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Identification of the side of window glass destruction as a type of diagnostic tasks of the forensic examination

Summary

The peculiarities of the diagnostic tasks of the forensic traces examination in determining the distraction side of the window, depending on the location of the relief drawing on the edges of the cracks and the end surfaces of the fragments are considered in this article. The effects of force on glass have been have been studied in this article. The changes in the lateral force and bending moment affecting the glass plate, which is loaded with force in the middle of the section and at the free end, are analyzed. The sections in which internal force factors have maximum values are established. The order of formation of radial and concentric cracks on the window glass is justified. The relief pattern on the edges of the cracks and the end surfaces of the glass fragments was examined. The mechanism for forming radial and concentric cracks of arcuate-shaped lines and serrations on the sides and ribs is justified. The process of formation of the intended radial cracks has been investigated and justified. Recommendations for removing and directing objects from glass for study are made.

Key words: identification of the destruction's side, formation of cracks, radial and concentric cracks, relief pattern, edges of cracks, marked radial cracks

A problem statement

During the examination of the scene, the investigator and the forensic inspector often have to deal with broken windows. In order to determine whether they are relevant to the fact of the incident, it is necessary to determine the nature of the damage to the window pane by the influence of any object, bullet, strong wind, etc. If the established fact of glass breaking, the mechanism of its damage shall be determined. In addition, depending on how the force was directed at the moment the glass was exposed, it is possible to determine from which side the damage occurred (from inside or outside the room). This fact has an important forensic significance, on which the investigation and detection of the offence depends.

The result of the above questions is carried out within the framework of forensic examination and relates to diagnostic tasks. In order to successfully carry out the examination, it is first necessary to remove, pack and deliver glass fragments correctly for further investigation.

Кайргалиев, Лобачева and Васильев (2014) states that shrapnel or fragments of glass products are one of the subjects of forensic analysis and occupy a significant place in the investigation of theft, homicide, traffic and other crimes. They note that glass has a number of properties that allow it to be used as evidence even after a considerable period of time since commitment of a crime (p. 244).

Маланьина (1984) asserts that the specific nature of glass products is determined by the high stability of their internal properties. These properties include the stability of the features, the unlimited identification period of the features, the stability of the form, which determines the set of morphological features (p. 15).

The definition of the destruction mechanism, as defined by Комкова, Беляева and Зайцев (2006), and the sides from which the destructive force has acted (installation of the side of the glass from which it was broken) refers to the types of diagnostic (task) issues of glass examination (pp. 149–150).

Thus, the forensic expert must have the expertise, techniques and methods necessary to carry out this type of expertise.

On the basis of the above, the study of the process of determining the side of the broken window pane behind the arrangement of the relief drawing on the edges of the cracks and the end surfaces of the fragments is relevant.

Analysis of recent studies and publications

Question of the criminalistics research of materials, substances and products was the main subject of scientific researches of Кайргалиев et al. (2014);

Маланьина (1984); Митричев, Хрусталев (2003). In the above works, consider the scientific basis of forensic research of certain types of materials, substances and products, including glass and ceramics. The authors revealed the classification of glass and the peculiarities of collecting glass objects at the scene. In addition, they examined methods and technical means of forensic investigation of the composition, structure and different properties of substances and materials were considered.

The work of Комкова et al. (2006) contains theoretical information and practical recommendations for the expert study of glass and its products. In the work mentioned above, modern algorithms are presented for carrying out complex (trace and materials science) examination of glass, peculiarities of production and expert examination of products from different types of glass, as well as the features of solving individual diagnostic (problems) questions.

However, in the mentioned above research works, the question of determining the side of the broken window pane behind the arrangement of the relief pattern on the edges of the cracks and end surfaces of the fragments remains insufficiently investigated.

The purpose of this paper is to highlight the peculiarities of solving diagnostic problems regarding the definition of the side from which the force acted on the glass behind the location of the relief pattern on the faces of cracks and end surfaces of fragments.

Statement of the main material

The solution of the diagnostic tasks of the glass examination is aimed at establishing the causes and conditions of changes in the properties of the object, its initial state and the temporal characteristics of the events (Комкова et al., 2006, p. 149).

Комкова et al. (2006) noted that, such task usually arises in connection with the investigation or staging of various criminal offences. Wherein the following issues are considered for the decision of the expert examination: the reason for the destruction of the article; the mechanism of destruction; the direction of action of the force or the party with which the force was acting; the object which destroyed the article, etc. (p. 36).

Комкова et al. (2006) highlight that the solving the above problems are based on the general provisions of the theory of strength and the features of the glass breaking mechanism, and refer to the shape of the fragments, the topography of the cracks, the microrelief of the destruction surface and the features of the internal structure of the object (p. 36).

We will cover the processes occurring during the action of force on the glass pane. According to Митричев, and Хрусталев (2003) glass fixed in frame is bent by force. They notes that the surface of the glazing on which the force is applied is in a compression state opposite the surface in a tensile state. In addition, in their opinion, the compression strength of the glass pane is considerably higher, so the breaking of the glass begins with the tensile surface, that is, the opposite, which is subject to the force (p. 243).

In order to assess the strength of the glazing, it is necessary to establish the sections where the internal forces: lateral force (*Q*) and bending moment (*M*), have the maximum values. According to Леденева, and Юганов (2009) the analysis of the internal force factors will be evident if the exponents of the variation of the lateral force (*Q*) and bending moment (*M*) along the central axis of the glass plate are constructed (p. 146).

Consider a glass plate fixed to the two supports with a loaded force *F* in the middle of the section (Fig. 1).

In the construction of the arc, the positive values of the transverse forces and bending moment are deposited upwards from the axis, the retracted values are set downwards; the axis of the arc is carried out parallel to the axis of the glass plate (Леденева, Юганов 2009, p. 146).

It can also be defined *Q* and *M* in any cross-section of the glass plate. For this pattern of applied force, the most dangerous is the cross-section in the middle of the passage of the glass plate, because at this point the maximum bending moment is active.

Никоноров and Евстропьев (2009) state that since the sides of the glass are fixed to the supports, the maximum bending occurs at the point where the force is applied. Therefore the glass is destroyed, when the force increases (above the maximum permissible force) (p. 20).

Taking into account that the force affects the entire surface of the glazing uniformly, extending radially to all sides equally from the application of force, cracks occur on the glazing, aiming at the radius of the action of the force (Fig. 2). These cracks cause fragments of triangular shape.

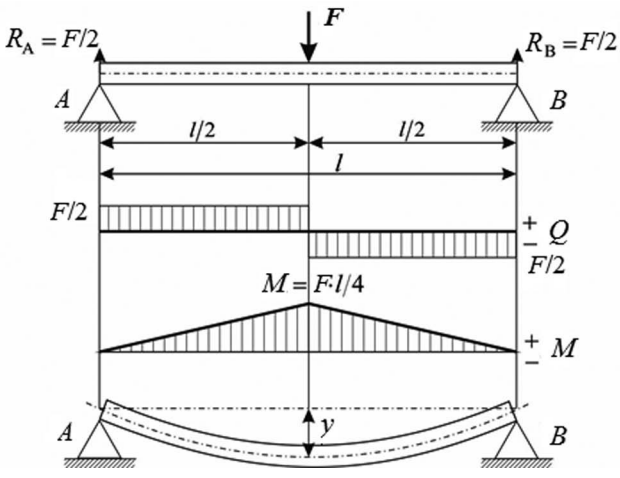

Fig 1. Transverse force (*Q*) and bending moment (*M*) for double-piston glass plate loaded to force F in the middle of the.

Note. A, *B* – are supports, R_A, R_B – reactions on supports *A* and *B*, *F* – force applied to glass plate, *l* – distance between supports *A* and *B*, y – deflection.

Fig 2. General view of radial cracks formed when glass fixed in the frame is broken.

The force on these fragments continues. Furthermore, individual fragments of glass are formed, which are fixed in the frame by only one edge and are separated by cracks. Under the effect of force, the free end of the fragment is bent, resulting in the extension of the upper layer of the already front surface and the compression of the rear surface of the glass.

To illustrate this, construct an epure for a glass plate with a clamped end loaded with concentrated force at the free end (Fig. 3).

Research conducted by Леденева and Юганов (2009) showed the following:

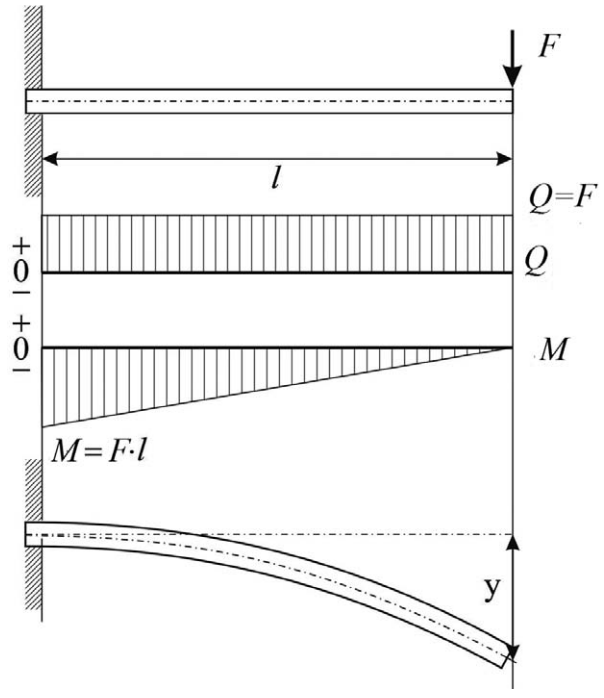

Fig. 3. Cross-force (*Q*) and bending moment (*M*) arches for glass plate with clamped end loaded with concentrated force at the free end.

In any section of the glass plate, the lateral force is equal to the applied force *F* and positive, because the external force tends to lower the right part of the glass plate (*Q* = *F*). The cross-force epure is a straight line parallel to the axis of the glass plate. The bending moment in the arbitrary cross-section of the glass plate from the free end equals the moment of external force *F* relative to the center of the cross-section and the unbreakable moment, because this force bends the glass plate by bending it upwards. The arch of flexion moments is an inclined straight line. Therefore, the largest absolute bending moment is reached in the section of the latch (p. 148).

Because the destructive force continues to act, and the deflection of the free end of the fragment becomes higher than the allowable deflection within the elasticity, the shard of glass at some point produces a crack that is concentrically located at the point of application of the force. Crack formation also begins on the surface, the upper layer of which is stretched, then spreading over the entire thickness of the glass.

Based on the above, it has been found that radial cracks and then concentric cracks are formed.

Thus, by analyzing the topography of cracks, it is possible to obtain information on the types and form of development of the trajectory of cracks, the cause of destruction and the rate of application of external forces to the glass.

Solving all diagnostic tasks in the expert examination of glass is based on the study of cracks and cracks (faces), because the signs arising at the moment of destruction of glass products are reflected in the topography of cracks and the nature of break-ins, which allows to get an answer to the questions asked during the study (Майлис, 2007).

In order to establish the side from which the breaking force on the glass has acted, in addition to the study of the topography of the cracks mportant information can be obtained from the study of the relief pattern on

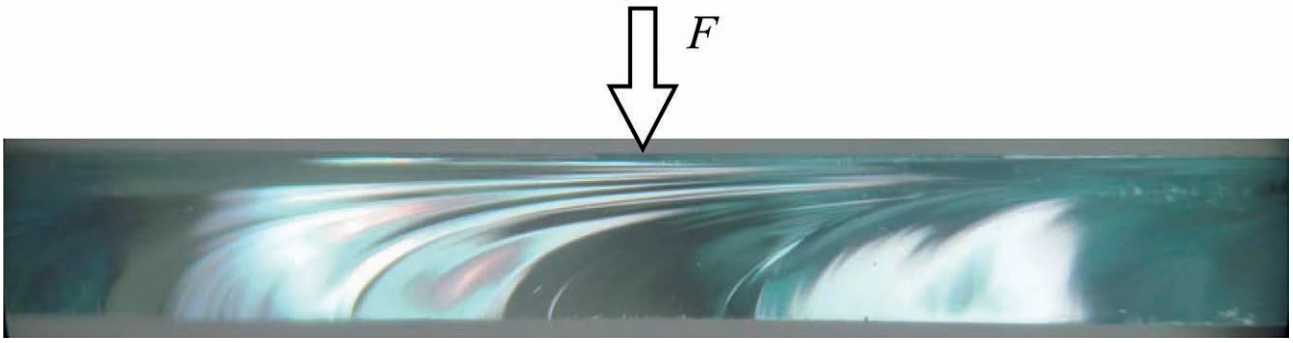

Fig. 4. General view of arcuate lines on the edge of a radial crack.

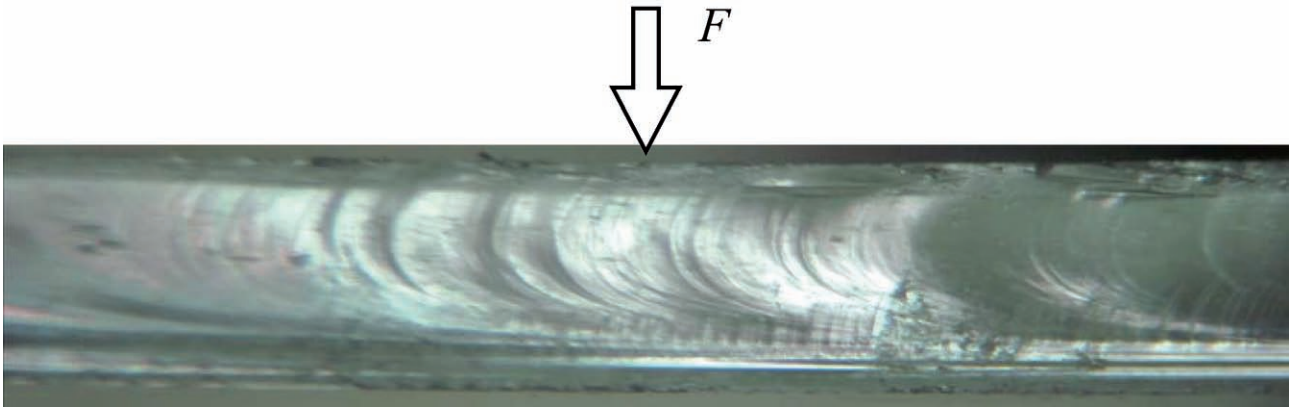

Fig. 5. General view of arcuate lines on the face of a concentric crack.

the edges of the cracks and the end surfaces of the fragments.

The analysis of the structure of cracks (breakage surfaces) is used in solving diagnostic problems and is based on one of the basic provisions. The cracks, formed from the surface, which is in a stretching state, converge into sheaves that narrow to the surface, which is in a compression state. Thus, when examining the edges of the cracks there is a relief drawing on them in the form of arcuate lines.

At the edges (rift) of radial cracks Комкова et al. (2006) assert that, the arcuate lines begin with the surface, opposite of the action of the force, converge at their ends into beams and adjoin to the surface of the force action (the side with which the destructive force on the glass acted) (Fig. 4), wherein, the radius of curvature of the arcs are removed from the point at which the force is applied (p.161). However, on concentric cracks, the beams converge on the opposite side of the force (Fig. 5).

The position of the arcs on the faces of radial and concentric cracks is explained by the fact that these cracks begin to arise from the surface, which tolerates stretching, then spreads over the entire thickness of

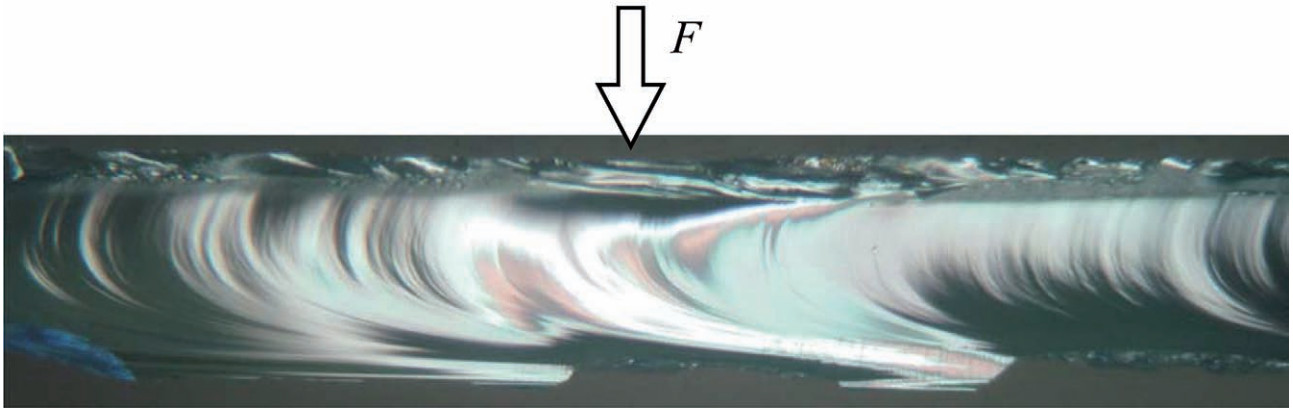

Fig. 6. General view of the notches on the edge of the glass fragment.

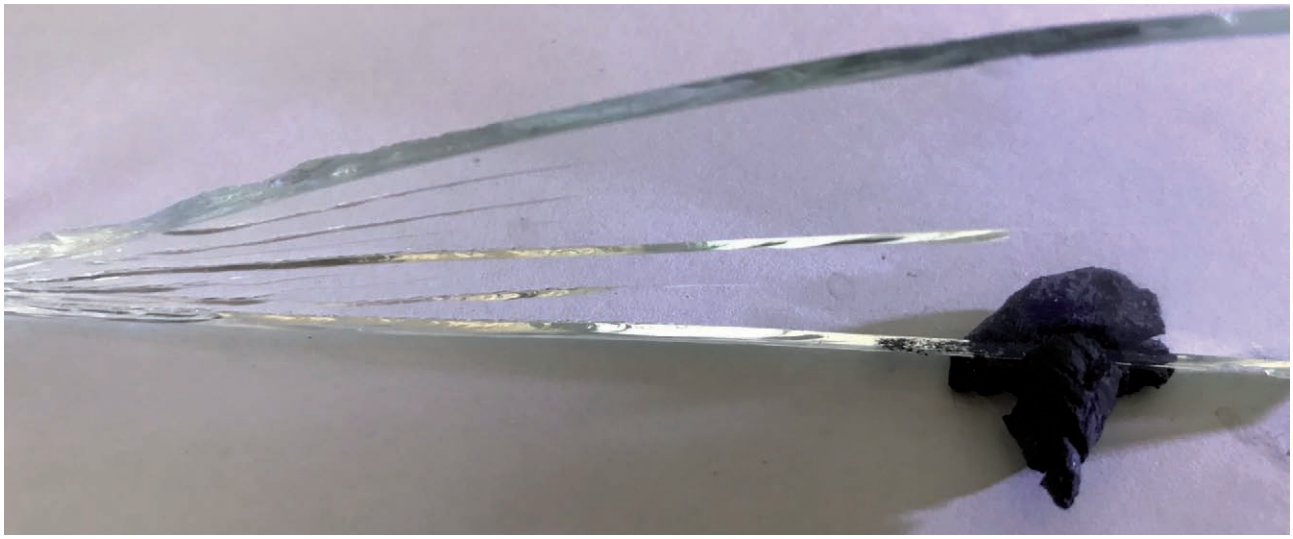

Fig. 7. General view of the intended radial cracks on the glass fragment (face).

the glass and causes the already destroyed surface, which is compressed. Consequently, the destruction of the surface that endures stretching is ahead of the destruction of the surface that endures compression. Therefore, the cracks take a direction along a curve from the surface that tolerates stretching to the opposite surface, going as if along the line of least resistance.

In addition, during the study, it was found that there were inequalities in the form of small serrations on the edges, on the surface which was stretched. Furthermore, on the sides of the radial cracks they are located in the area of the force action, and on the sides of the concentric cracks they are located in the areas most stretched (Fig. 6).

This is due to the fact that when a crack occurs at the point of application of force, the surface layer of the glass breaks to form an unequal edge, expressed in the form of small, visible and appreciable serrations.

After the broken glass integrity, further fractures do not occur due to rupture, but as a consequence of the split, the glass appears to be lacerated. Therefore, at rib regions farther away from the point of application of force, edge inequalities are much less pronounced.

In addition, radial cracks appear on the glass fragments adjacent to the area of influence of the force, which are through in the area of application of the force and, in the course of propagation, cracks in the direction of the periphery partial character, that is, that did not pass through the entire thickness of the glass. They are located on the opposite surface to which the force was applied (Fig. 7).

The presence of the intended cracks on this surface confirms the earlier conclusion that the destruction of the glass starts from the surface that is stretched.

Thus, the diagnostic tasks of examination of glass in order to determine the direction of action of the force or the side with which the force was exerted can, in most cases, be solved if as many fragments as possible are presented. In the event of the removal of fragments of glass, the inner and outer sides shall be marked. The most efficient investigation of the fragments that remained in the frame.

The implementation of the following recommendations for the removal and presentation of objects from glass for study is essential for the successful examination of glass.

1. Remove from the scene and submit for examination all the glass fragments found (if possible).
2. The physical evidence should be submitted for examination in the form in which it was found (different traces may be preserved on the surface of the fragments).
3. When removing fragments of window glass (from the frame), mark the outer or inner sides of the fragments; if there are cracks on the fragments, indicate to which places they reach.
4. During packing, measures should be taken to prevent fragments from breaking during transport.
5. Do not use glass containers for packaging of evidence.
6. Indicate whether it is possible or undesirable to destroy part of the physical evidence during the study.

Taking into account the particularities of the glass examination, the general diagnostic procedures for determining the side of the window glass destruction are as follows:

The first stage. Familiarization with the research objects and the case materials. The objects of the study are glass fragments removed from the scene. At this stage, the characteristics of the objects and the status of the research should be established. As a result of the study, it is established whether there are signs of exposure on the glass fragments provided for the research.

The second stage. The study of the morphological features of the research objects. At this stage, it is necessary to identify the external features of the investigated objects. During the study, general parameters are set: color, shape, geometric dimensions. The study determines whether the subjects in question share a common ancestry.

The third stage. The trace study and reconstruction of the product. At this stage, it is necessary to identify common separation surfaces and to reconstruct the product. As a result of the study, all fragments are folded along the split lines, radial and concentric cracks are determined.

The fourth stage. Crack examination (visual and microscopic). The goal of the stage is to study the topography of cracks, including small cracks and those that have not sprouted. The study identifies the epicentre of the impact and establishes the grid pattern of cracks. As a result of the study on the pattern of cracks, the number of destructive effects, the nature and direction of the impact are determined.

The fifth stage. The study of fractures (visual and microscopic). The task of the stage is to study the micro relief of fractures. The study identifies the side of the force application and concludes that the destruction of the article started at the identified point and was mechanical.

The sixth stage. Compiling the synthesizing part and drawing conclusions. The task of the stage is to make the synthesis part, to substantiate and to formulate the conclusion. This step describes the results of the study to determine the point and direction of application of the destructive force and the effect on the glass. The findings describe the traces identified and indicate the nature of the destructive effect. The conclusions should determine the specific circumstances of the event or the facts surrounding it. An example of the answer to the question raised about the side (external or internal) of the window glass destruction is stated as follows: "The force which destroyed the window glass directed inside the room" or "The force which destroyed the window glass directed from inside the room".

Conclusions

Therefore, in performing the diagnostic tasks of the examination of the glass to determine the direction of action of the force or the party with which the force was acting, it is necessary to know the following:

1. The location of the broken glass fragments at the scene of the incident (most of the fragments are on the opposite side of the force).
2. The location of the relief pattern on the he edges of the cracks (in the radial cracks the end of the arcs converge in a sheaf to the surface from which the force was applied and in the concentric cracks to the opposite surface).
3. The presence of serrations on the edges of the faces (serrations formed on the edges of the edges of radial cracks – on the side opposite to the surface to which the force was applied, on the sides of concentric cracks – on the side to which the force was applied).
4. The presence of the intended radial cracks (they are formed on the side opposite to the surface to which the force was applied).

However, according to Комкова et al. (2006) the side where the glass was broken may not be for all products. Exceptions include:

– a hardened or polished glass which is destroyed in an avalanche without a characteristic microrelief;
– a small glass pane tightly fixed in the ramps (the fort) because it does not exhibit bending and the area of the object's impact is comparable to the area of the glass;
– articles that were destroyed by heating or explosion because they lack the so-called "focus of destruction" of the point of application of force (p. 161).

Source of figures:
Figure 1: Леденева, Юганов, 2009, p. 150.
The figure has been modified for the needs of this article.
Figure 2: https://sputnik.kg/images/101944/58/1019445881.jpg
Figure 3: Леденева, Юганов, 2009, p. 148.
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Figures 4–7: Authors

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