

Construction Equipment used in Highways Projects and the Risk of their Use on the Safety of Workers

Sedqi Esmaeel Rezouki

Baghdad University, Collage of Engineering, Al- Jadriya compound Road, Baghdad, Iraq

Abstract: Construction projects in general and highways projects in particular are of a special nature, and their most important features are the length of the period, which may lead to changing the conditions, which makes them contain multiple risks, as a result of the length of implementation and multi-stages, starting from the start of the project, The final delivery, which leads to an increase in the conditions of uncertainty and increase the probability of risk, and to demonstrate the risk of using road equipment on the safety of workers, and management of these risks, after the completion of the collection of studies and literature on the subjects of safety management in road projects, From In the province of Najaf - Iraq to view the risks that accompanied multiple types of highways projects, after that, the researcher organized special forms, these forms were then distributed to a large sample of experts (30 experts) , and after unloading the results and statistical analysis, the conclusions and recommendations are prepared by the researcher necessary to manage the risks of the use of construction equipment in highways projects on the safety of workers.

Keywords: safety, risk, highways projects, highways projects' equipment, highways projects' workers.

1. Introduction

Roads are considered one of the most important ways to help in the transfer of people and goods around the world also modern road network is considered one of the most important elements of development due to its role in achieving communication between the regions, villages, and cities with each other in addition to its role in achieving economic growth, as they contribute to the prosperity of trade and economic activities and ease traffic between urban communities and between production areas and areas of distribution .

The creation and expansion of the highways passes through many stages and needs to a large numbers of equipment and elements of construction in addition to large numbers of human resources and this led to complicates the risk management inside this construction sites and how to find a safe site contributes to the protection of those engineers , foremen , workers, etc. and creates a good ways without risks and problems as much as possible , where academic studies indicated that there are huge numbers of people work in construction Industry around the world for example only in United States nearly 6.5 million people work at approximately 252,000 construction sites across the nation on any given day. The fatal injury rate for the construction industry is higher than the national average in this category for all industries [1].

2. Functional Classification of Roads

In the process by which streets and highways are grouped into classes, or systems, according to the character of traffic service that they are intended to provide. There are three [2] or four [3] highway functional classifications: (highway), arterial, collector, and local roads. All streets and highways are grouped into one of these classes, depending on the character of the traffic (i.e., local or long distance) and the degree of land access that they allow , these classifications

are described in Table below :-

Table 1: Functional classification of roads

Functional System	Services Provided
Arterial	Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.
Collector	Provides a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials.
Local	Consists of all roads not defined as arterials or collectors; primarily provides access to land with little or no through movement.

3. Composition of Road Structure

Road Structure Cross Section is composed of the following components [4]

- Sub Base
- Base Course
- Sub Grade or Binder Course
- Surface/Wearing Course

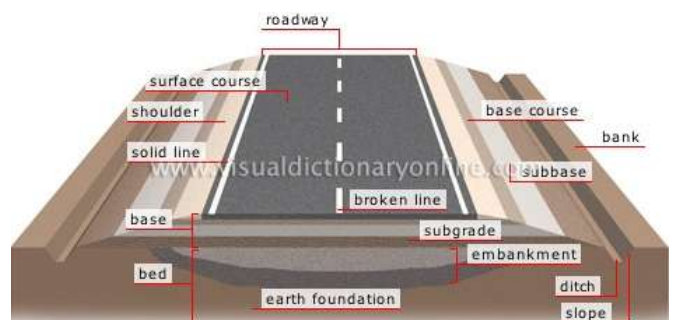


Figure 1: Composition of road structure

4. The Risk of Highways Construction Equipment's used on Workers

4.1 Public safety guidelines

Generally, for safe sites in asphalt paving operations everyone should do these guidelines of public safety, which included below [5]:-

- Make sure fire-extinguishing equipment (foam type) is present at all times.
- Ensure that asphalt distributor or asphalt kettle are in a level position (before heating) and are located at a safe distance from buildings and any flammable materials.
- Avoid exposure to fumes from hot bituminous material-stay on the windward side.
- Wear gloves and full body clothing to avoid prolonged skin contact or burns from hot bituminous material
- Wherever possible, minimize personnel near pneumatic cleaning operations and strict control of operatives near moving machines.
- A man must be stationed with a horn to warn others of the dangers and to prevent them walking across the area being rolled.
- Reversing alarms must be fitted to all plant machinery on site and flashing lights at must be switched on specially during night and when inclement weather.
- During asphalt laying workers must have plenty of fluid and be encouraged to take as much as possible. During extreme environmental heat Isotonic drinks to be used.
- Foremen need to monitor their workers for any signs of heat exhaustion.
- Operator using vibration equipment must wear earplugs and be taught about vibration white finger (causes, signs, symptoms and prevention).
- Ensure good standard of lighting, at night, for the work area.
- The supervisor or deputy should be on site during working hours.
- Leaking machinery must be repaired or removed from site at first opportunity. Plastic sheeting can only be used as a short-term solution.
- Restricted areas and safe distances should be established.
- Keep the public away from the work area.
- All others / workers in close proximity must wear earplugs and safety spectacles.

4.2 On Body Protection

Danger: Serious body injuries can result from blows to the body.

Solution [5]

4.2.1 Eye and Face Protection

- Safety glasses or face shields are worn anytime work operations can cause foreign objects getting into the eye such as during welding, cutting, grinding, nailing (or when working with concrete and/or harmful chemicals or when exposed to flying particles).
- Eye and face protectors are selected based on anticipated

hazards.

- Safety glasses or face shields are worn when exposed to any electrical hazards including work on energized electrical systems.

4.2.2 Foot Protection

- Construction workers should wear work shoes or boots with slip-resistant and puncture-resistant soles.
- Safety-toed footwear is worn to prevent crushed toes when working around heavy equipment or falling objects.

4.2.3 Hand Protection

- Gloves should fit snugly.
- Workers wear the right gloves for the job (for example, heavy-duty rubber gloves for concrete work, welding gloves for welding, insulated gloves and sleeves when exposed to electrical hazards).

4.2.4 Head Protection

- Workers shall wear hard hats where there is a potential for objects falling from above, bumps to their heads from fixed objects, or of accidental head contact with electrical hazards.
- Hard hats are routinely inspected for dents, cracks or deterioration.
- Hard hats are replaced after a heavy blow or electrical shock.
- Hard hats are maintained in good condition.

4.3 Paving Heavy Equipment

4.3.1 Forklifts

Danger: Approximately 100 employees on USA only are fatally injured and approximately 95,000 employees are injured every year while operating powered industrial trucks. Forklift turnover accounts for a significant number of these fatalities.

Solutions:

- Train and certify all operators to ensure that they operate forklifts safely.
- Do not allow any employee under 18 years old to operate a forklift.
- Properly maintain haulage equipment, including tires.
- Do not modify or make attachments that affect the capacity and safe operation of the forklift without written approval from the forklift's manufacturer.
- Examine forklift truck for defects before using.
- Follow safe operating procedures for picking up, moving, putting down and stacking loads.
- Drive safely--never exceed 5 mph and slowdown in congested or slippery surface areas.
- Prohibit stunt driving and horseplay.
- Do not handle loads that are heavier than the capacity of the industrial truck.
- Remove unsafe or defective forklift trucks from service.
- Operators shall always wear seatbelts.
- Avoid traveling with elevated loads.
- Assure that rollover protective structure is in place.
- Make certain that the reverse signal alarm is operational

and audible above the surrounding noise level [7].

4.4 Roads Heavy Equipment

Danger: there are many problems, risks, and dangers that afflict workers in road projects for example hot asphalt can cause burns because asphalt materials are flammable and hot, Carcinogen, run over, inhalation of toxic gases, exposure to sunlight and direct and indirect injuries. It's especially true when workers use roads heavy equipment [8].

4.4.1 Pavers

It is common practice to spray the machine before laying operations commence. This should be done before the screed heater is ignited. Tools and equipment should be securely stowed and all working platforms free of obstructions.

It is essential that the machine operator:

- Ensures that nobody is standing on the machine, in the hopper, on the side arms or on the top of the screed before putting the machine into motion
- Never leave the controls while the machine is in motion
- Ensure the hopper is clear except for working material before engaging switches or clutches
- At the end of the working day park the machine so as not to cause an obstruction to road users.

It is essential that all persons:

- Stand clear of the screed when it is being raised or lowered
- Stand clear of the hopper sides when they are being raised or lowered
- Never touch or lean on the side arms when the machine is working
- Never enter the hopper when the engine is running
- Never stand in front of the hopper when a vehicle is reversing to discharge its load [9]

4.4.2 Planers

The operation of planning machines is essentially the removal of old (worn) road surfaces to a controlled depth producing screenings in a granular form which can be recovered and removed from the working site.

It is essential that the planer operator:

- Gives clear warning when he intends to move the planer or put it into operation
- Ensures the way is clear of other persons, vehicles and equipment before putting the machine in motion
- Never leave the machine controls while the machine is in motion
- Co-operates with the screw man, other machinery attendants and the drivers of vehicles removing the screenings from the loading-out conveyor
- Observes and conforms with traffic directional notices and signs
- Ensures that the doors enclosing the cutters are not opened except when, or until, the cutters are stationary and the engine stopped
- It is essential that screw men and attendants:
- Co-operate with the machine operator and act on any warning or instruction he may give

- Do not walk under the loading-out conveyor whilst the machine is working and discharging into a vehicle
- When passing from one side of the machine to the other, pass always in front of the machine
- Keep their feet clear of the machine while it is planing, particularly at the rear of the drum box
- Wear high visibility jackets, safety helmets and goggles as required
- Supervise drivers reversing their vehicles to below the loading-out conveyor
- Are alert at all times to traffic flow
- Use cones or markers when necessary to preserve a safe working area
- Never remove any machine guard or cover plate unless under the direct instruction of the machine operator [9].

4.4.3 Chipping Machines

Chipping machines which operate behind paving machines and in front of road rollers require the following precautions:

- Persons should keep clear of the traversing hopper wheels and track whilst the machine is in motion
- When it is necessary to use the poking tool to reduce blockages or clogging all machinery should be disengaged [9].

4.4.4 Road Rollers

Road rollers include both steel and pneumatic wheeled rollers and vibrating rollers, towed or pedestrian.

4.4.4.1 Steel and pneumatic wheeled rollers

Before moving, the driver should always ensure that the way is clear of objects and other persons. Rollers spend 50% of their working cycle reversing and drivers must look to the rear during reversing the machine

When a roller attachment is in use. e.g. scarifier, or asphalt cutter, the driver must not give it his whole attention; he must always ensure the way ahead is clear.

Coasting a roller down inclines is dangerous and must never be permitted. If it is not possible to park on level ground then the wheels should be chocked. The hand brake should always be applied when the machine is parked [9].

4.4.4.2 Vibrating rollers

Safety footwear should be worn by all operators. When working near kerbs and side-walls operators must beware of impact and collisions.

Where a diversion for pedestrians is necessary it must be properly signed. Pedestrian rollers should be fitted with a "dead man's handle to prevent crushing injuries.

When unloading/loading from a trailer, the latter must have effective brakes, or be suitably chocked, with legs positioned to prevent tilting.

Be aware of steel drums against a steel low-loader floor as the machine could slide and overturn [9].

4.4.5 Dump Trucks

The following guidance should be implemented in relation to the safe use of Dump Trucks, this would also apply in most cases to tipper lorries and tractors and dump trailers.

- Keep to the vehicles load limits, don't overload
- Turn corners with care as you could overturn
- Give way to loaded vehicles
- Look out for overhead power lines
- Ensure the vehicle or trailer body is lowered before moving
- Keep a safe distance from other vehicles
- Observe speed limits and other vehicles
- Allow more braking distance when fully loaded
- Use brake retarders/exhaust brakes as designed
- Travel at a speed consistent with site conditions
- Obey the signalers instructions
- Do not travel with the body raised unless for shunting forward to clear material from the body.
- Never allow loading to take place over your cab
- Never carry passengers unless there is a proper seat and it is recommended by the vehicle manufacturer
- Never work or allow anyone to work under a raised body or cab unless a proper safety bar is fitted as designed.
- Never reverse unless you are sure it is safe to do so
- Look out for person using mobile phones as they may not see or hear you, look out for other vehicles and persons in the area.
- Do not remain in your cab during loading unless a proper approved overhead protection.

5. Field Analysis

To show the positive aspects and scrutinizing the negative aspects in order to set treatment and appropriate alternatives. The method of data collection by the open questionnaires and they are one of the important methods to obtain adequate information. It has been used by the researcher to inquire about the reality of Construction equipment used in highways projects and the risk of their use on the safety of workers in Ministry of Construction and Housing - Roads and Bridges Department - Najaf branch.

After reviewing a large number literature of studies on Construction equipment used in highways projects and consulting many site engineers in In the specialization of roads and directly reviewing the highways maintenance administrators and asking a number of direct questions and obtaining the appropriate answers that enrich the research and help the researcher, the filed questionnaire form was prepared according to the Five Likert Scale

5.1 Scientific specialization

It seems clear from the Fig (2) that there is a great proportion of the research sample are civil engineers and are generally influential in most the governmental projects, because of that Now, after giving the weight of each degree of influence has been collecting the results of the questionnaire and duplicates cursor over each factor of the proposed factors by the researcher to be the severity of occurrence guide

most of the committees that designed or implemented the projects consisting of engineers from different disciplines therefore they were part of the sample, but less proportions, Fig (2) shows the distribution of the sample according to scientific specialization

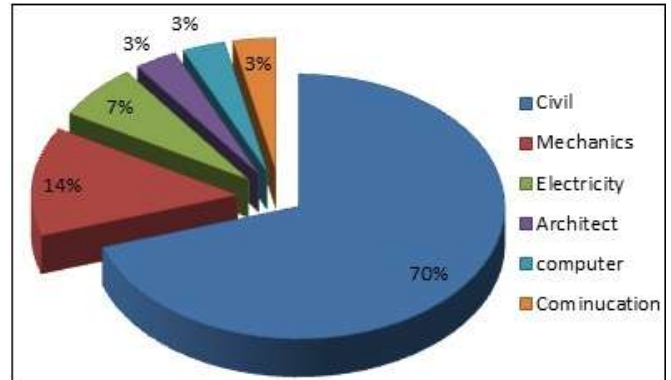


Figure 2: The distribution of the sample according to scientific specialization

5.2 Field Experience in Engineering

Fig (3) shows the distribution of the research sample according to the field experience in engineering

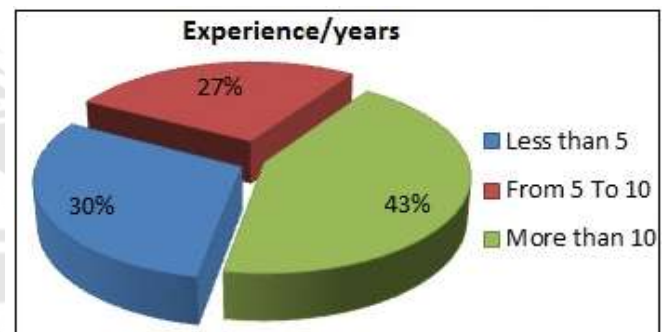


Figure 3: The distribution of the sample by experience

5.3 Statistical analysis of the results

To find out most common construction equipment's risks in highways projects and the popular types of the equipment used in this projects the researcher will using Likert scale and give each indicator of the questionnaire it's weight as shown in table(2).

Table 2: Likert scale's weight

Degree of Severity		
Option	Weight	Meaning
Very Frequently	5	It occurs largely in the construction project
Occasionally	4	It occurs occasionally in the construction project
Seldom	3	It occurs lowly in the construction project
Rarely	2	It occurs rarely in the construction project
Never	1	It never occur in the construction project

account and the statement of the most equipment used in the construction of road projects in Iraq from the standpoint of respondents also found the percentage of

their answer with respect to each factor influential factors as shown below in table (3).

Table 3: The number and the percentage of iterations indexed over each factor and severity index for using roads equipment

Equipment Answers	Forklift	Pavers	Planers	Chipping machines	Steel and pneumatic rollers	Vibrating rollers	Dump trucks
Commonly used	2	29	11	5	27	11	30
Medium used	12	1	13	10	2	13	0
Seldom used	8	0	4	6	1	4	0
Rarely used	5	0	2	7	0	1	0
Not used	3	0	0	2	0	0	0
Mean (%)	63.34	99.34	82	66	97.34	82.76	100

Now after finding out the most equipment used in Najaf roads' projects, -Iraq, the researcher will moving to the second part of the questionnaire process to know the risks resulting from the use of road equipment on the safety of workers after finding the number of frequencies and the

percentage for each frequency in front of each factor and the severity index occurrence of each risk chose from the researcher, as shown in table no. (4) As well as find the top five risks affecting on workers in construction sites as shown below in table (5).

Table 4: The number and the percentage of iterations indexed over each factor and severity index for risk of using equipment in road projects

Risks	Degree of frequency					Mean (%)
	Very Frequently	Occasionally	Seldom	Rarely	Never	
Exposure to run over during the work of construction equipment at the site	2	6	16	6	0	62.67
Injury poisoning as a result of inhalation of toxic gases	0	6	12	9	3	54
Exposure to burns caused by the use of incendiary materials as coal tar and other	1	8	9	6	6	54.67
The fall in non-flat sites at work	4	9	9	7	1	65.33
Wound infection as a result of the fall of the heavy parts on the body	4	9	10	2	5	63.34
Exposure to infection due overloading the equipment	4	6	10	7	3	60.67
Exposure to infection as a result of banter driver equipment at work	4	7	10	8	1	63.34
Exposure to infection as a result of driving at high speed equipment	7	7	4	10	2	64.67
Exposure to infection as a result of lack of experience driver equipment	4	11	7	6	2	66
Exposure to infection as a result of the use of old equipment and consumer and inoperable	4	11	8	3	4	65.34
Exposure to infection as a result of a lack of regular maintenance on the equipment before use	3	15	8	3	1	70.67
Exposure to infection as a result of the existence of numerous barriers to work such as electricity wires and water pipes	5	14	8	3	0	74

Table 5: The top five risks affecting on workers in construction sites

No	The top five risks affecting on workers in construction sites	Mean (%)
1	Exposure to infection as a result of lack of equipment driver's commitment to the instructions and guidance safety while driving in construction sites	79.34
2	Exposure to infection as a result of the existence of numerous barriers to work such as electricity wires and water pipes	74
3	Exposure to infection as a result of a lack of regular maintenance on the equipment before use	70.76
4	Exposure to infection as a result of lack of experience driver equipment	66
5	Exposure to infection as a result of the use of old equipment and consumer and inoperable	65.34

6. Conclusion

The researcher conclude by using table (3), the vast majority of respondents confirmed the use of common equipment in Iraq's road projects without the other modern types , The researcher find that a few of them used Chipping machines and the proportion is lower than modern paving equipment as a forklift in road projects as well as infer from that most types risks that affect the safety of road projects in Iraq, according to the opinion of the respondents are in the first class being injured as a result of lack of commitment by the driver devices to the instructions and directives of safety while driving on construction sites and to the extent the second exposure as a result there are many barriers to work such as electricity wires and water pipes and foremost third, the injury occurs as a result of the lack of regular

maintenance on the equipment before using it and then conclude that exposure to infection as a result of a lack of equipment driver experience and finally the injury occur as a result of the use of old equipment and inoperable and the consumer and the fall of the sites uneven and results of the survey conclude that the vast majority of engineers are committed to instructions and plans of occupational safety and trying to avoid injury before they occur using posters, etc. The use of trained personnel in the work and prevent loading equipment more than a capacity and are demanding a periodic maintenance on the equipment, as well as prevented from using the old equipment in their positions and thus conclude that some of the projects where you get the risk inside, may the engineering supervision staff sufficient number is not available or may not be available where an expert cadre supervisor required class.

7. Recommendations

The researcher recommends the use of modern phases of construction equipment used in road paving projects in Iraq also recommends that supervisions engineering staff should be expert and train and on a sufficient number in construction projects, especially in road projects and avoid reliance on labor as much as possible in the transfer of loads particularly high loads, and the need to apply the government safety codes in all construction projects and as a researcher recommends that the allocation of the management of the site during work which manages the work area and the consequent movement of cadres working in order to prevent access problems and risks that affect the safety of workers in the construction sites as the researcher recommends also the establishment of a number of training , technical lectures and educational courses for cadres especially in long-term projects to avoid the risk as much as possible and finally researcher recommends diversifying respondents views promised only rely on public sector employees and increase the number of forms to get the most accurate results.

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