ramadi city only and the total amount of debris in Ramadi city reached 12millions M3 due to Terror Wars from 2013 to 2015
- To disposal the debris out side the city we need costs of transportation but in future after the development of city and grow of infrastructure we will need other cost of debris transportation can be named as future transportation costs .
- 80% of Ramadi city has been destroyed completely



Photo2. show the destroyed of Ramadi city



Photo3 show the destroyed of Ramadi city

Steps of buildings demolition:

1-remove the war waste by other companies





2-Concrete demolition machines to separate of reinforced steel





3-Re-adjustment of steel bars



3-Load the trucks with debris to the Al-sarah landfill

Location of landfills

➤ There are two landfills in Ramadi city :

1-Al-sarah landfall in Al-sofia area with dimensions of 3000m length ,300 m width and 7 to 9 depth

2- Alhafria in Ramadi center with length of 1450 m and 100 width and 8m depth





Locations of landfills in Ramadi

Process of taking samples

- Thirty samples were taken randomly every twenty-five meters by shovel machine from AL-sarah landfill and the total quantity of the samples was 40 m³.as shown below
- The samples of debris materials was crushed in a small Crusher located near of University of Anbar.
- 40 m³ of debris materials was crashed within two hours.
- Max. size of debris materials is 75mm
- The wood and plastic materials are throw away by the sieve after steps of crashing as shown in photos .
- The cost of crashing per cubic meter was 1500 Iraqi Dinar it is Cheaper than price of a cubic meter of natural subbase from quarries which it is 2000 Iraqi Dinars .



Sampling process



Photo 7. show Debris materials inside the hopper



Photo 8. show the demolition waste subbase on the belt of crusher



Photo 9. show the demolition waste subbase on the sieve after crashing



Fill the hopper with debris



Crushing of debris



Crushing of debris

Tests of debris materials

- 1- Chemical tests for debris materials : Four samples were taken randomly for Sulfate content (So_3), Gypsum content and Total soluble salts test (TSS) .
 - 2- Sieve analysis test .
 - 3- proportion of debris materials
 - 4- compaction test
 - 4- CBR value
 - 5- Resilient modules
- Effect of radiation is non according to the studies of United Nation Environment Program (UNEP) .

Table 2. show the chemical tests for debris materials

TESTS	Sample 1	Sample 2	Sample 3	Sample 4	Average	Specifications
Sulphate content tests So3%	1.20	1.18	1.28	1.24	1.22	Max. 5 %
Total soluble salts test (TSS)%	5.59	5.30	5.04	6.07	5.5	Max. 10 %
Gypsum content tests%	2.58	2.70	2.51	2.65	2.61	Max . 10.75%

Sieve analysis test of debris materials

- The properties of debris materials are the gradation ,optimum moisture content and CBR Value and Table 3. show the sieve analysis for debris materials .

Sieve NO.mm	% of passing	Iraqi specification class A	B	C	D
75	100	100	--	-	-
50	100	95-100	100	-	-
25	81	---	75-95	100	100
9.5	43	30-65	40-75	50-85	60-100
4.75	31	25-55	30-60	35-65	50-85
2.36	23	16-42	21-42	26-52	42-72
0.3	7.2	7-18	14-28	14-28	23-42
0.075	4.4	2-8	5-15	5-15	5-20

Table 4 show Proportion of debris materials

Sample NO.	Total weight gr.	% of concrete and gravel	%of brick	% of rocks	% of gypsum	%of ceramic	% of Asphalt concrete	%of fine materials	%of glass	%of wood	%of plastic materials
1	3000	59.96	5.22	1.5	0.91	0.58	0.18	31.29	0.2	0.16	0
2	6431.5	31.5	1.64	5.2	0.87	3.9	0.37	56.2	0.007	0.03	0.15
3	5577	35.16	0.37	2.24	0.23	0.16	0.08	61.35	0.26	0.08	0.01
4	7065	29.46	4.11	0.96	0.04	1.24	0.5	63.45	0.07	0.08	0.04
5	7586	26.49	0.89	2.41	0.01	0.46	0.97	68.60	0.05	0.09	0
6	7050	40.58	0.15	0.93	0.01	0.22	2.36	55.68	0.01	0	0.01
7	7849	45.16	2.01	0.52	0.06	0.03	0.02	52.10	0.02	0.01	0.02
8	8268	34.96	0.33	2.67	0.22	0.14	0.03	61.58	0.01	0	0.01
9	5847	47.64	0.47	1.59	0.22	0.32	0.10	49.47	0.08	0.03	0.03
10	4078	29.42	1.15	9.12	0.34	0.02	0	59.66	0.09	0.02	0.14
11	6111	38.79	0.73	0.75	0.11	0.26	0	59.10	0.11	0.08	0.03
12	6945	38.12	0.54	22.75	1.35	0.56	0	36.54	0.05	0.01	0.04
13	6208	32.21	1.32	3.91	1.20	0.25	0.01	60.61	0.41	0.01	0.01
14	6388	47.37	0.04	0.68	0.23	0.18	10.42	41.01	0	0.01	0.01
Average%	6314.53	38.34	1.35	3.94	0.41	0.59	1.07	54.04	0.09	0.04	0.03

Construction of test section

- The dimensions of test section are (6m *6m)
- Laying the debris materials with 20 cm thickness .
- spraying with water then compact the materials by using steel roller as shown bellow.



Photo 10, 11.12 shows laying the demolition waste subbase for testing



Photo 13,14,15 shows the sprinkle with water , compaction and test the samples

Compaction and sieve analysis test



The results of tests

- Five samples were taken to calculate the compaction test.
- The max. dry density was 20.35kg/m³.
- The optimum moisture content was 8 % .
- The average percentage of compaction was 95.98 % as shown in table 5.
- The CBR value was 37%. According to the general specifications of roads and bridges (SORB/R6,1999) .
- Resilient modules of debris martials was 377.7 Mpa. According to estimation of base layer coefficient at granular base course .

Sample No.	%of compaction
A1	96.7
A2	97.5
A3	95
A4	95.2
A5	95.5
Average%	95.98

Workshops

1- in Mosul University on 19-20 March 2018 organized by UNEP and UN-Habitat.

2- in Anbar university from 7-8 November 2018, with Governorate of Anbar , and the support of the UN Environment Program (UNEP): we obtained formal agreement from the local government on 6 sites for crushing the debris

3- -in Kirkuk university On 27 and 28 March 2019, with Governorate of Kirkuk , and the support of the United Nations Assistance Mission in Iraq (UNAMI) and UN Environment Programme (UNEP):

NO	Governorate	Quantity of debris	Cost of recycling in Iraqi dinars	Quarries of natural materials /mix aggregate	Cost of natural material/ mix aggregate In Iraqi Dinars	Notes
1	Anbar – Ramadi	12 million cubic meters	1500	Qarma	4000	High cost and good gradation and without salt but cost of transportation 11000 ID per m3
				Grichi	2000	Less cost and bad gradation and content of salt but cost of transportation 2000 ID per m3
2	Kirkuk	6 million cubic meters	1500	Kirkuk quarries	2000	Less cost and good gradation but cost of transportation 2000 ID per m3
3	Mosul	7,651,837 tones	1500	Mosul quarries	2000	Less cost and good gradation but cost of transportation 2000 ID per m3

Costs of debris recycling and natural material

Result of workshops

- ✓ One crusher was purchased in the province of Mosul by (IOM) and in cooperation with the UNEP to the municipality of Mosul.as shown bellow .
- ✓ The production of the crusher is 80 tons per day
- ✓ The price of the crusher 70 thousand dollars.



Conclusion

- the chemical tests for debris materials SO_3 , Gypsum and TSS tests were 1.22, 2.61 and 5.5 % Respectively it is within range of general specifications of road and bridges.
- The gradation of debris materials was class (A) for roads construction .
- the percentage of concrete and gravel was 38.34 % and fine materials was 54.04% .
- the Effect of gypsum , glass , wood and plastic materials is very low .
- The production of debris materials is cheaper than the natural subbase

❖ Recommendations

- installing debris crusher in the site of Al-Sarah landfill because it is considered the biggest place to disposal the debris of debris materials with dimensions of 3000 meters length and a width of 300 meters and a depth varying from 7 to 9 meters
- Using the aggregate from debris materials in manufacture of curbstone , concrete block and concrete block pavement

THANK YOU