NEW HAMMER CAGE DESIGNS

Introduction

Once the 2001 Edmonton Congress adopted a 34.92 degree landing sector it was essential that new cage designs be developed as soon as possible so as to increase safety.

Based on experience with the cage installed at the IAAF Throwing Centre at Szombathely Hungary, a new cage design shown in the Figure attached was presented to and accepted by the 2003 Paris Congress

Calculation of Throwing Danger Zone

I have arbitrarily determined that the release of the hammer head is tangentially from a circumscribing circle 1.4 metres outside the hammer circle (i.e. 2.407m radius from the centre of the circle. A study [(1)] undertaken at the 1999 World Championships Seville during the hammer throwing finals would seem to confirm the reasonableness of this assumption. The danger zone can then be determined mathematically or more approximately by drawing the release trajectory. The mathematical calculation method gives an 83 degree danger zone for the pre 2004 cage compared with the 85 degrees that has been quoted in the Handbook for many years.

Obviously the point of release of the hammer by different throwers will depend on their throwing technique and final release position within the circle as well as the anthrometrical measurements of each thrower. However, for the purposes of comparing the effectiveness of different designs it is a reasonable tool.

Position of Closed Gate

The most effective position for a closed hammer cage gate is tangential to the trajectory of the hammer not at right angles to the closer landing sector line. In Table 1 I have indicated the most effective position of the end of the closed gate for various designs.

TABLE 1 ALTERNATIVE HAMMER CAGE DESIGNS

	C/L to Pivot a	C/L to Gate Opening b	Cage Opening c	Gate Length d	C/L Opening e	Width of Opening Gate closed	Appro Dang Deg
Pre 2004 Separate Circles Cage converted to concentric circles	5.70	6.30	6.00	2.00	1.09	4.09	
Pre 2004 Separate Circles Cage converted to concentric circles and the gates increased to 2.6m	5.7	6.86	6.00	2.60	0.67	3.67	
Pre 2004 Design	4.20	4.88	6.00	2.00	1.12	4.12	
2004 Design	7.00	7.88	6.00	2.00	1.21	4.21	
Alternative design	7.00	8.08	7.00	2.45	1.30	4.80	
Alternative design	4.20	5.66	6.00	3.20	0.14	3.14	

Pre 2004 Cage Design

The pre 2004 hammer cage design even if correctly installed had a danger zone of about 83 degrees. This meant that a hooked throw of near world record distance could land on the main sprint track. The change of the landing sector to 34.92 degrees in 2001 with that cage design did not decrease the danger zone.

Alternative New Designs

The Paris Congress approved design gives a danger zone of about 53 degrees.

My two alternative designs as illustrated in the attached sketches (Figures 2 & 3) have wider gates and in the case of Figure 3 a 7m cage opening with 2.45m wide gates. These designs give the same danger zone as the IAAF approved design.

Increasing the width of the cage opening with wider gates was suggested formally by the USA in Proposal 195 to the Edmonton Congress and the suggestion was referred to the

IAAF Technical Committee for further consideration. In support of the proposal it was argued that it would avoid the problem of the hammer handle or wire hitting the cage on the far side of the cage.

The landing area danger zone for a concentric discus circle with the 7m wide gate opening would be increased compared with the standard discus cage with a 6m wide opening unless the hammer cage gates are partly closed. This is discussed further in a separate paper on discus cages.

Many hammer cage designs have the gate pivot posts set away from the position of the netting so that the actual lengths of the gates would be longer than the dimensions shown on figures 1 to 3 inclusive for the position of the netting. This could result in the gates being of very heavy construction making the gates difficult to manoeuvre into position. Also some manufacturers at present transport their gates by airfreight and it may be that the wider gates will not fit in most aircraft holds.

Modification of existing Hammer Cages

To take advantage of the smaller landing sector the simplest modification is to increase the gate length to 3.2m. This will decrease the opening available to the thrower, proportionally for the smaller landing sector angle, from the present 4.12m to 3.14m.

The danger zone would be reduced to approximately 53 degrees.

Cages with separate discus and hammer circles illustrated in the IAAF Handbooks in 1998-1999 and prior could be utilised without modification of the cage if the two separate circles are replaced with concentric discus and hammer circles centred at 5.7m from the cage opening. The danger zone for the hammer would be 64 degrees with this arrangement. To reduce the danger zone to 53 degrees the gates would have to be increased from 2 metres to 2.6m.

Manufacturers will have to examine their present designs to determine the best way of improving the safety of the cage to match the new design adopted by the IAAF.

Restriction Caused by Far Side Netting

Calculations and observation by me show that there is more restriction to throwers with the Congress approved new cage design than with the pre 2004 hammer cage design. The 7.00m wide cage opening configuration gives less restriction whilst the alternative of increasing the existing 2m wide gate to 3.2m does not change the restriction.

Danger Zones

The pre 2004 cage design for an IAAF standard track with a hammer circle near the 1500 metres start and a 85 degree danger zone has the centre of the circle at approximately

66m from the main straight kerb and approximately 36m from the back straight kerb based on the Sydney 2000 Olympics stadium where the centre of the landing sector was angled at 15 degrees to the main axis of the track. This meant that spectators sitting close to the back straight could be in danger from a left-handed thrower lobbing a hammer onto the track with considerable bounce thereafter or directly into the crowd.

The situation is progressively improved by increasing the length of the gates or extending the cage side panels, as is the case with the Paris Congress approved design. For a 53 degree danger zone the equivalent distances to the kerb are 86m and 85m respectively. The actual distances will vary slightly depending on the landing sector orientation and the location of the circle with respect to the track kerb.

The area of the arena to the present Men's Open World Record of 86.74m that is a danger zone for a selection of danger zone angles is shown in the table hereunder.

Danger Zone Angle	Danger Zone Area Sq. Metres
34.92	2293
53	3480
60	3939
85	5581

Note that no allowance is made in the above figures for a hammer bouncing further when it lands on track synthetic surface.

Conclusions

To take full advantage of the reduced landing sector it is necessary to increase the length of the gates or add to the cage side wings. The cheapest solution for new and existing cages with concentric circles would be to keep the pivot point of the gate netting at 4.2 m from the centre of the circle and increase the length of the gates to 3.2m.

It is rational to keep the present cage opening of 6.00m so that there will be no difference between existing cages modified by extending the gates and any completely new cages.

That said there is capacity for manufacturers to provide innovative designs that provide equivalent or better protection. Also IAAF Rule 192 is written so as to allow manufacturers to offer innovative designs of different dimensions if the danger zone for their design is not greater than the standard design illustrated in the IAAF Handbook.

The advantages of having a wider cage opening and longer gates are offset by the complexities necessary for a combined hammer and discus cage to reduce the width of the cage opening when the cage is being used for discus. Also the wider gates could be very heavy.

Recommendations

(a) Modification of existing cages as proposed above to give a 53 degree danger zone be accepted as an alternative to the Paris Congress approved hammer cage.
(b) Other cage designs including those with wider gate openings that provide equivalent or better safety protection may be submitted for IAAF Product Certificates.

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Reference:

(1) Gutiérrez, M., Soto, V.M.,Rojas, F.J. (2002). A biomechanical analysis of the individual techniques of the hammer throw finalists in the Seville Athletics World Championship 1999. IAAF New Studies in Athletics 2.2002, 15-26.