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Casting of Track Impressions Using Glue Gun Stick or HMA

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A B S T R A C T

In forensic science, trace evidences are as important as other evidences such as biological evidence, physical evidences, etc. . Such trace evidences are track impressions which includes tire marks or footwear impression. Footwear impression is one of the most reliable evidence for linking the crime scene with suspect and victim. Tire marks also play very important role in establishing the information about the vehicle used in crime. On a crime scene these footwear impressions are the most common evidence. It is found in crimes such as homicide, robbery, theft, etc. . it is found in both indoor crime scenes and outdoor crime scenes. Footwear impressions and tire marks may of three types Visible impressions also known as 2-D impressions, Plastic prints also known as 3-D prints and Latent impressions also known as invisible prints. In this paper we are going to discuss about 3-D impressions and it's casting method. Since footwear impressions and tire marks came in existence casting of 3-D impressions is done only by Plaster of Paris i.e. POP. This POP is brittle in nature and needs much more time for drying out. But here we are using non-mechanical method which only need a heat source for melting the Glue Gun Stick or Hot Melt Adhesive. We have melt this adhesive using normal gas stove and poured it over the impression got the results out. We got the impressions so clear that even the no. of the outsole of footwear is visible. This takes much lesser time to dry and is much more durable then POP. It is even much more affordable then POP.

Keywords: Forensic Science, Track Impression, 3D Prints, POP, Glue Gun Stick, Hot Melt Adhesive (HMA)

1. INTRODUCTION

According to one of the definition given by William J. impression evidences are, "the objects or materials which can gain or opt. the character of other material or object due to even slight physical contact."[1]. Impression evidences which can be encountered at the crime scene are bite marks, fingerprints, footwear impressions, tool marks, tire marks, etc.. Footwear impressions or tire marks are considered as the pattern evidences or trace evidences or track evidences which occur only by the simple surface contact or even by a slight touch. These are the most common evidences which can be encountered at crime scene. These impressions are dependent upon the Locard's principle of exchange; it states that every touch leaves a trace which is commonly ignored by the perpetrator.

Footwear evidences are the best evidences which are used to link suspect with crime and crime scene and so as tire marks. When the biological evidences are absent footwear impression is the only evidence which is used to identify the offender. These impressions may not identify the suspect clearly but it can link the suspect very easily. The quality may differ due to the place where impression has occurred but it is enough for identifying the type of footwear worn by the suspect. These impressions may be found at various crime scenes such as hit n run cases, robbery, theft, homicide, etc.

Similarly, tire marks are also very useful in identifying whether the committed crime has involvement of vehicle or not. By the presence of tire marks we can also get to know the type of vehicle used in commitment of crime, we can even trace the origin of tire marks that from where the tire marks are originated.

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Places where footwear impressions can be found at crime scene:

(1) The place from where to where suspect has moved or kept his movement,

(2) The place where crime has taken place,

(3) Near the vehicle of suspect,

(4) Even on the secondary crime scene, etc.

Places where tire marks can be found:

(1) Maybe where the body of the suspect is dumped,

(2) Where the crime has committed,

(3) Even at the secondary crime scene, etc.

1.2 HISTORY

Forensic comparative science involves examination of various types of evidences such as biological evidences as blood, semen, etc.; trace evidences such as tire marks and footwear impressions; latent prints; etc. .[2] Track impressions are considered to be the oldest impressions used as comparative evidences.[2] These impressions can be found in a series or as single impression of a vehicle, a person or animals.[2] Earlier during 9600 BC man used to find their food using these marks only they would get the idea of direction or type of animal with the help of their foot impressions.[2]

Examination of footwear impression and tire marks are carried out for almost 200 years. Earliest case solved using footwear impression was Richardson case in Scotland in 1786. In this case, the impression of boots of murderer was found near the marshy area of victim's place where her dear body was found. The impressions of boots were in a running gait pattern and the impressions were deep into the soil. By examining the impression the investigator gets to know that the outsole of boots has lots of nails in it and have lots of new patches. The investigator then compared the boots with the boots of the guests that appeared on the funeral of the girl on the next day, by this they caught the criminal.[3]
After this case footwear impression gained an important position in investigation of crime.

1.3 PRINCIPLE OF TRACKMARK IMPRESSIONS

These track marks occur due to Locard's principle of Exchange which states that **'every touch leaves a trace'.** Principle of examination of track marks is almost similar to that of fingerprints. Tire or footwear leave behind their impressions or prints, commonly referred as 'imprints'. [4]

Types of track marks depend upon the type of surface they have formed. Impressions are left behind on porous surfaces such as sand, mud, snow, etc. and imprints are formed on surfaces such as tiles, concrete, etc..[4] As footwear and tire are used frequently, their physical characters may alter with time which is known as wear, and it can be seen in imprints and impressions.[4]

1.4 CHARACTERISTICS OF IMPRESSION OR PRINTS

These marks are having mainly 3 characteristics;

1) Class characters
2) Wear characters
3) Individual characters

1) Class characters – Class characters occur due to different types of manufacturing processes. There are two types of class characters first is limited class characters and another is general class characters. Limited class characters are the variations which occur due to some peculiarities in some molds due to frequent use. General characters are the characters which are common in the footwear or tire of same brand or model.[4]

2) Wear characters – Wear are the characters which cause when footwear or tire is used for longer period. It is dependent upon the surface they are used, at which place the pressure is applied, for how much time they are used; to which brand they belong as some brands cause wear like characters so that their product could be different from other companies. It also refers to how extreme damage is caused to the tread of tire or outsole of footwear. [4]

3) **Individual characters –** Individual characters are the characters that occur due to the usage of particular footwear or tire**.** These can be permanent such as cut marks, kind of gap caused, etc. and it can be temporary also such as pebbleor stone or twig gets struck in between gaps.[4]

1.5 TYPES OF IMPRESSION OR IMPRINTS CAUSED

You can find either of three types of impressions on crime scene.

1. Latent prints
2. Visible prints
3. Plastic prints

1. **Latent prints** are the impressions that are caused due to the static charge between the tread of footwear or tires and are not visible to naked eyes. These are also known as chance prints are can be seen or developed using various methods or powders which are depended upon the surface where prints are formed.[4]
2. **Visible prints** are also known as 2-D prints, it basically refers to the transfer of material from the tread of the object to the surface. These prints are visible with naked eyes. As for example bloody footprints or muddy tire marks on concrete.[4]
3. **Plastic prints** are also known as 3-D prints; they are caused on porous surfaces such as sand, snow, mud, etc.. They can be collected and stored for examination by casting methods.[4]

1.6 COLLECTION OR RECORDING OF PRINTS

Collection or recording of these prints are done in various ways such as sketching, photography, lifting, and casting.

1. **Sketching –** For getting proper information from the evidence it is necessary to document, collect, preserve the evidence. After taking necessary photographs from the crime scene various techniques are used to collect and preserve the evidence, but however, these methods cannot protect or maintain the identity of prints. Whenever prints are found on porous surfaces casting is used to preserve the prints. But when they are found on hard and immovable substances sketching and documenting the prints are the best available options.

2. **Photography –** Photographing the evidence is the crucial part of crime scene evaluation, especially in case of impressions or imprints. Photographs should be taken at an angle of 90 degree so that perfect size of the impression can be determined. Overall photography should be done, close-up should be taken and alternate light source or other chemical methods should be used to enhance the minute details of the prints so that they could be captured in photographs.

3. **Lifting –** For lifting adhesive paper is used they are kept in the contact of the imprints cause due to dirt or dust. This adhesive paper is then treated with 0.05 gm. of crystal violet and then with 500 ml of distilled water so that prints could get stained and then can be traced or saved for future reference. Examples of lifters are gelatin lifters and electrostatic lifters.

4. **Casting –** Casting is the method used for 3-D impressions which are formed over porous surfaces. Here, for casting POP is used and sometimes dental stones are also used.

1.7 ANALYSIS OF IMPRESSION

Analysis of impressions can be done by the information gathered through the outer sole impressions of footwear, tread marks of tire and inner sole impressions of footwear. From outer impressions we can determine the no. of suspects, path involved in crime scene, whether the secondary crime scene is involved or not, such information can be determined. We can get these impressions from floor, ground, carpet, body of victim which results due to kicking. Tread marks of tires are used determine the involvement of vehicle in crime, through this we can get idea of owner of the vehicle also.Inner impressions are on the surfaces where the foot of the individual is in contact. From this we can directly link the suspect with the crime scene.

1.8 FORENSIC RELEVANCE

Footwear impressions are very important for crime scene reconstruction, it also tells about no. of suspects involved in a crime, how the events occur during the commencement of crime, entry and exit points of crime, etc.Tire marks can determine type of vehicle used, etc.. This was all about the track marks which we are going to study or cast here. Now, let's have some information regarding the material which we have used for casting.

I.9 GLUE GUN STICKS OF HOT MELT ADHESIVE (HMA)

Glue gun sticks are is a type or form of thermoplastic adhesive. It is also known as plastic glue as it is also made from waste plastic, ethylene-vinyl acetate copolymers. Its melting point ranges from 90^{o} C to 120^{o} C.[5]

These glue sticks consists of one base material and others are additives so that the degree of crystallization could be high.[5]

Due to faster crystallization rate high bonds are formed between the material and HMA. It could dry just within 10 min and can also be reused. Even they are environment friendly as HMAs are made from waste plastic material.

Fig. 1 – Glue Gun Sticks

2. METHODOLOGY

The type of research we did is qualitative research. Our main aim was to use a kind of material so that casting of track marks such as footwear impressions or tire marks can be made easy and less time consuming and which can be more reliable than POP less tacky procedure and which could give accurate results.

2.1 MATERIALS USED FOR RESEARCH

Here we are using different types of surfaces for casting the prints or footwear impressions and tire marks. Surfaces were mud, sand, construction material and even ice as snow was not available.

For this purpose here we are using trays in which we are creating these surfaces, a heat source (gas stove as we have used for this dissertation), glue gun sticks or also known as hot melt adhesive, hair setting spray for setting the surface and a ruler for measuring the print.

2.2 PROCEDURE

We have used the common procedure or conventional procedures used for casting but our casting material is just different.

The methodology used here is common for all the surfaces we are using for our analysis.

(1) Firstly, we have to create desired surfaces by collecting the sand, mud, sand obtained from construction site and ice in the tray.
(2) Then take the impressions of track marks on the tray of desired surfaces.
(3) Then using the setting spray or you can say hair setting spray just set the print so that while pouring our casting mixture small details of the print could not be alter.
(4) Then measure the length of the print just as the usual process we are doing while POP casting of the prints.
(5) After that using a heat source, we have used a gas stove in a vessel heat these HMAs or say glue gun sticks to the gel like consistency and after that pour it on the print directly. There is no need of any kind of frame around the print.
(6) You will get your prints ready just within 10 min. Here are the pictures of our work done.
(7) Observations are as follows.

Fig. 2 – Footwear impressions taken on Mud

Fig. 3 – Footwear impressions taken on soil

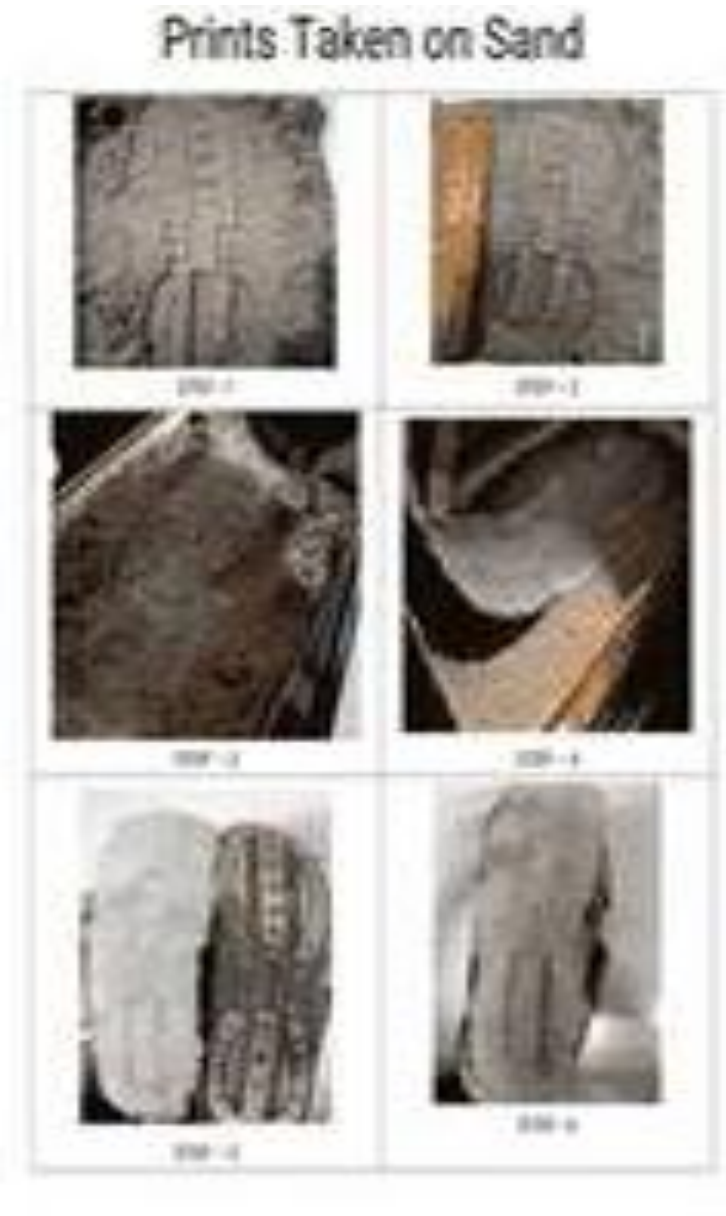

Fig. 3 – Impressions taken on Sand

Fig. 4 - Impressions taken on sand found at construction site

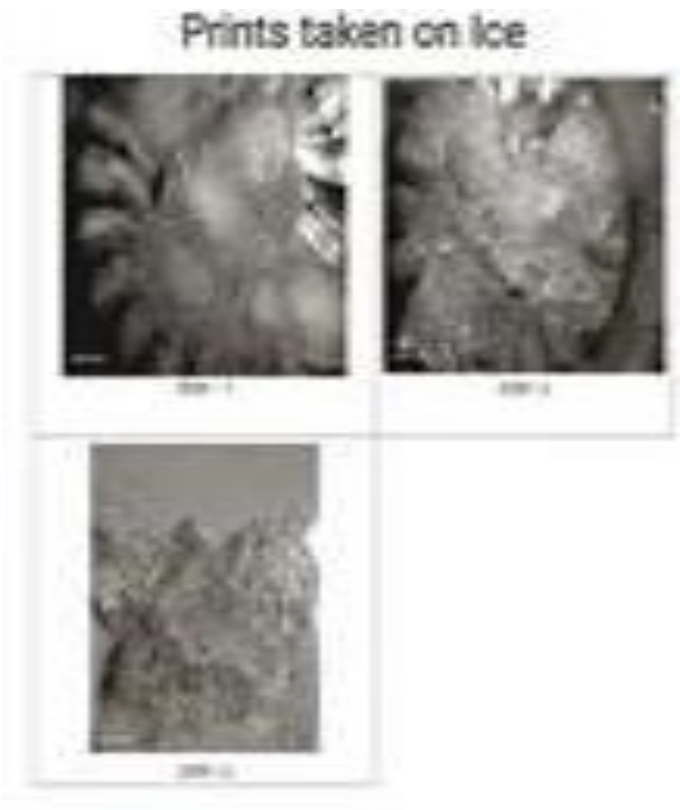

Fig. 5 – Sample cast prepared over ice

Fig. 6 – Tire marks on sand found at construction site

3. RESULTS AND DISCUSSION

Results are as follows:

A tremendous incline is seen in crime rates not only in our country but all around the world. In such worsening situation there is need of having new techniques or new methods to be discovered for making the evidences more reliable so that there should not be any question mark over the authenticity of the evidence.

In such situation, there is heavy workload over forensic scientists and even they have a huge amount of back log because the crime rate is increasing but the man power is stagnant. So, such methods or materials should be discovered so that we could have quick and accurate results.

Talking about first footprint impression which was taken on mud; the mud was wet naturally and its texture was smooth, as there were no pebbles or stones in it. We have taken 12 glue gun sticks, cut them into small pieces and then melted it on gas stove for 5 min then poured it on print and got our results within 10 min. As you can see in first print the no. of footwear is also visible. Even we can collect the material from the cast and then we can analyse it also.

Now, moving onto second print. We have taken this print also on mud because the type of outsole impression was different and also this mud was a bit dry and having lumps. Main thing to analyse or observe here was, whether we can get proper impression on dry soil which is uneven? And the answer is yes, that in this case also our caste came out very easily and we could also get the minute details of our impression. The significant point to be considered here that uneven texture of the mud didn't bother the cast and sustained its accuracy.

Coming onto third impression, we have taken a bit different surface which is sand. Sand was fragile than mud and it could alter if some thick viscous sol^{n} falls over it. But it was good to see that this material or HMA is also successful over sand.

Forth impression was taken on soil which is found at construction site which consists of mud, sand, pebble, cement, stone, etc. this surface was chosen because it is having many variations in its composition and it was interesting to see that not even a single pebble get stick to the surface of cast and the cast came out to be so accurate and specific with all the minute details of the concerned footprint.

Fifth cast was just a sample cast which was taken on ice as snow was not available. We have used this surface in order to ensure its credibility over snowy surface as the point of concern here is that since HMA sticks require quite high temperature to be melted and convert into a gel like substance such high temperature may not dismantle the original footmarks and it is impressive to see that on ice also it came out pretty well even fast as compared to other prints. Ice was also stable it was not melted at all. The cast came out in just 7 min.

The main aim of this dissertation was to use different material or chemical rather than POP so that casting of track marks could be made easy, more accurate, more durable, could be easily kept anywhere and less time consuming.

Initially I had used resin, for casting; but it failed miserably. There were three reasons behind its failure. The reasons are as follows:

1. It was non – UV resistant, so it could not work outside or at outdoor crime scene and generally these track marks are found outside or at outdoor crime scene. I could understand this when I kept the cast outside in sunlight just for an hour and as soon as I had lifted the print it broke down.
2. It's curing or say drying time was much more than POP; and this much time is not affordable for any crime scene investigator. Resin took almost 24 hours to get cured and we cannot give this much time for just 1 cast.
3. It gets absorbed in soil. As soon as we poured the resin over the impression it start getting absorbed by soil or you can say the selected surfaces. We have created these surfaces in an empty box so when it got dried we have to break that box because the cast didn't came out but resin had bind the soil only in the form of impression. So the lifting process was also difficult.

These were some reason due to which our first material which was resin failed miserably.

Then we tried casting the track marks using HMA and it gave the accurate results and it could stand all the aspects of our aim.

The first aspect was to make casting process feasible. Using HMA as casting material, the process was made feasible as it didn't require any frame to settle the casting material at its place or to be on the impression properly. It didn't require any supervision till it dry because drying time is much lesser.

The second aspect was to have more accurate results. Sometimes, while using POP if print gets disturbed it would affect the cast also. But by using HMA even the disturbance to impressions would not affect the cast. This would result into more accurate cast which would help in further investigation.

Third thing was to have more durable cast. In POP, sometimes while lifting the cast it breaks this leads to wastage of POP, time and efforts. Also while the POP cast is taken to laboratories at that time also it breaks. This would lead to the breaking of chain of custody. So to maintain chain of custody HMA is much effective. You can even fold the cast and it would not break or gets disturbed.

Fig. 8 – Durability of cast

Forth aspect was to make cast cure or dry out in comparatively much less time as POP takes. POP takes about overnight to dry but HMA just takes 10 min to dry. It is even cost effective. Single impression uses 10 sticks of HMA and each stick costs 5 bucks. And within 10 min we will get our cast.
Fifth aspect was that the cast could consume less space in laboratories. It does not require any kind of box or container to preserve the cast you can store in plastic zip lock bags and it could easily be taken anywhere. As you can see in figure 5.2 the cast is comparatively thin.

Fig. 9 – Occupies less space

This study demonstrates the use of HMAs or glue gun sticks in casting of 3D impressions or prints of track marks very efficiently and in lesser time which is very important to be recovered from a crime scene. Future works need to find some very efficient method which can provide us more accurate results so that evaluation can be done properly. Future work needs to compare the current traditional material used for casting with this new material so that HMAs can be used legally and for practical purposes at crime scene. Many environment friendly materials can also be discovered for casting purposes. Quality of HMAs can also be enhanced using the study material which provides us information regarding the effect of weather or different environment conditions on the casts**.**

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