Optimization of Concrete Mix with Tungsten Composite Materials as a Gamma- Ray Radiation Shielding

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ABSTRACT

The current study aimed to enhance the performance of concrete as a shield for gamma rays by testing the addition of four different types of tungsten. The tungsten was added replacing 30% of concrete, either as, tungsten oxide S1, ditungsten carbide S2, tungsten carbide S3, or tungsten metal S4. The measurements were performed using a gamma spectrometer NaI(Tl) detector at 662 keV, while Phys-X/PSD software was used for theoretical calculations. The evaluation of shielding properties was made according to several parameters such as mass attenuation coefficient (μ_m), half-value layer (HVL), tenth value layer (TVL), radiation protection efficiency (RPE %), effective atomic numbers (Z_{eff}), effective electron density (N_{eff}) and effective conductivity (C_{eff}) of the prepared composites concrete. The results showed that the (μ_m) and RPE% values were enhanced, the best results were given for the concrete containing tungsten metal S4, while the lowest was for concrete containing tungsten oxide S1. Also, exposure buildup factor (EBF) values were computed for the 0.015–10 MeV energy range up to 20 mfp. The largest and lowest values for EBF were obtained for S0 and S4 samples, respectively.

Keywords: *Radiation shielding; Mass attenuation coefficients, effective atomic number, Half and Tenth Value Layer, Radiation protection efficiency.*

I. INTRODUCTION

The utilization of radiation in industrial and medical fields is progressively increased. Some of its well-known uses are power generation, medical diagnosis, radiotherapy, nuclear power, and many other processes. One of the most challenging problems in using radiation is how to control this powerful energy. The three principles of radiation protection are time, distance, and shielding. So, it is necessary to produce shielding materials that attenuate radiation, such as that gained from X-rays or γ-rays. Shields are used to protecting personal life and different materials from radiation hazardous. It is important in the choice of the radiation shielding material, to verify the kind and energy of the radiation source [1]. The principle of preparing a radiation shield is to understand the interaction of radiation with matter. The amount of the reaction is incredibly dependent on an atomic number such as the density of the shielding material [2]. As a result of the scientific development in the world of materials, it found that the radiation shields have flexible mechanical and economical properties, with low cost and non-toxicity, in particular for radiation gamma and X-ray [3].

Concrete is viewed to be an exceptional, cheaper, and multi-purpose shielding material. It includes a mixture of various light and heavy elements having the ability to attenuate photons and neutrons. The shielding characteristics of concrete may be modified to a wider range of uses, by modifying its composition. One of the major advantages of concrete is that it has a composite-type substance. It contains a combination of aggregate particles (sand, gravel, stone, and filler) with cement or a binder. So, there is an opportunity to enhance its elemental composition by mixing it with other elements for better shielding properties [4]. The overall performance of gamma-ray protecting concrete has already been simulated and investigated experimentally [5]. Tungsten is a non-toxic element, which displays a better performance in gamma-ray shielding compared to lead, and is easy to mix with concrete as an additive. This can enhance the shielding ability of the material. Where, by varying the quantity of additive in concrete, its density will be increased, this causes a much better performance [6]. Since tungsten has been historically used as a protecting shield against X-rays and gamma rays, due to its high mass density of more than 11.34 g/cm^3 which provides a good radiation shielding performance, it also has low toxicity compared to lead and it has high melting point [8]. Also, it has the best temperature behavior compared with all common metals [9]. So, tungsten has a similar radiation shielding capability as lead, but it is less dangerous [10].

The current study aimed to compare the gamma protection efficiency of some tungsten compounds mixed with concrete by the experimental and theoretical methods. To investigate tungsten composites' shielding ability against γ rays, five samples were prepared, one sample of plain concrete, while for the other four samples 30% of concrete was replaced by different tungsten compounds. Samples have been investigated against gamma radiation ^{137}Cs source at energy 662 KeV. The linear and mass attenuation coefficients were calculated. The experimental results have been compared with Phys-X/PSD software. Half value layer (HVL), tenth value layer (TVL), radiation protection efficiency (RPE %), and effective atomic number Z_{eff} were calculated. The Z_{eff} of compounds and composite materials plays an important role in representing the attenuation of X-rays and gamma-rays, especially for dose calculations in radiation therapy [10].

II. MATERIALS AND METHODS

1.Samples Preparation

In this study, standard concrete (S0) was chosen as a primary shield and four composite standard concrete by adding four different types of tungsten, the tungsten was added replacing 30% of concrete, either as, tungsten oxide S1, ditungsten carbide S2, tungsten carbide S3 or tungsten metal S4. The standard concrete of cuboids shape was cast by manual mixing in the laboratory. The quantities of the concrete component were presented in table 1. And also, a hyper plasticizer was employed in proportion with the weight of cement amount, for reducing the dosage of cement. The five concrete shields were prepared in different thicknesses from 1 to 5 cm.

Table1. The quantities compounds of the Concrete Mix Design

S. N.	A constituent of 0.25 m^3	Quantity
1	Weight of cement	60 Kg
2	The volume of coarse aggregate	0.180
3	The volume of fine aggregate	0.11
4	Weight of water	30 Kg
5	Wight of hyper plasticizer	20 g

2. Experimental Measurement of Gamma Ray

In this study, shielding properties of different types of tungsten composites shield have been studied experimentally by using a gamma-ray spectrometer with a 3×3 NaI (Tl) detector. For energy calibration of the system, two gamma sources were used ^{60}Co and ^{137}Cs radioactive gamma point sources with energies 661.7, 1173.2, and 1332.5 keV. All the samples of elemental solids are uniformly cylinder-shaped. The prepared samples were investigated against the Cs-137 radioisotope source exhibit an activity of 5μCi.

3. Theoretical Study

3.1. Calculations of Gamma-Ray Attenuation Parameters

In this work, the Phys-X/PSD software is used to calculate the radiation mass attenuation coefficients of the studied samples. In this program, each sample of shielding material has been defined by their elemental fractions. The mass attenuation coefficients of all samples are calculated using the Phys-X/PSD program by Eq.(1).

$$\mu_{\mu} = \sum_{i=1}^{n} w_i \times \mu_{m,i} \qquad (1)$$

Where W_i and $\mu_{m,i}$ are the percentages by weight and mass attenuation coefficient of the i^{th} element in the concrete, respectively [12,13].

Linear (μ) attenuation coefficient is evaluated by comparing I and I_0, which are the measured count rates of the detector with and without the absorber of thickness x (cm), respectively by Eq.(2).

$$\mu = \frac{\ln(I_0/I)}{x} \qquad (2)$$

The intensity of the beam will be attenuated according to Beere Lambert's law [14].

Transmission %of any type of matter, for gamma-rays energy of E through-thickness x (cm) of shield material, was calculated through Eq. (3).

$$\text{Transmission } \% = \frac{I(E,x)}{I(E,0)} \times 100\% \qquad (3)$$

Where I (E, x), or I is a gamma-rays intensity for shielding material with thickness x and I(E,0) or I_o is a gamma-rays intensity in the absence of shield material [15].

Mass Attenuation Coefficient (μ_m) is one of the important parameters to evaluate the shielding topographies of materials. The μ_m is a measure of the degree of absorption or scattering of radiation by a chemical species or substance at a given wave-length per unit mass. The coefficient μ_m (in cm^2g^{-1}) is obtained by dividing the linear attenuation coefficient μ by the density ρ of the absorber material by Eq. (4) [14].

$$\mu_m = \frac{\mu}{\rho} \qquad (4)$$

μ_m is a constant that defines the rate of energy loss by a photon beam as it traverses a medium.

The HVL and TVL are the most regular quantities used for describing the ability of penetration gamma radiations in shield materials, so they describe the gamma-ray shielding strength for the studied sample. They are meaning that the thicknesses of a sample at which the intensity of the primary photon beam is reduced to half and one-tenth of its original value, respectively. Also, MFP indicates the distance that the radiation travels in the shield materials between two subsequent collisions. These three values are calculated by equations Eq. (5,6 and 7). It will increase with increasing the penetrating capability of radiation. Thus, for a better shielding material, a low HVL value is preferred [12, 16, 17].

$$HVL = \frac{ln2}{\mu} \quad (5) \qquad TVL = \frac{ln10}{\mu} \quad (6) \qquad MFP = \frac{1}{\mu} \quad (7)$$

3.2. Radiation Protection Efficiency (RPE%)

RPE% is a very important parameter to show the shield efficiency % to protect against radiation and calculated by using the following Eq.(8) [18].

$$RPE\% = \left(1 - \frac{I}{I_0}\right) \times 100\ \% \qquad (8)$$

3.3. Effective atomic numbers (Zeff) and Effective electron density (N_{eff})

Zeff can be calculated based on the calculation of the atomic cross-section (σa) and electronic cross-section (σel) for materials that are determined by using the values of the mass attenuation coefficients of

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all composite concrete (μ_m) obtained by running the Win- XCOM program. The Zeff is computed by Eq.(9).

$$Z_{eff} = \frac{\boldsymbol{\sigma_a}}{\boldsymbol{\sigma_{el}}} = \frac{\frac{\mu m}{N_A \Sigma_i \frac{wi}{Ai}}}{\frac{1}{N_A} \sum f_i \frac{A_i}{Z_i} (\mu_m)_i} \qquad (9)$$

Where NA is Avogadro's number, Ai is the atomic weight of an i^th element, fi denotes the fractional abundance of the element i for the number of atoms, and Zi is the atomic number of i^th element [19]. N_{eff} is also calculated as follows [19]:

$$N_{eff} = N_A \frac{nZ_{eff}}{\Sigma_i n_i A_i} \qquad (10)$$

Where n_i is the number of atoms of the ith constituent element, n is the total number of atoms.

3.4 The exposure build-up factors (EBF)

BFs are characteristics of the secondary radiations made inside the medium and thus the energy deposited/absorbed inside the medium. EBF of any material is frequently calculated utilizing the equivalent atomic number (Z_{eq}) and G-P fitting parameters; it can calculate by next equation [20].

$$Z_{eq} = \frac{Z_1 (\log R_2 - \log R) + Z_2 (logR - LogR_1)}{(logR_2 - \log R_1)} \qquad (11)$$

Z_1 and Z_2 represent the atomic numbers of elements corresponding to the ratios R1 and R2 respectively, R is the ratio of $\mu_{compton}$ to μ_{total} for the shield at specific energy value.

The G-P parameters of a, b, c, d, and X_k for the mixture are taken from the database report of the American Nuclear Society (ANSI/ANS-6.4.3) which were used to compute the EBF from the G-P fitting formula given in the following equations at each incident photon energy E and penetration depth X (in mean free path, mfp).

$$B(E,X) = 1 + (K^x - 1)\frac{(b-1)}{k-1}, \quad k \neq 1 \qquad (12)$$

$$B(E,x) = 1 + (b-1)x, \quad k = 1 \qquad (13)$$

$$K(E,X) = cX^a + d\frac{\tanh(X/X_k - 2) - \tanh(-2)}{1 - \tanh(-2)} \quad \textit{for penetration depth } X \leq 40 \textit{ mfp}$$

3.5 The effective conductivity (C_{eff})

C_{eff} values of material calculated as follows [21]:

$$C_{eff} = \frac{N_{eff} \rho e^2 \tau}{m_e}$$

where, e, m_e, and $\boldsymbol{\tau}$ are the charge, mass, and relaxation time of electron, respectively.

III. RESULTS AND DISCUSSION

1. EDX results

The elemental mass fractions of five concrete composite samples have been estimated using the EDX spectroscopy technique. Their chemical compositions in weight % of different studied composite concrete samples with tungsten compound have shown in Table 2.

Table2. The chemical compositions of concrete samples (weight %).

Elements	S0	S1	S2	S3	S4
C	0	0	0.018	0.009	0
O	0.492	0.401	0.343	0.345	0.334
Na	0.005	0.004	0.003	0.005	0.004
Mg	0.003	0.002	0.001	0.002	0.002
Al	0.037	0.026	0.027	0.026	0.026
Si	0.370	0.259	0.258	0.259	0.259
Ca	0.082	0.057	0.056	0.057	0.057
Fe	0.011	0.008	0.007	0.008	0.008
W	0	0.256	0.283	0.291	0.299

2. Shielding parameters

Samples with different thicknesses ranging from 1 to 5 cm were exposed to the energy of 662keV, and then ln (I/I_0) was plotted against the thickness as shown in Figure (1). The slope of the straight line represents the experimental linear attenuation coefficient. Figure (2) reveals that the linear attenuation coefficient value of concrete containing tungsten metal S4 is enormously higher than the plain concrete sample S0, where it increased from 0.083cm^{-1} for S0 to 0.63 cm^{-1} for S4, which has the best attenuation for gamma rays.

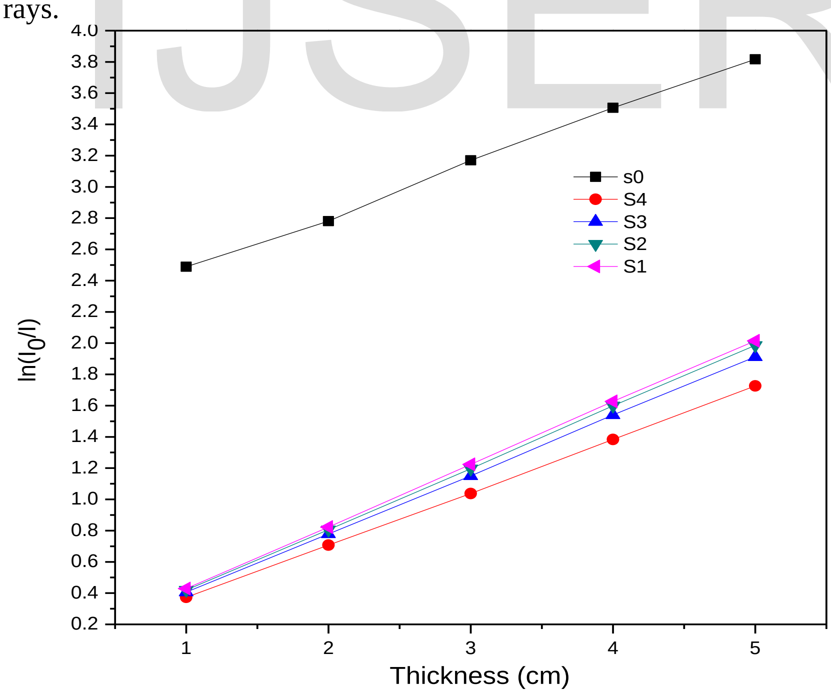

Fig. 1. Ln(I0/I) values as a function of the thickness for all composite concrete samples.

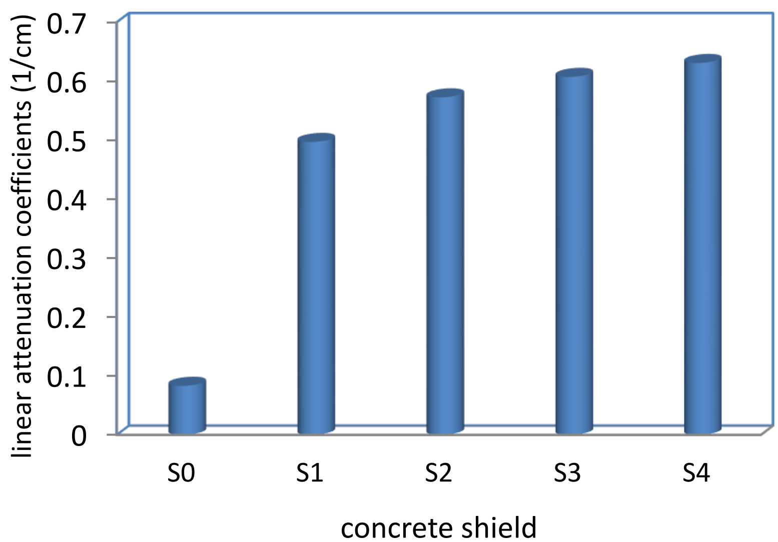

Fig.2. The values of the linear attenuation coefficient (μ) of gamma-ray for all composite concrete samples

Transmission % for gamma-ray at energy 662 KeV as a function of thickness X (cm) for all studied samples is placed in Table (3). It can be easily noticed that the transmission decreased as the thickness of the sample increased. Moreover, the results indicating thatS0 has the highest transmission% values, while S4 has the lowest values. The previous relationship was indicated as an inversely proportional between the thickness X of the shield and the transmission%.

Table 3. The transmission % for all studied composite concretes at a different thickness (cm) for energy 662 KeV.

Thickness (cm)	Transmission %				
	S0	S1	S2	S3	S4
1	85.13	68.85	66.60	65.74	65.08
2	70.11	49.31	45.89	44.66	43.93
3	53.04	35.45	31.67	30.23	29.42
4	38.12	25.07	21.42	20.22	19.65
5	29.84	17.80	14.77	13.72	13.33

Figure (3) is plotted to identify the thickness of each composite concrete sample studied which is equivalent to 3cm thickness of ordinary concrete sample at transmission 53%.

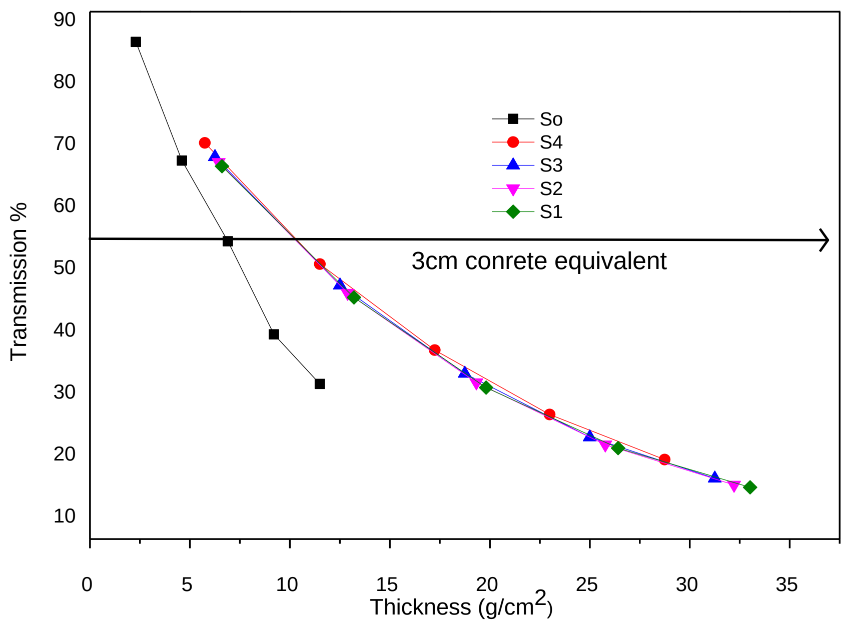

Fig. 3. Transmission % with the thickness of studies samples (g/cm^2).

To achieve this requirement, the X-axis of this figure represents the thickness t_z (g/cm^2)which is calculated by multiply the thickness (cm) of each sample(which is 3 cm) by its densityρverses its transmission % in the Y-axis. Then by using the horizontal line at transmission 53% and equation (9), the value of the thickness to other studied samples at the same transmission% can be estimated [22].

$$X = \frac{t_z}{\rho} \qquad (9)$$

*X(3cm)*was the thickness of composite concrete required to provide 3 cm concrete equivalency, and t_z was the thickness in g/cm^2 where the curve for tungsten composite concrete crosses the 3cm concrete equivalency. By using the equation above and Fig. 3, we found that 1.79 cm of S1, 1.622cm of S2, 1.6 cm of S3and 1.57cmof S4 has transmission of 53.2% when exposed to gamma-ray with the energy of 662keV, which is equivalent to 3cm of S0.

Table 4 shows the experimental and theatrical μm of the investigated concrete and tungsten composites shields at 662 KeV of gamma-ray energy. It was observed that the μm values of the studied samples are higher than that of S0, where the maximum value is realized forS4 while the minimum value is given by S1. The last result can be attributed to the high density of S4, where composite containing tungsten metal has the highest density. The relative difference (RD) between the theoretical and experimental values of μm was computed by equation (10).

$$RD = \frac{Calculated - Measusred}{Calculated} X100 \qquad (10)$$

From this table, it is clear that the theoretical values of μm by Phys-X/PSD software were higher than the corresponding experimental values of each composite concrete. This can be endorsed to the effect of mixture rule of the chemical composition of the samples without neglecting the effects of the atomic wave function of molecular bonding and the crystalline nature of molecular arrangements which can decrease μm values [23].

Table 4. Relative difference (RD) between experimental and theoretical μ_m results for all studied concrete composite at 662 keV.

Shields	Experimental	Theoretical	RD
S0	0.070	0.077	9.1
S1	0.086	0.100	14.0
S2	0.092	0.102	9.8
S3	0.094	0.102	7.8
S4	0.096	0.102	5.9

The linear correlation (R2) between μ_m and weight fraction of tungsten in all studied shields is shown in Fig. 4 and R2 was found equal to 0.98. This Fig. explains why S4 is the best shield, where it has the highest tungsten weight fraction. So, we can understand that the shielding efficiency of the composites in descending order, which is S4> S3> S2> S1, has the same order of tungsten weight fraction.

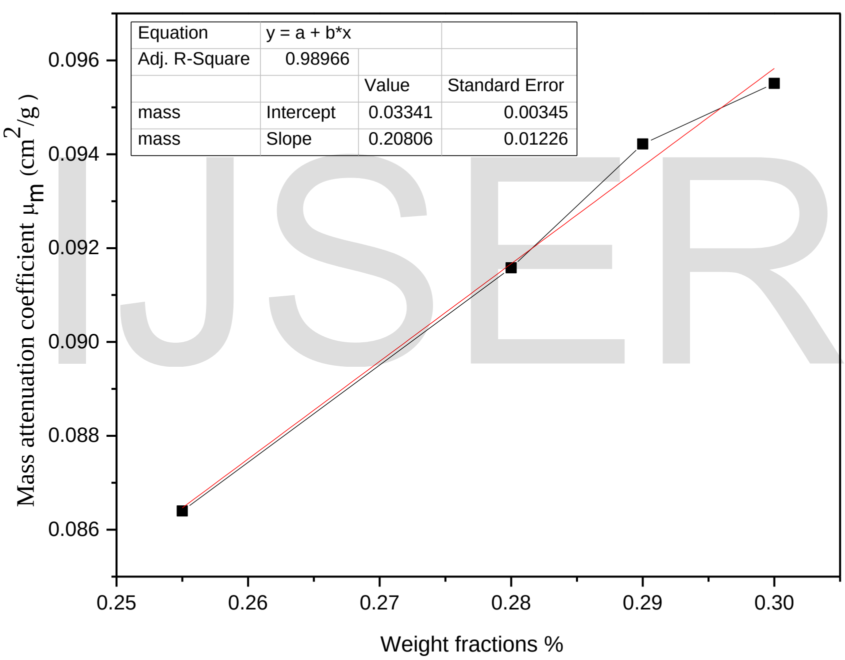

Fig. 4. Mass attenuation coefficients of different composites concrete shields as a function of tungsten weight fraction

The values of RPE% of the investigated tungsten composites shields for gamma rays with an energy of 0.661MeV have been calculated using Eq. (8) and presented in Fig.5. From this Fig., it can be noticed that the range of RPE % increased from 15% for S0 to 39% for S1, 43% for S2, 46% for S3, and 47% for S4. The RPE% results are completely in agreement with all the other results, Where S4 has the highest RPE%, while S0 has the lowest value. It can be also noticed that composite containing 30% WO_2 (S1) has the worse results compared to other studied composites.

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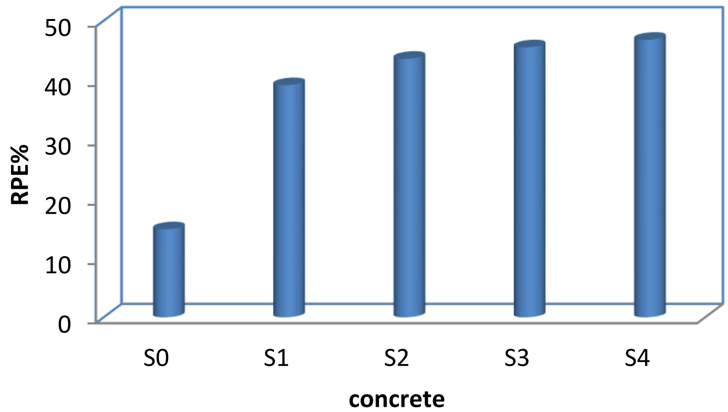

Fig.5. The calculated Radiation protection efficiency for studied composites concrete shields.

The computed values of HVL and TVL for all the studied shields are displayed in Fig. 6. It was noted that HVL values are in the range between1.098 and 8.349 cm, and TVL values were in the range from 3.65 to 27.74 cm.

	S0	S1	S2	S3	S4
HVL	8.35	1.4	1.21	1.14	1.1
TVL	27.74	4.64	4.02	3.79	3.65
MFP	5.63	2.07	1.82	1.78	1.73

Fig. 6 Values of HVL, TVL, and MFP (cm) for all studied composite concrete.

It can be noticed that S4 has the lowest values of HVL, TVl, and MFP, while S0 has the highest values. Also, the HVL of S1 is 1.40 cm which is higher than S4 but lower than S0. In other words, it can be believed that 1.09 cm thickness of S4 concrete containing 30% of tungsten metal is equivalent to 8.35 cm of S0 to reduce half of the photons emitted by gamma rays with an energy of 0.661MeV. Also, S4 has the lowest value of MFP.

The Z_{eff} for studied shields were calculated for the energy ranged from 0.05 MeV to 10 MeV via the theoretical mass attenuation coefficients obtained by the Phy-X program and shown in Fig.7. According to Fig. 7, in all energy regions, S4 has the highest values of Z_{eff}; while S0 has the lowest values. The maximum values obtained at 80 keV, which are 11.9 for S0, 52.2 for S1, 53.1 for S2, 53.8 for S3, and 54.4 for S4 respectively. For energies greater than 80 keV, there is a decrease in Z_{eff} values for all the samples. It was clear that the values of Z_{eff} were large in the low-energy range due to the dominance of the photoelectric absorption process in this energy region, but then it decreases progressively with increasing energy before starting to increase again and becoming constant at high energies due to the pair production, it also depends on chemical composition and μm of each shield.

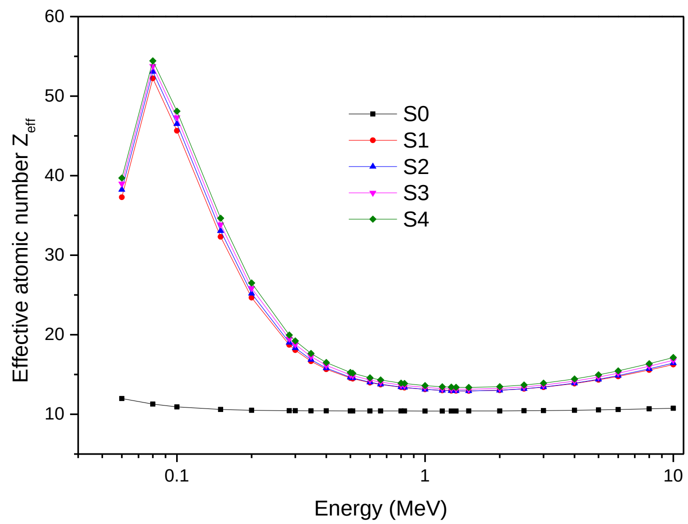

Fig.7. Variation of effective atomic number for all studied composite concrete with energies (MeV)

N_{eff} is the most important shielding parameter that indicates the effective conductivity of a material at a given ambient temperature depending on the incident photon energy. The N_{eff} and C_{eff} are shown and listed in Fig. 8 and Table 5, respectively. The photons penetrating the concrete collision the electrons and convert them into free electrons. The increase in the number of free electrons leads to an increase in the electrical conductivity of the concrete. The density and energy of incident photon seem to alter the electrical conductivity conjointly changes the protecting features. Hence, it is very significant to know the C_{eff} factor, which shows how a concrete preserves its features agreeing to nuclear applications. As observed in Fig. 8 N_{eff} behaviors are identical to C_{eff} behaviors at the same energies.

It's seen, the variations of N_{eff} results obtained as a function of incident photon energy are similar to the changes of Z_{eff} values. Furthermore, it's seen from Fig. 8 that there is a peak at about 0.08 MeV. These peaks can be attributed to *K*-shell absorption edges.

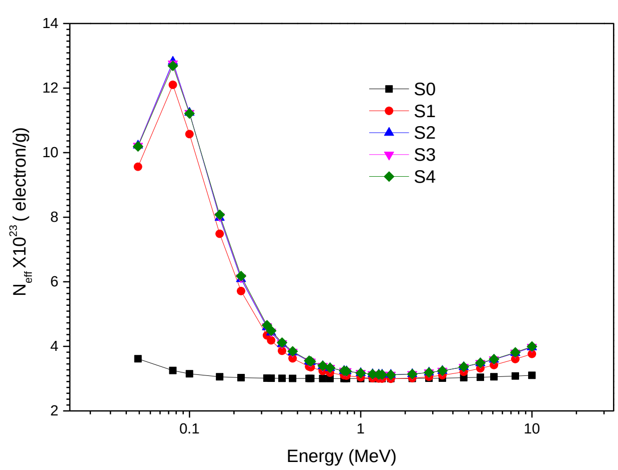

Fig.8 Variation of effective electron density for all studied composite concrete with energies (MeV).

Besides, S4 has the highest Z_{eff} and N_{eff} , also it has the highest value of C_{eff}. Where the S4 has additive pure tungsten. This suggests that this composite concrete sample S4 can be absorbing incoming gamma radiation more than other samples and has the highest $C_{eff.}$, So it has superior efficiency in gamma-rays shielding.

Table 5. Effective conductivity (C_{eff}) (S/m) for studied composite concrete**.**

	C_{eff} x 10^8				
E (MeV)	**S0**	**S1**	**S2**	**S3**	**S4**
0.050	5.07	31.30	36.30	37.10	38.50
0.060	5.03	23.90	27.70	28.30	29.40
0.080	5.00	18.20	20.90	21.40	22.20
0.100	5.00	17.50	20.10	20.60	21.40
0.150	5.00	16.20	18.50	18.90	19.60
0.200	4.99	15.20	17.40	17.70	18.30
0.300	4.99	14.00	16.00	16.30	16.80
0.400	4.99	13.30	15.10	15.40	15.90
0.500	4.98	13.00	14.70	15.00	15.50
0.600	4.98	12.70	14.40	14.70	15.10
0.662	4.98	12.60	14.30	14.50	14.90
0.800	4.98	12.60	14.20	14.50	14.90
1.000	4.98	12.50	14.20	14.40	14.90
1.170	4.99	12.60	14.30	14.50	15.00
1.280	5.00	12.80	14.50	14.70	15.20
1.330	5.01	13.00	14.70	15.00	15.50
2.000	5.05	13.90	15.80	16.10	16.60
3.000	5.11	15.10	17.30	17.60	18.20
4.000	5.15	15.80	18.10	18.40	19.00
5.000	5.22	17.00	19.60	20.00	20.70
6.000	5.07	14.30	16.30	16.60	17.20
8.000	5.11	15.10	17.30	17.60	18.20
10.000	5.15	15.80	18.10	18.40	19.00

Fig. 9 shows the relation between the N_{eff} , $C_{eff,}$ and Z_{eff} for sample S4, wherewith increasing Z_{eff} the value of N_{eff} increased, and also the C_{eff} increased. So, N_{eff} and C_{eff} behaviors are identical to Z_{eff} behavior**.**

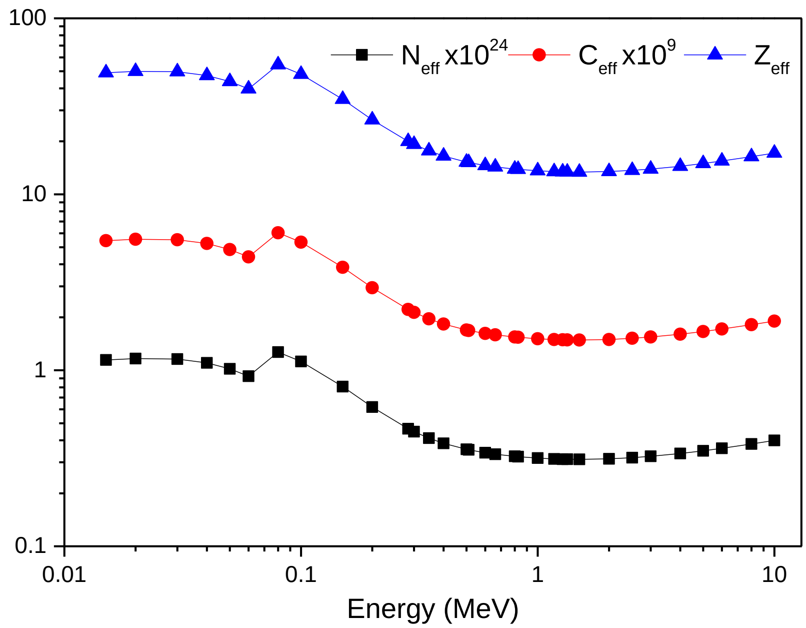

Fig.9 Variation of N_{eff}, C_{eff} and Z_{eff} with energies for S4.

Fig. 10 (a-e) describes the changing of EBF with the gamma energy range of 0.015–15 MeV up to 20 mfp for S0, S1, S2, S3, S4 concrete. The trend of the EBF with energy is similar for all concrete samples. For So, EBF was low at energies less than 0.1 MeV and increase steadily with increasing energy up to 0.15 MeV before and then descending as the energy rises. While EBF values for S1, S2, S3, and S4 were increasing steadily with increasing energy up to 1 MeV and then descending as the energy rises. Moreover, the EBF increases with increasing the penetration depth. The highest value of the EBF is obtained for S0 composites and varied between 1.03 and 107 at 1 and 20 mfp respectively, while the lowest EBF is obtained for S4 and varied between 1.01 and 15.6 at 1 and 20 mfp respectively. Fig.11 reveals to the additive of tungsten compounds decreases the EBF. For all studied concrete, the calculated EBF values decrease within the order S4< <s3 <s2 <s1, and accordingly, the lowest values are achieved for the S4 sample as it contains higher Z_{eff} values, whereas, it was a great shield for gamma.

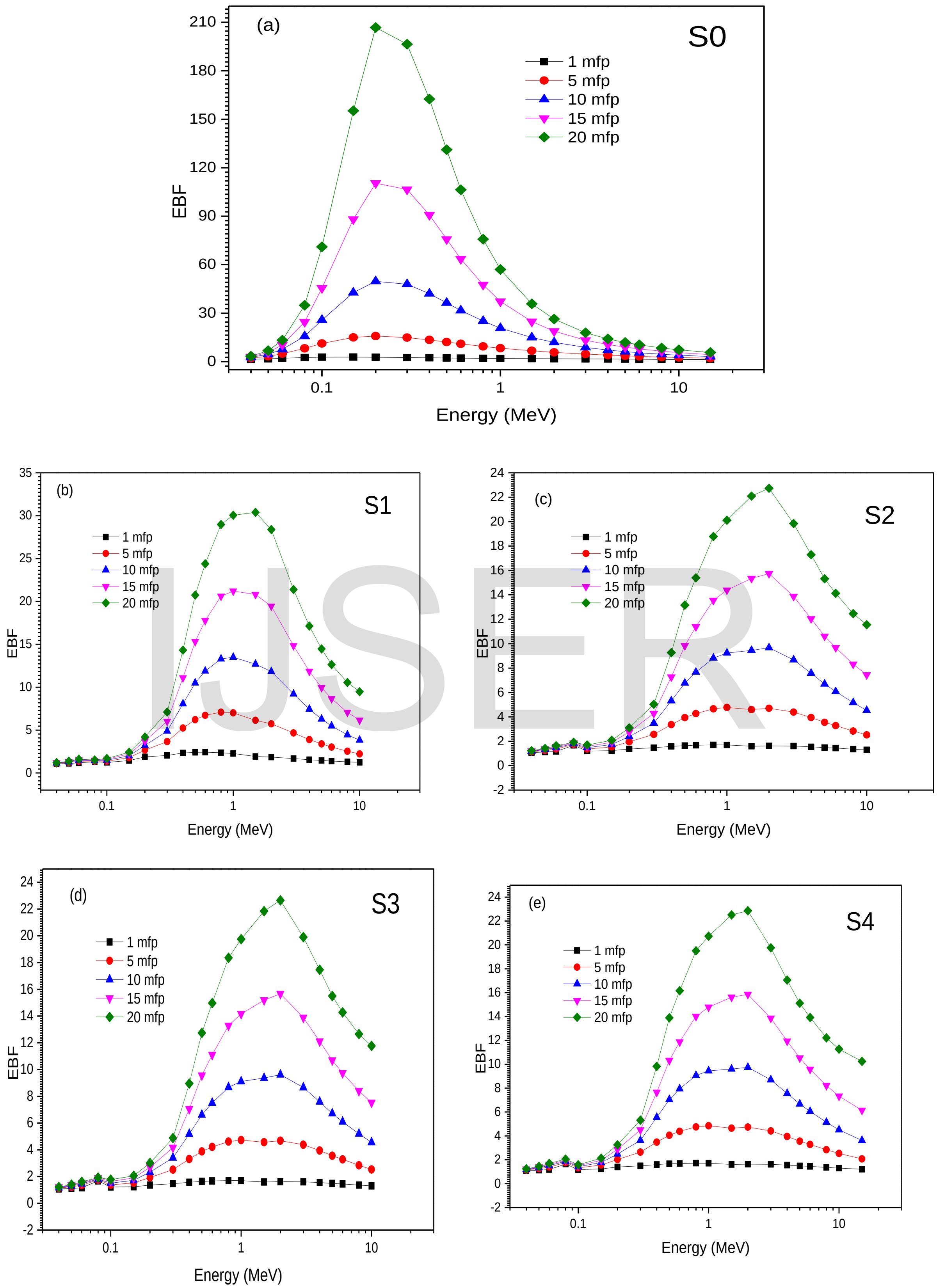

Fig. 10 (a-e): Variation of EBF with gamma-ray energy for all studied shields.

A comparison between the most important shielding parameters such as HVL, TVL, MFP, MAC, $Z_{eff,}$ and N_{eff}, of some materials that are usually used as radiation shielding and the examined composite concrete samples are given in Table 6. The results showed that concrete contains tungsten S4 is much better than all other materials.

Table 6. Comparison of many shielding parameters for different materials with present samples at gamma energy 662 KeV.

Samples	HVL	TVL	MFP	μ_m	Z_{eff}	N_{eff} x 10^{23}	
S1	1.4	4.64	2.07	0.086	13.74	3.18	Present study
S2	1.21	4.02	1.82	0.092	13.79	3.32	Present study
S3	1.14	3.79	1.78	0.094	14.04	3.33	Present study
S4	1.1	3.65	1.73	0.096	14.31	3.34	Present study
Ordinary concrete	7.74	25.70	11.16	0.0814	15.15	3.04	[24]
Hematite-serpentine	3.05	10.12	4.39	0.0787	9.98	2.91	[24]
Ba polymer concrete	5.89	19.57	8.49	0.0668	10.16	2.46	[25]
Ilmenite–limonite	--	--	--	0.076	11.52	2.93	[26]
Basalt–magnetite	--	--	--	0.077	10.01	2.98	[26]
Steel–magnetite	--	--	--	0.075	15.51	2.89	[26]
Barite concrete	2.33	7.75	--	0.0784	15.08	2.95	[27]

IV. CONCLUSION

In this study, the capability of tungsten concrete composite to attenuate gamma radiation was investigated; it was also compared with plain concrete. The linear and mass attenuation coefficients of all studied samples have been carried out against Cs-137. The results showed that both mass and linear attenuation coefficients of the prepared composites are higher than the plain concrete sample. Linear attenuation coefficient of concrete sample S0 is 0.083 cm^{-1}, while it becomes 0.63 $cm^{-1}$for composite containing tungsten S4, whereas μ_m increased from 0.070 (cm^2/g) for S0 up to 0.096 (cm^2/g) for S4. Also, RPE % values jumped from 15% for S0 up to 47% for S4, while it is 39% for S1, 43% for S2, and 46% for S3. Also, the values of HVL and TVL were very low for S4, where the HVL is reached for S4 using 1.09 cm thickness, while it needs a thickness of 8.35cm for plain concrete. On the other hand, only1.79 cm thickness of S1, 1.622 cm for S2, 1.6 cm for S3, and 1.57cm for S4 are equivalent to 3cm thickness of pure concrete (S0), which providing transmission% equal to 53.2% at 662 KeV of gamma-ray. It's found that S4 is the best shield, where it has the highest tungsten weight fraction. Consequently, it can be noticed that tungsten-concrete composites are promising alternative materials for gamma shielding. The order of choosing tungsten compounds as additives to concrete to be used as a shielding material isW>W2C>WC>WO2.

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