Classification of Egyptian Railway Grade Crossing

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Abstract: Grade crossing accidents in Egypt Railways shows that its about 6.7 accidents per million train.km, while the average grade crossing accidents worldwide are 0.65 accidents per million train.km, which is equivalent to ten times the world average[1]. Accidents rate on grade crossing represent about half the total accidents in Egypt Railways. This paper aims to safely alignment for grade crossing, avoiding accidents and the resulting losses and reaching to the necessary recommendations to achieve safe and safety on railway lines by applying the modern technology and safety systems. To realize this goal, grade crossing accidents should be studied then classifying according to the following, straitening of the grade crossing and determined the most severity grade crossing repeated accidents, fatalities and injuries. There are several factors that affect the dangerous of grade crossings, including train traffic and in this research was to find relative severity and this is more specific and then find out which one is more in need of development .

Keywords: Grade crossings, Egyptian National Railway, Relative severity, Train traffic

1. Introduction

Grade crossings is one of the most important and the most dangerous areas on railway lines because it represents points of conjunctions for the road network with the railway network which may cause the occurrence of many accidents that lead to the humanity and materiality losses.

Egyptian Railway represent the largest service organizations in the area where the lines stretching for a distance of 9750 km of railway for the movement of 1.5 million citizens every day, as it employs 73 thousand workers and employees and have 705 stations plus 1332 level crossing (Official), in addition of using 855 Bridge or grade crossing and exceed its services passenger traffic to serve freight traffic and beyond Million ton .

Railway is the safest mean of transportation at all; average road deaths between ten to twenty times the deaths on the railway .

Most importantly, there is a general trend among drivers and pedestrians of violation and non-compliance with traffic rules and regulations. The situation is further aggravated by a deficiency in traffic legislation and a lack of serious management and enforcement.

2. Definitions

2.1Grade crossings[2]

It's a road crossing whose road passes across one or more lines of railway at grade. If a road crosses adjacent tracks of one or more railway companies, with a distance of 30 m or less between track centre lines, measured along the travelled surface of the road parallel to the axis of the road, it is considered to be one grade crossing. However, two adjacent but separate roads that cross a line of railway are considered as separate grade crossings.

2.2Crossing surface[2]

It's the part of the road surface of the grade crossing that lies between the rails of each track and the part that lies outside the rails up to the ends of the railway ties, including the elevation of the railway tracks in relation to the road.

2.3Average annual daily traffic[2]

(a) With respect to a line of railway, it's the number of train and engine movements over a point or segment of the line of railway in any year divided by the number of days in that year.
(b) with respect to a road, it's the total number of vehicles passing over a point or segment of the road in both directions in one year, divided by the number of days in that year.

2.4 Passive protection[3]

The application of passive traffic control devices (signage) which provides an unchanging warning to the road user whether a train is approaching the crossing or not.

2.5 Active protection[3]

The application of warning devices to warn road users of the train approach when the train is a minimum time from entering the road-rail intersection. In some cases it also block the access to the crossing.

3. Classification of grade crossing on Egyptian Railway[4]

3.1Legal (formal) : which are officially recognized by ENR

3.1.1 Public grade crossings are constructed operated and maintained by ENR, while any public grade crossing is required to have warning sign and pavement markings .

(a) Active (protected) : these include automatically or manually activated flashing lights or flashing lights in combination with gates .
In terms of operation of the flashing lights and gates, active grade crossings can be classified into:

(1)Mechanically operated devices, which are linked to, operated and insured via the nearest block kiosk .

(2)Mechanically operated devices that are manned, most mechanically operated public grade crossing in Egypt are 24 hours manned with responsibility of ensuring gate or chain closing .

(3)Automatically or electrically operated devices, these are electrical circuits located on the rail track at predetermined distances from the grade crossings and activated by the passage of trains .

(4)Automatically operated that is manned, most electrically operated public grade crossing in Egypt are 24 hours manned with responsibility of ensuring gate or chain closing .

(b) Passive (unprotected) : these range from being a footpath or a completely opened crossing to a manually operated crossing . In order to transfer a grade crossing from being passive to active, a number of factors have to be considering. these include, the crossing traffic, the number of passing trains and the accidents or violation history of the grade crossing .

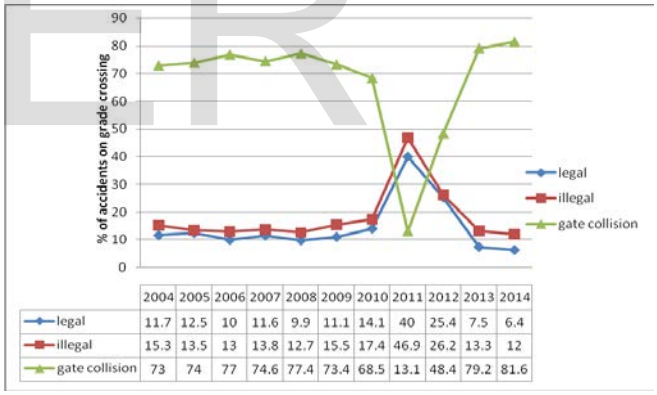
3.1.2 Private grade crossings are constructed operated and maintained by a private entity that the rail track passes its premises .

3.2Illegal (informal) : usually takes place in residential areas that are physically divided by railway or in areas where residences are on one side of the rail and work locations are on the other sides of the rail these informal grade crossings are common in urban areas in Egypt .
ENR is making much effort to close these informal grade crossings or alternatively transferring it is formal crossings .

4. Purposed methodology to determined the grade crossing priority classification according to their severity

4.1 Compute no. of accidents at grade crossings

From statistical tables of Egyptian National Railway has been complied number of accidents at grade crossings in the study period .



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
legal	11.7	12.5	10	11.6	9.9	11.1	14.1	40	25.4	7.5	6.4
illegal	15.3	13.5	13	13.8	12.7	15.5	17.4	46.9	26.2	13.3	12
gate collision	73	74	77	74.6	77.4	73.4	68.5	13.1	48.4	79.2	81.6

Figure 1: Shows the percentage of accidents at ENR grade crossing during the period 2004 – 2014

From the figure we notice the variation which occur of gate collision because of the security conditions of the country in 2011, led to a high incidence of legal and illegal grade crossing .

Table 1: ENR grade crossing accidents during 2004 -2014

Item / Year	Total railway accidents (No.)	Accidents level crossings (No.)				Level crossing accident %
		legal*	illegal**	gate collision***	total	at level crossings/ Total accidents
2004	975	65	85	405	555	57
2005	1043	69	75	409	553	53
2006	1118	46	73	433	552	49
2007	1231	66	79	426	571	46
2008	1248	56	72	440	568	46
2009	1344	55	77	364	496	37
2010	1057	63	78	307	448	42
2011	327	58	68	19	145	44
2012	447	70	72	133	275	62
2013	774	41	72	430	543	70
2014	1044	53	99	672	824	79

Source: ENR statistics - General Administration of control on the operating

*Road vehicle or pedestrian collision by trains at legal grade crossings
** Road vehicle or pedestrian collision by trains at illegal grade crossings
*** Road vehicle collision by grade crossings gate

Conclusions:
1- For legal grade crossings: accidents grade crossings irregularly fluctuated from 41 to 70 during 2004 – 2014
2- For illegal grade crossings: accidents grade crossings irregularly fluctuated from 68 to 85 during 2004 – 2014
3- For gate collision grade crossings: accidents grade crossings irregularly fluctuated from 307 to 433 during 2004 – 2014 except in 2011 and 2012 the accidents were 19 and 133 respectively

4.2 Identify the most severity grade crossings during the study period

It has counted the number of accidents at every grade crossing under study .

Table 2: Number of accidents on the most severity grade crossings during 2004-2014

	Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	Line	G.C.	Acc.	Acc.	Acc.	Acc.	Acc.	Acc.	Acc.	Acc.	Acc.	Acc.	Acc.
1	Sedi Gaber-Abo Qer	Elnoqrashi	2	4	3	6	5		4	1	2	2	2
2	Sedi Gaber-Abo Qer	Elmaamora	1	3	1	4	4	1	2			1	
3	Sedi Gaber-Abo Qer	Ghabrial	1	2	2	1			1	4	2		
4	Sedi Gaber-Abo Qer	Elzahriya			1	2	1			1			
5	Qabari-Matrouh	Arafa	1	1			2	3					
6	Qabari-Matrouh	Margham	3	1	1	3		2					
7	Qabari-Matrouh	Genina elqabari	1	1	1				4	1		1	2
8	Qabari-Matrouh	Moharam baik	3						1				
9	Qabari-Matrouh	Elfaraa				1			1				1
10	Qabari-Matrouh	Elmetras						1	2				
11	Qabari-Matrouh	Aameria/ Sedi Abd Elkader				1	1		1		1		
12	Qabari-Matrouh	Ekingy Mariuot/Elsalam		1	1	2		1	1	3			1
13	Ethad-Qabari	Elazema/Badr	1				1	1					1
14	Ethad-Qabari	Elbostan	1	1	1		1	3	2				1
15	Rasheid-Elmaamora	Elboseily	3		2	4		1	2		2		2
16	Cairo-Tanta	Tala	1	2	1			1			3		1
17	Ain Shams-Suez	Elgesh	1			1	1						
18	Suez-Ismaelia	Suez Triangle/ Elganaien	4	3	4	1		1	3	3	2		2
19	Cairo-High Dam	Maghagha	1	1		1			2		1		
20	Cairo-High Dam	Alekhsas		2	1			1					
21	Cairo-High Dam	BANI MAZAR		2	2	1	1				2		
22	Cairo-High Dam	Denawiya				1	1		2	1			
23	Cairo-High Dam	Om Khenan					2	1		2	3		
24	Cairo-High Dam	Elshanhoria&Elsheikh Amer/khazam	3			1		1		2	1		3

Source: ENR statistics - General Administration of control on the operating

4.3 Compute the average annual daily train traffic at the chosen grade crossings

It has counted the number of daily train traffic pass on every grade crossing in the subject of study and then find annual train traffic on them **[5]**.

Table 3: Classification of the grade crossings and their official daily train traffic

	Line	Grade Crossing	Total acc. 2004 – 2014	Train.Year
1	Sedi Gaber-Abo Qer	Elnoqrashi	31	48545
2	Suez-Ismaelia	Suez Triangle/ Elganaien	23	21170
3	Sedi Gaber-Abo Qer	Elmaamora	17	48545
4	Rasheid-Elmaamora	Elboseily	16	10950
5	Sedi Gaber-Abo Qer	Ghabrial	13	48545
6	Qabari-Matrouh	Genina Elqabari	11	13870
7	Cairo-High Dam	Elshanhoria&Elsheikh Amer/khazam	11	24820
8	Qabari-Matrouh	Margham	10	13870
9	Qabari-Matrouh	Ekingy Mariuot/Elsalam	10	13870
10	Ethad-Qabari	Elbostan	10	8760
11	Cairo-Tanta	Tala	9	13870
12	Cairo-High Dam	Bani Mazar	8	37595
13	Cairo-High Dam	Om Khenan	8	40515
14	Qabari-Matrouh	Arafa	7	16164
15	Cairo-High Dam	Maghagha	6	40515
16	Sedi Gaber-Abo Qer	Elzahriya	5	48545
17	Cairo-High Dam	Denawiya	5	40515
18	Qabari-Matrouh	Moharam baik	4	19814
19	Qabari-Matrouh	Aameria/ Sedi Abd Elkader	4	13870
20	Ethad-Qabari	Elazema/Badr	4	8760
21	Cairo-High Dam	Alekhsas	4	37595
22	Qabari-Matrouh	Elfaraa	3	13870
23	Qabari-Matrouh	Elmetras	3	13870
24	Ain Shams-Suez	Elgesh	3	8030

4.4 Calculate the relative severity for the chosen grade crossings and then rearrange them

Found the relative severity at every grade crossing in each year by dividing the number of accidents at grade crossings on train traffic volumes then assemblage and find average of them .

Relative Severity = The grade crossing priority classification according to their absolute severity/official annual train traffic for the most severity grade crossings

Unit = accidents/10000 train

Table 4: Relative severity for each grade crossings during 2004-2014

	Year / Line	G.C.	2004 Acc.	2005 Acc.	2006 Acc.	2007 Acc.	2008 Acc.	2009 Acc.	2010 Acc.	2011 Acc.	2012 Acc.	2013 Acc.	2014 Acc.	Total	Ave. R.S.
1	Sedi Gaber-Abo Qer	Elnoqrashi	0.412	0.824	0.618	1.24	1.03		0.824	0.206	0.412	0.412	0.412	6.39	.581
2	Suez-Ismaelia	Suez Triangle/ Elganaien	1.89	1.42	1.89	0.47		0.47	1.42	1.42	0.945		0.945	10.87	.989
3	Sedi Gaber-Abo Qer	Elmaamora	0.206	0.618	0.206	0.824	0.824	0.206	0.412			0.206		3.502	.318
4	Rashed-Elmamora	Elboseily	2.74		1.83	3.65		0.913	1.83		1.83		1.83	14.623	1.33
5	Sedi Gaber-Abo Qer	Ghabrial	0.206	0.412	0.412	0.206			0.206	0.824	0.412			2.678	.243
6	Qabari-Matrouh	Genina Elqabari	0.721	0.721	0.721				2.884	0.721		0.721	1.442	7.931	.721
7	Cairo-High Dam	Elshanhoria&Elsheikh Amer/khazam	1.21			0.403		0.403		0.806	0.403		1.21	4.435	.403
8	Qabari-Matrouh	Marghaam	2.163	0.721	0.721	2.163		1.442						7.21	.655
9	Qabari-Matrouh	Ekingy Mariuot/ Elsalam		0.721	0.721	1.442		0.721	0.721	2.163			0.721	7.21	.655
10	Ethad-Qabari	Elbostan	1.142	1.142	1.142		1.142	3.425	2.283				1.14	11.418	1.038
11	Cairo-Tanta	Tala	0.721	1.442	0.721			0.721			2.163		0.721	6.489	.59
12	Cairo-High Dam	BANI MAZAR		0.532	0.532	0.266	0.266				0.532			2.128	.193
13	Cairo-High Dam	Om Khenan					0.494	0.247		0.494	0.741			1.976	.18
14	Qabari-Matrouh	Arafa	0.619	0.619			1.24	1.856						4.334	.394
15	Cairo-High Dam	Maghagha	0.247	0.247		0.247			0.494		0.247			1.482	.135
16	Sedi Gaber-Abo Qer	Elzahriya			0.206	0.412	0.206			0.206				1.03	.094
17	Cairo-High Dam	Denawiya				0.247	0.247		0.494	0.247				1.235	.112
18	Qabari-Matrouh	Moharam baik	1.51						0.505					2.015	.183
19	Qabari-Matrouh	Aameria/ Sedi Abd Elkader				0.721	0.721		0.721		0.721			2.884	.262
20	Ethad-Qabari	Elazema/ Badr	1.142				1.142	1.142					1.142	4.568	.415
21	Cairo-High Dam	Alekhsas		0.532	0.266			0.266						1.064	.097
22	Qabari-Matrouh	Elfaraa				0.721			0.721				0.721	2.163	.197
23	Qabari-Matrouh	Elmetras						0.721	1.442					2.163	.197
24	Ain Shams-Suez	Elgesh	1.245			1.245	1.245							3.735	.34

4.5 Re-Classification of The grade crossing according to their relative severity

Table 5: Average of relative severity for the studying spot grade crossings during 2004-2014

	Line	Grade crossing	Ave. R.S.
1	Rasheid-Elmaamora	Elboseily	1.33
2	Ethad-Qabari	Elbostan	1.038
3	Suez-Ismaelia	Suez Triangle/ Elganaien	.989
4	Qabari-Matrouh	Genina Elqabari	.721
5	Qabari-Matrouh	Margham	.655
6	Qabari-Matrouh	Ekingy Mariuot/Elsalam	.655
7	Cairo-Tanta	Tala	.59
8	Sedi Gaber-Abo Qer	Elnoqrashi	.581
9	Ethad-Qabari	Elazema/Badr	.415
10	Cairo-High Dam	Elshanhoria&Elsheikh Amer/khazam	.403
11	Qabari-Matrouh	Arafa	.394
12	Ain Shams-Suez	Elgesh	.34
13	Sedi Gaber-Abo Qer	Elmaamora	.318
14	Qabari-Matrouh	Aameria/ Sedi Abd Elkader	.262
15	Sedi Gaber-Abo Qer	Ghabrial	.243
16	Qabari-Matrouh	Elfaraa	.197
17	Qabari-Matrouh	Elmetras	.197
18	Cairo-High Dam	Bani Mazar	.193
19	Qabari-Matrouh	Moharam baik	.183
20	Cairo-High Dam	Om Khenan	.18
21	Cairo-High Dam	Maghagha	.135
22	Cairo-High Dam	Denawiya	.112
23	Cairo-High Dam	Alekhsas	.097
24	Sedi Gaber-Abo Qer	Elzahriya	.094

Conclusions:

Dangerous level crossings are not considered the number of accidents and train traffic only, but there are other influences must be taken into consideration, including traffic volume of vehicles and pedestrian .

5. Conclusions and Recommendations

1. This method applied to all grade crossings Egypt annually to see none of them needs to be developed priority .

The development of grade crossings elements (civil works - operating and control systems works)

2. Re- planning the entrances and exits of grade crossings .

3. Adjusting the downhill of roads at the entrances of grade crossings .

4. Adjusting the intersection corners of the road with a railway line .

5. Provide seeing triangle at grade crossings entrances.

6. Improve the entrances and exits as well as increasing the width of the grade crossing by two lanes for each direction with a separator between the two-way .

7. Put up warning signs, regulatory and the ground planning for vehicles movement when approaching the grade crossing area .

8. Provide some grade crossings with effective control and automatic gates .

9. Improve lighting in cooperation with localities .

10. Use appropriate methods for paving the grade crossings according to the size and weights of vehicles axes .

11. Improve the working environment for the grade crossing workers through the establishment of a typical room for the grade crossing workers .

12. Separation between pedestrian traffic and vehicles for grade crossing of high capacity .

13. Make the walls around the grade crossing not to obscure vision .

14. Determine the technical authorities who responsible for the operation of the grade crossing with the Railway Authority .

15. Determine the responsibility of the resident individuals directly on grade crossings .

6. References

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