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Article

Additional Safety Measures for Movable Bridges, A Bridge Too Far? A Calculated Approach on Proportional Safety for Movable Bridges in the Netherlands

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Abstract: This article explores a proportional safety approach for movable bridges, aligning with the core principles of Dutch safety policies: the use of the Dutch norm for an individual risk (IR) of one fatality per hundred thousand people exposed (denoted as IR = 10^{-5}) and a reasonable investment maximum of € 80.000, - per gained disability adjusted life year (DALY). Based on the actual history of accidents the individual risk for people using movable bridges is around 10^{-7} and thus easily meets the Dutch norm. Movable bridges in the Netherlands are thus more than 'safe enough' and do not require extra investments in safety measures. If the municipal and provincial authorities in charge of movable bridges do decide to invest in extra safety measures, a reasonable maximum budget is € 2.2 million a year for all 1.500 movable bridges. Here it is assumed that the newly implemented safety measures verifiably lead to preventing all casualties.

Keywords: Movable Bridge; Proportional Safety; Reasonable Safety; Individual Risk; Disability Adjusted Life Years

1. Introduction

On the morning (11:35 am) of the 6th of February in 2015, the remotely controlled movable bridge 'Den Uylbrug' in Zaandam (the Netherlands) was about to be opened to let numerous ships pass [1]. At that moment, a 57-year-old woman found herself with her bicycle on the cycle lane of the bridge. The central command of the bridge ordered to ignite the yellow blinking pre-warning signs 100 meters before the bridge, which the woman had just passed. Moments later she passed a red traffic signal and a (not yet closed) boom barrier with red blinking lights, which were both activated approximately fifteen seconds before she passed them. While she was cycling on the movable part of the bridge, she heard (as usual) the bells ringing, used to warn traffic about the bridge being opened not long after. Instead of hurrying to get herself away from the movable part of the bridge, she approached the second boom barrier (meant for traffic coming from the other side) and stepped off of her bicycle, thinking she had approached the first boom barrier (which she had already passed). Not realizing she was standing exactly on the movable part of the bridge; she kept waiting in front of the barrier for the bridge to open. When the command was given to open the bridge and the bridge started to move underneath the woman, she hurried to the side of the bridge to find something to hold onto. She held on to a rail and after the bridge was completely opened, the woman fell down from a height of 15m and tragically lost her life. During this accident she was visible on the CCTV footage multiple times, yet not noted by the operator of the central command office somewhere else in the city.

This exotic accident led to an investigation by the Dutch Safety Board on the safety of remotely controlled movable bridges in the Netherlands [1]. In their report, the board recommended municipal and provincial authorities to implement additional measures to deal with identified causes to prevent this type of accident from happening again. This raised questions amongst municipal and provincial authorities on how to decide what future investments regarding the safety of movable bridges are reasonable in the absence of a national standardized approach.

An example of a movable bridge is presented in Figure 1.

Figure 1. A movable bridge in the Netherlands (Copyright: Michiel Wijnbergh).

The goal of this research note is to explore a proportional approach to the safety of movable bridges in the form of a cost-benefit analysis that is in accordance with general Dutch safety policies.

The two pillars for Dutch safety policies are:

(1) the acceptable norm for individual risk is a maximum of one death for every 100.000 people exposed to a risk category per year. The decision what forms a risk category is a political one. Within a given risk category several sub risks may exist. For a sub risk of a risk category a norm of 10^{-6} should be used to facilitate easier calculations that is assuming that no-one is exposed to more than 10 sub risks at a given time. These norms were first mentioned in 1989 in a governmental memorandum send to the parliament 'Dealing with Risks: approaching risks in environmental policies' [2] and since then form a basis for safety legislation for a wide range of risks in the Netherlands [3]. Important to mention is that this norm was explicitly introduced with the goal to harmonize safety policies in the Netherlands, which is why this norm also may be applicable for safety policies for movable bridges.

(2) investments in risks should be proportional to the extra safety gained. Since the turn of the century this has been operationalized in terms of a maximum investment for Disability Adjusted Life Years (DALYs) gained as originally proposed by the World Health Organization. A DALY is a

measuring unit used to express the loss of healthy life years. Young people who lose their life then have a bigger impact on the final calculation of the investment to prevent them from losing their life, since they logically lose significantly more life years than elderly people when they die. This measuring unit is also applicable to express back injuries, broken legs and other forms of heavy injuries, so that the damage in health to injured people and people who lose their life can be added up. A norm for the safety investment of € 80.000, - per DALY has been advised by the Dutch Council for Health [4] i.e. 3.2 million euro's is considered a proportional investment to save an average statistical person of 40 years. This norm is in accordance with international practice [5]. Thus, in situations where the earlier mentioned norm of IR 10^{-5} is met, additional investments of € 80.000, - per DALY should verifiably result in additional safety.

As an aside, the 1989 memorandum also stated that attention should be paid to the so-called group risk, which is the chance of people dying in groups of more than 10 individuals. It was advised that the chance of such a group becoming a lethal victim of a risk should be 10^{-7}, i.e. 10 times smaller than the risk of 10 individuals dying due to the risk (10^{-6}) in the same year.

To be clear, safety policies in the Netherlands (see Table 1) are still differentiated when it comes to applying the norm of an individual risk of 10^{-5}. These differences can partially be explained by the historical embedding of safety policies in ministerial departments. Another reason is political coincidence, meaning that safety policy changes are made because of accidents ('this may happen no more) and the resulting so called 'policy windows' for those experts that focus on a specific risk without caring for the broader picture. This is called the risk-regulation-reflex [6].

Table 1. Applied norms in Dutch safety policies [7].

Type of safety policies	Dutch legal norm for IR?
external safety	10^{-6}, seen as sub risk of all industrial risks
aviation safety	no norm but in practice lower than 10^{-6}
water safety (dikes)	10^{-5}
traffic safety	political acceptance of 10^{-4}
exposure to hazardous substances	10^{-6} per class of substances

2. Methods

2.1. Analysing Accidents in A Period of Twenty Years

To gain insight into the risks of movable bridges in the Netherlands we conducted an analysis of twenty years of known accidents. For this analysis we assumed that accidents inherent to movable bridges are so called 'exotic risks'. Meaning; because of the rarity of such accidents occurring, there will be media outlets reporting on them when they do happen. We utilized the Dutch nationwide database 'LexisNexis' for this analysis, which contains information from over two hundred national and local newspapers, newsmagazines, and websites. In our search we used combined terms such as: 'accident movable bridge', 'failure movable bridge', 'wounded movable bridge', and 'death movable bridge'.

For each accident we then analysed how people were injured and whether people lost their lives due to said accident. In accordance with methods used by the World Health Organization, we analysed the severity of their injuries and based the amount of lost DALYs on said severity, meaning severe injuries lead to a larger amount of DALYs than less severe injuries. For individuals who lost their lives and whose age was mentioned, we subtracted their age from the average amount of healthy years per life (being 80). For individuals whose age wasn't mentioned we assumed they were on average 40 years old.

2.2. Calculating the (Individual) Risk

For each individual accident we then analysed (if possible, with the presented data) the extent to which one or more individuals were injured or lost their lives. We then divided said accidents in four categories of accidents, after which we calculated (see formula 1 below) for each category the risk of accidents with a lethal victim per movable bridge per year in the Netherlands. We then used this information to calculate the individual risk (see formula 2 below) for an exposed Dutch citizen to lose their life in an accident involving a movable bridge.

risk per bridge per year = lethal victims scenario X in 20 years / 20 years / 1500 movable bridges in the Netherlands, (1)

individual risk = (risk per bridge per year / amount of people exposed to risk) * number of exposures to risk of an average user (2)

To calculate the individual risk, it is necessary to calculate the amount of people being exposed to said risk. We divided the exposed citizens in motorized vehicles, cyclists, scooters, and pedestrians. We chose not to include mechanics and other employers, since the number of events in which they were involved in twenty years were negligible (and thus so was the individual risk). Based on the length of the Dutch road network and number of movable bridges, we calculated for each category how long on average it would take for them to encounter a movable bridge using their form of transport. We then used the average amount of kilometres travelled and the total amount of citizens for each form of transport, to calculate how many movable bridges each citizen would pass in a year. By multiplying that average with the total amount of people using said transport, we calculated the amount of people on average crossing movable bridges in one year (i.e. amount of exposed people).

Since our four categories of risks only materialize while the movable bridge is actually moving (or opened), we also calculated the average amount of time an average movable bridge in the Netherlands would be opened, as well as how many times a bridge would open on a daily basis. We then used only a percentage of the calculated exposed individuals (the same percentage a bridge would be open or moving) in our further calculations.

3. Results

3.1. Analysing Accidents in A Period of Twenty Years

Between 2000 and 2020, we found twenty-nine accidents in the Netherlands related to movable bridges where serious injuries or fatalities happened. We have defined a serious injury as an accident (expectedly) resulting in one or more life years lost. In total, we identified a loss of 547 DALYs over 20 years, averaging 27.3 DALYs per year (see annex 1).

Note that using the above number of DALYs lost per year we directly derive that the maximum budget for safety investments is € 2.2 million a year for all 1500 movable bridges. Here we use the Dutch proportionality rule that, investments in safety measures are reasonable as long as the standard of a maximum of € 80.000, - is met for each life year won with said measures.

We have then divided these twenty-nine accidents in four categories, being 1) getting trapped by two boom barriers on the movable part of the bridge, 2) getting stuck between movable parts of the bridge, 3) colliding with boom barriers, and 4) falling down an open bridge to compute the individual risk per risk category.

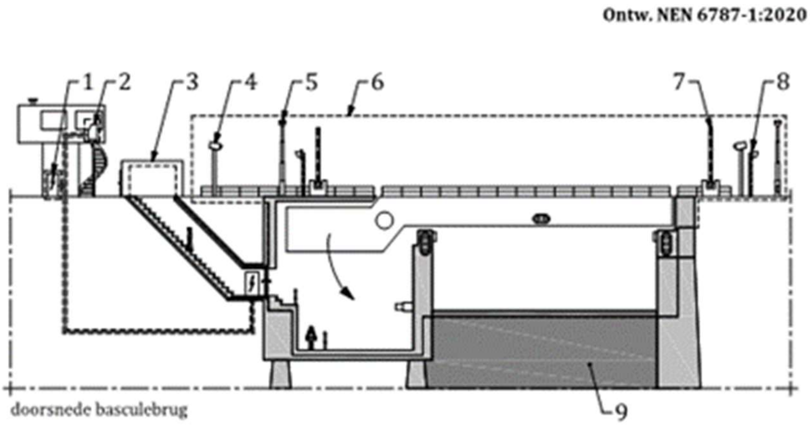

Figure 2. Cross-sectional view of a movable bridge (Source: NEN 6787-1:2020, www.nen.nl).

3.1.1. Getting Trapped between Boom Barriers

The first category of accidents we have found involves people getting trapped between two boom barriers, not being seen by the central command of the bridge and not being able to get away before the bridge would open. After the opening of the bridge these people would then fall off the bridge resulting in very serious injuries and often death. Sometimes people would know to be on the wrong side of the barriers, but sometimes their behaviour showed that people would not (as presented in paragraph 1).

We have found that three people have lost their lives as a direct result of getting trapped between two movable boom barriers on the movable part of the bridge. When using formula 1, this leads us to a chance of this scenario occurring of one in ten thousand ($1{,}0 * 10^{-4}$) per bridge per year.

3.1.2. Getting Stuck between Movable Parts

The second category of accidents we have found is people (mostly cyclists, scooters, and pedestrians, getting stuck between movable parts of the bridge. These accidents often happened when people found themselves awaiting the opening of the bridge but standing too close to the bridge or moving parts around the bridge. They would then get hit in the head by moving parts and/or trip whilst getting stuck between them.

We have found that three people have lost their lives as a direct result of getting stuck between movable parts of the bridge. When using formula 1, this leads us to chance of this scenario occurring of one in ten thousand ($1{,}0 * 10^{-4}$) per bridge per year.

3.1.3. Colliding With Boom Barriers

The third category of accidents we have found is people colliding with boom barriers, with serious or fatal injuries consequently. This category involves mostly (motor)cyclists, scooters, and pedestrians. Examples of this scenario show us that accidents like these happen for example due to people being blinded by the sun while nearing the bridge or can't anticipate on the closing of said moving barriers due to the speed of their vehicle. Sometimes situations have occurred when the moving barriers came down unexpectedly due to malfunctions, whilst people did not have enough

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time to anticipate and get out of the way.

We have found that two people have lost their lives as a direct result of colliding with boom barriers. When using formula 1, this leads us to chance of this scenario occurring of six-and-a-half in one hundred thousand ($6{,}7 * 10^{-5}$) per bridge per year.

3.1.4. Falling Down an Open Bridge

The fourth and final category of accidents we have found is people falling down an open bridge, not realizing the bridge was opened in the first place. An important side note for this category is the fact that three out of the five times this accident type has occurred took place on the same movable bridge, at night during the weekend and within three years of each other. The situation on said bridge was adapted after the third accident had taken place by repositioning the boom barriers.

We have found that five people have lost their lives as a direct result of falling down an open bridge. When using formula 1, this leads us to chance of this scenario occurring of one-and-a-half in ten thousand ($1{,}7 * 10^{-4}$) per bridge per year.

3.2. The Individual Risk for All Four Scenarios

As we have described in paragraph 2.2, it is necessary to calculate the amount of people being exposed to each risk to calculate the individual risk for each category using formula 2 (see Table 2 for the average exposure to said risks). When it comes to motorized vehicles, we have found that each vehicle meets a movable bridge every 93km and they move 17.000km a year on average, which means they meet 183 movable bridges on average each year [8, 9, 10]. Assuming each motorized vehicle is driven by a single person, we multiply the number of motorized vehicles with the number of movable bridges they meet each year [11, 12]. This means that 1.5 billion motorized vehicles are exposed to said risks each year.

Table 2. Average exposure to said risks.

Transport	Amount of km driven/walked needed to pass a movable bridge	Yearly amount of driven/walked km	Yearly number of movable bridges passed	Individuals exposed to risks each year
motorized vehicles	93	17.000	183	1.5 billion
cyclists	51	1.100	22	300 million
scooters	51	800	16	20 million
pedestrians	51	270	5	55 million

When it comes to cyclists, we have found that each cyclist meets a movable bridge every 51km and they move 1.100km a year on average, which means they meet 22 movable bridges on average each year [13, 14]. We then multiply the number of cycles with the number of movable bridges they meet each year, which means that 300 million cyclists are exposed to said risks each year.

When it comes to scooters, we have found that each scooter meets a movable bridge every 51km and they move 800km a year on average, which means they meet 16 movable bridges on average each year [9, 15]. We then multiply the number of scooters with the number of movable bridges they meet each year, which means that 20 million scooters are exposed to said risks each year.

When it comes to pedestrians, we have found that each pedestrian also meets a movable bridge every 51km and they move 270km a year on average, which means they meet 5 movable bridges on average each year [16]. We then multiply the number of pedestrians with the number of movable bridges they meet each year, which means that 55 million pedestrians are exposed to said risks each year.

3.2.1. Getting Trapped between Boom Barriers

Based on our analysis of twenty years of accidents, we found that for this scenario motorized vehicles, cyclists, scooters and pedestrians are exposed to the risk. For a single bridge this means approximately 36 thousand individuals. Following formula 2, we find a risk per exposed individual per year of $2.7 * 10^{-9}$. Multiplying this risk with the number of exposures to the risk means that the individual risk for motorized vehicles is $5,1 * 10^{-7}$, for cyclists $6,1 * 10^{-8}$, for scooters $4,4 * 10^{-8}$, and for pedestrians $1,4 * 10^{-8}$. On average, the individual risk for exposed individuals is to $1,6 * 10^{-7}$.

3.2.2. Getting Stuck between Movable Parts

Based on our analysis of twenty years of accidents, we found that for this scenario cyclists, scooters and pedestrians are exposed to the risk. For a single bridge this means approximately 7 thousand individuals. Following formula 2, we find a risk per exposed individual per year of $1,4 * 10^{-8}$. Multiplying this risk with the number of exposures to the risk means that the individual risk for cyclists is $3,1 * 10^{-7}$, for scooters $2,2 * 10^{-7}$, and for pedestrians $7,1 * 10^{-8}$. On average, the individual risk for exposed individuals is to $2,0 * 10^{-7}$.

3.2.3. Colliding with Boom Barriers

Based on our analysis of twenty years of accidents, we found that for this scenario cyclists, scooters and pedestrians are exposed to the risk. For a single bridge this means approximately 7 thousand individuals. Following formula 2, we find a risk per exposed individual per year of $9,6 * 10^{-9}$. Multiplying this risk with the number of exposures to the risk means that the individual risk for cyclists is $2,1 * 10^{-7}$, for scooters $1,5 * 10^{-7}$, and for pedestrians $4,8 * 10^{-8}$. On average, the individual risk for exposed individuals is to $1,4 * 10^{-7}$.

3.2.4. Falling Down an Open Bridge

Based on our analysis of twenty years of accidents, we found that for this scenario motorized vehicles, cyclists, and scooters are exposed to the risk. For a single bridge this means approximately 34 thousand individuals. Following formula 2, we find a risk per exposed individual per year of $4,9 * 10^{-9}$. Multiplying this risk with the number of exposures to the risk means that the individual risk for motorized vehicles is $8,9 * 10^{-7}$, for cyclists $1,1 * 10^{-7}$, and for scooters $7,8 * 10^{-8}$. On average, the individual risk for exposed individuals is to $3,4 * 10^{-7}$.

4. Discussion and Conclusion

4.1. Conclusion

As presented in this paper, the individual risk for people using movable bridges (around 10^{-7}) easily meets the Dutch norm of IR 10^{-5} for risk categories with a margin of one hundred times lower. As explained it is a political choice to consider the risk movable bridges pose as a risk category in itself or as a sub risk of another risk category. However, even when municipal and provincial authorities would decide to aim for the 10^{-6}-norm for a sub risk of a risk category, the norm would (easily) be met. Thus, based on the actual history of accidents in the last twenty years, movable bridges in the Netherlands are ‘safe enough’ and do not require extra investments in safety measures.

Should the municipal and provincial authorities decide to invest in extra safety measures, based on the historical loss of life years (calculated as 27,3 DALYs per year) they have a maximum budget of € 2.2 million a year for all 1500 movable bridges to do so, if these newly implemented safety measures verifiably lead to corresponding additional safety. Here we use the Dutch proportionality rule that, investments in safety measures are reasonable as long as the standard of a maximum of € 80.000, - is met for each life year won with said measures.

4.2. On the Possible Safety Measures

Our media database provides no trustworthy insight in the causes of the accidents. Such an insight is necessary to determine whether a measure could be *effective* at all before, as we do, calculate whether the interventions is *efficient*.

Furthermore, it should be realized that the current safety measures to prevent people from falling into the water when approaching an open bridge, can also lead to unsafety. A notable example being the movable boom barriers between which people can be trapped or collide with. Therefore, future research should investigate whether less specific safety measures could actually improve the overall safety of movable bridges. One, perhaps counter-intuitive, example would be to replace the boom barriers with a ‘normal’ traffic light (used on intersections) to improve the recognizability of the deviant traffic situation.

4.3. Uncertainties

The calculation of the individual risk and the DALYs lost is based on a limited data set of 29 accidents in 20 years and for the subcategories that correspond to a particular mechanism (trapped, stuck, collide, fall) only around 3 – 5 accidents are found in these 20 years. As explained above we feel that here there is no underreporting and thus no uncertainty here. However, starting from the assumption that the accidents are binomially distributed over the years with $p = 1/5$ the standard deviation would be $20 * 1/5 * 4/5 = 3,2$, i.e. for all subcategories the two standard deviation boundaries roughly corresponding to the 95% limit would be 0 – 11 accidents. For the resulting IR’s this means a possible factor 2 or factor 3 difference i.e. this makes no difference for the conclusion that the IR 10^{-5} norm is satisfied.

4.4. Another Presentation

As another presentation of the data, suggested by an anonymous reviewer, is to compute the overall societal risk of the movable bridges and the probable societal value of measures. For this we assume that all Dutch are equally exposed to the risk: the individual risk than amounts to the 13 deaths over 20 years for 17 million Dutchmen is $4 * 10^{-8}$. The probable societal value of this for an individual using the 3.2 million per statistical life then is around a euro per year.

4.5. Policy Advise

Based on our findings municipal and provincial authorities in the Netherlands are advised to stop investing in extra safety measures for movable bridges that turn out to be disproportional and should better rethink their approach of the safety of movable bridges.

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Appendix A

In this appendix, an overview is given in Table A1 of accidents involving movable bridges between 2000 and 2020. These are explicitly accidents that are inherent to the movable nature of the bridge. Thus, 'normal' traffic accidents that occur on a bridge but are not attributable to the (potential) movement of the bridge are therefore excluded.

Table A1. Accidents involving movable bridges between 2000 and 2020.

Year	Bridge	DALY-related information	Description of accident
2000	Diemen	Man (57)	Got trapped between the bridge and a pleasure boat. He acted quickly when the bridge threatened to land on his boat, injuring his legs.
2001	Amsterdamse Baan	Woman (21)	Scooter collided head-on with a lowering boom barrier, not seen due to the setting sun.
2003	Spijkenisserbrug	Five injured (2 toddlers, a 9-year-old, two adults)	Due to a technical malfunction, the bridge unexpectedly rose; the front car crashed into the bridge, sending four occupants to the hospital, and a fifth person suffered from abrasions.
2003	Appingedam	Girl (10)	Leaned over a fence and did not notice the bridge coming down. She was hit by the bridge on her head and later died from her injuries.
2003	Kampen	Boy (17)	Moped rider collided with a boom barrier, sustaining multiple injuries to his head, chin, and body.
2003	Aduard	Girl (11)	Got trapped between the bridge and a wall and died from her injuries. She was standing in a permitted area watching a ship, but there was no safe shielding.
2004	Hefbrug Zuidhorn	Woman (77)	Trapped between the bridge's closing booms, fell off.
2005	Sluiskil	Man (unknown)	Heavy collision because the bridge operator relied solely on radar and did not look outside. The bridge closed while a vessel was approaching at a considerable speed and collided with the bridge. A bridge support destroyed the wheelhouse of the ship/boat. The skipper suffered severe back injuries.
2005	Uitwellingerga	Man (26)	Closing booms had already started to close, but the driver thought he could still pass underneath; rammed two booms and ended up in the ditch. The driver had scrapes and a stiff neck.
2006	Twistvlietbrug Zwolle	Woman (76)	Remained on the wrong side of the closing booms, fell from the bridge onto the asphalt with her wheelchair.
2006	Maastricht	Woman (52)	Hit by a closing boom while waiting.
2006	Zwijndrecht	Man (76)	Drove through a red light and got trapped between the booms, landed on the lower roadway, and was injured.
2006	Dinteloord	Man (82)	Remained on the bridge to watch a vessel, fell from the bridge when it opened, and died. The man was almost deaf.
2006	Spijkenisserbrug	Man	Scooter rider fell when the bridge was lowering, fell over the edge of the bridge, his arm got stuck between the closing part and the fixed road. He was trapped for two hours.

2007	Spijkenisserbrug	Man (44)	Motorcyclist collided with a closing boom that had suddenly closed after opening earlier.
2007	A6 Ketelbrug I	Woman (64)	Got trapped between the closing booms, reversed, but fell into the gap that opened and drowned.
2009	Botlekbrug I	Woman (49)	Drove through a closed boom barrier and off the open bridge into the water and died.
2010	A6 Ketelbrug II	3 persons with minor injuries	Various cars damaged due to a fault in the control system; the bridge could open with emergency control without warning to road users.
2010	Botlekbrug II	Woman (29)	Drove through a closed boom barrier and off the open bridge into the water and died.
2011	Botlekbrug III	Man (33)	Drove through a closed boom barrier and off the open bridge into the water and died.
2011	Afsluitdijk	Man (unknown)	Drove at very high speed through the closed booms and drove five meters lower into the water and died.
2012	Gorinchem	Man (80)	Hit by a closing boom while cycling, died from the accident's effects.
2012	Sint Servaasbrug	Girl (6)	Got her leg trapped when the remotely operated movable part of the bridge came down. Injured her leg.
2012	Erasmusbrug Rotterdam	Man (42)	Scooter rider died after colliding with a closed boom barrier.
2013	Emtenbroekerdijk	Bridge operator (56)	For unknown reasons, he became trapped while operating the bridge and died.
2014	A6 Ketelbrug III	Mechanic	Mechanic broke his ankle in the control room during maintenance work on the bridge.
2015	Termeerbrug	Man (27)	Helmsman hit his head hard against the bridge while sailing and died from the consequences.
2015	Zaanstad I	Woman (57)	Got trapped between the closing booms, fell and died when the bridge deck moved, not seen by the operator.
2015	Hefbrug Waddinxveen	Man (unknown)	A work vessel got stuck under the bridge, a person on the ship was hit by metal, but the cause is unknown.
2016	Grevelingensluis	Man (56)	Drove off an open bridge, was initially unharmed but was injured after attempting to jump onto a concrete edge.
2017	Gouda Haastrechtsebrug	Mechanic (57)	Mechanic got trapped between two gears during maintenance work, severely injured.
2017	Spijkenisserbrug	Man (41)	Cycled on the wrong side of the bridge at night, fell during a bridge opening, and died.
2017	Weert Stadsbrug	Woman (90)	Woman with a walker on the bridge when it rose, fell off the edge of the bridge, and was saved by a bystander. The woman was slightly injured.
2017	Ouderkerk aan den Amstel	Man (unknown)	Died after hitting his head against the closed bridge deck while sailing.
2018	Zaanstad II	Elderly couple (77, 78)	The couple was on the movable part of the bridge, not noticed by the bridge operator; both fell from the open bridge and were seriously injured.
2018	Koningin Maximabrug Alphen aan de Rijn	Skipper (unknown)	A cargo ship collided with the bridge, likely misjudged by the skipper. The wheelhouse was destroyed; the skipper was injured, and there was damage to the bridge.
2018	Albert Schweitzerbrug	Elderly man	Crashed into the closing booms with a mobility scooter, likely blinded by the sun. The accident prevented the bridge from opening, traffic was disrupted. The man was taken to the hospital for a check-up.
2018	Gouda Julianasluis	Man (62)	Stood between the closing booms, thought he was safe while waiting, but fell several meters down when the bridge opened and was severely injured: shattered wrist, many scrapes, and bumps.

2019	Parkhavenbrug Rotterdam	Two lightly injured, details unknown.	An inland vessel collided with the bridge, heavily damaging the wheelhouse, and two people were slightly injured.

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