



CICA Position Paper

Articulated Crane Operator Requirements

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1. Purpose

The current High Risk Work License system allows operators who have a slewing mobile crane license to operate Articulated Cranes. Articulated crane operation is unique to the operation of other types of mobile cranes. Crane operators who operate Articulated Cranes must operate the crane according to the manufacturer's instructions. Their competency for Articulated Crane operation should be verified independent of slewing crane operation competency.

2. Background

An articulated crane (a variant of non-slewing cranes) is a type of mobile crane that is designed to travel on public roads, and is designed to lift and often carry a load to its destination. Different from slewing mobile cranes, articulated cranes normally do not have stabiliser legs or outriggers; they have a permanent articulation joint in their construction, allowing the crane to manoeuvre and place loads. Articulated cranes are designed to national or international standards and must be design registered where capacity is greater than 10 tonnes. Examples of these standards are Australian WHS Acts and Regulations, Crane Code of Practice and Australian Standard 1418.5-2013.

Articulated cranes are popular in Australia. There are over 5000 articulated cranes in operation which make up approximately 50% of the total number of mobile cranes in Australia. Nearly every crane company has at least one articulated crane and many companies have fleets of these cranes. Articulated cranes have displaced the work usually completed by smaller hydraulic truck cranes as the set up time is significantly shorter and the load can be picked up and carried by the crane to the destination.

Many accidents have been reported involving articulated cranes due to crane operators not following manufacturer instructions for site conditions, lifting conditions or are unfamiliar with the operation of articulated cranes.



Figure 1: Articulated Crane Rollover when Carrying a Load [1]

At a bridge construction project, a 'pick and carry' mobile crane moved across a slope whilst travelling with a suspended load. This reduced the crane's lifting capacity and caused it to tip on its side. Preliminary findings indicate that the crane operator's and engineer's assessments of the lift and the travel path did not consider the dangers of carrying a load on a slope.

3. Articulated Crane Operator Licence and Skill Requirements

A person who operates a crane must hold the relevant high risk work license for the type of crane they are to operate. Licensing authorities require articulated crane operators to hold a non-slewing mobile crane licence, classified as CN, or any of the slewing crane licences (C2, C6, C1, C0) to operate an articulated mobile crane, if it has a rated capacity greater than 3 tonnes.

To obtain the CN licence, an articulated crane operator must correctly ^[2]:

- Carry out all necessary pre-operational checks;
- Prepare a safe operational plan to deal with typical hazards and control the risks arising from those hazards;
- Set-up the crane;
- Understand and interpret load charts and data plates;
- Respond to hand and whistle signals for load movement;
- Calculate the safe working loads of slings in various configurations;
- Inspect lifting gear for defects;
- Assess the weight of loads;
- Operate the crane under actual or simulated working conditions;
- Understand the use of various items of lifting gear; and
- Shut down and secure the crane.

4. Comparison of Operating Features of Slewing Mobile Cranes and Articulated Cranes

Even though crane operator skill requirements are similar between different types of cranes, articulated cranes have their own special operating features that differentiate themselves from other types of mobile cranes, i.e. slewing mobile cranes.

Contrary to slewing mobile cranes, articulated cranes typically do not have stabiliser legs or outriggers; crane stability is entirely from the crane tyres. Crane rated capacities on tyres depend on tyre capacity, condition of the tyres, tyre air pressure [Figure 2(a)] and ground condition. All tyres must be checked and inflated to the recommended pressure before lifting ^[2]. Ground shall be examined to understand ground conditions. Crane shall set up on a firm, level and uniform surface. The crane operator shall read and fully understand the manufacturer's instructions for site conditions and lifting conditions before conducting the lift.

During the lifting operation, slewing mobile cranes usually lift the load from a fixed location, whereas articulated cranes often travel on sites with their load. When operating the crane to lift and carry a load, the crane operator shall follow the manufacturer's instructions. Adverse operating conditions should be considered, including the supporting surface, pendulum action of the load, jerking or sudden stops of the load and other factors affecting stability, as rated lifting capacities are based on freely suspended loads with the crane on a firm, level (max.1% slope / 0.6 °) and uniform surface ^[1]. Crane operators shall take into consideration changing ground conditions (uneven road surface, potholes, etc.) will cause a reduction in crane rated capacity. See below Figure 2(b) and Figure 2(c) for examples of crane stability problems

caused by changing ground conditions when travelling on road. These conditions effectively create a side slope condition and the rated capacity of the crane reduces to ensure the crane remains stable. Manufacturer's instructions should be followed for operating on a side slope. If no deration chart or instruction is given on side slope operation, crane shall not be operated on side slope.

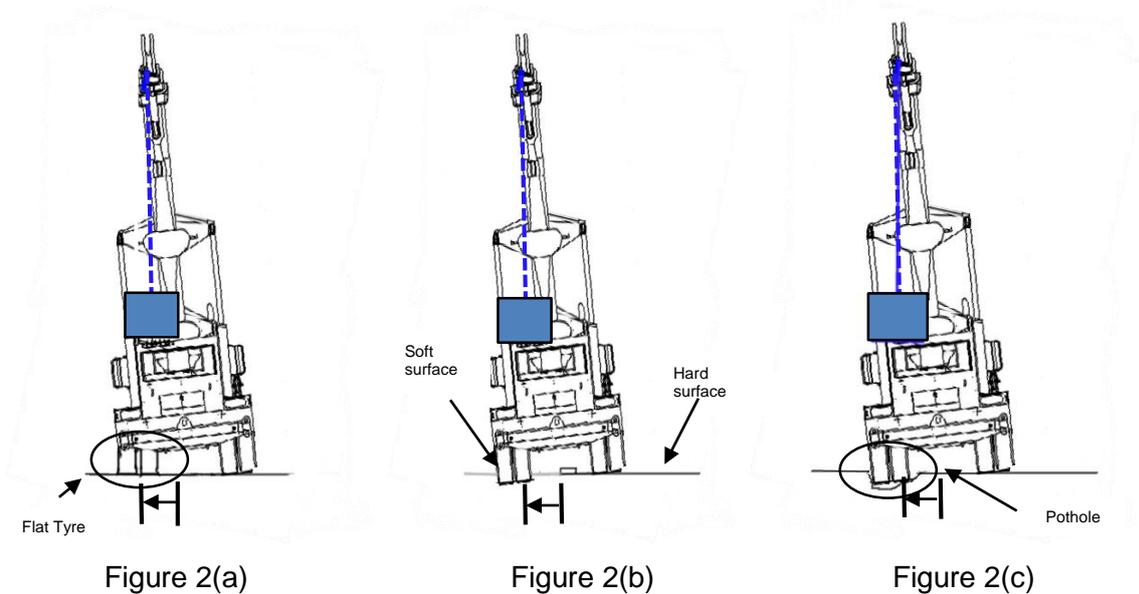


Figure 2: Crane stability problems caused by (a) using incorrect tyre pressure (b) changing ground conditions and (c) pothole on the ground

When lifting a load on a side slope, it induces a side load as the load swings down the slope and this affects the tipping line of the crane. Crane operators shall follow the deration percentage specified on the deration load chart provided by the crane manufacturer to calculate the appropriate crane rated capacity for their lifting job. See Appendix A for examples of how to use the side slope deration chart.

Combination of crane articulation and ground side slope can cause serious problems for crane stabilization, crane travelling path analysis and de-rating calculation of the crane lifting capacity shall be conducted during the work planning phase, crane side slope indicators shall be correctly interpreted and crane side-slope chart shall be used.

Unlike slewing mobile cranes that can perform lifting operations with a slewing angle of 360°, the articulated cranes' operation is only permitted through the crane articulation range, typically up to 40°. Most articulated cranes have a reduced rated capacity above 10° articulation. During crane articulation, the crane's centre of gravity gets closer to the axis of rotation which causes the moment from the crane counterweight to be reduced. A reduced rated capacity chart has to be used if entering the articulation range of 10° to 40° during the operation (as illustrated in Appendix B)

5. Conclusion

Current crane licence classifications allow licenced slewing crane operators to operate articulated cranes. However, from the above comparison, there are several key set-up and operational differences between a slewing mobile crane and an articulated mobile crane. The special aspects that are required to operate an articulated crane are not discussed or emphasized in slewing crane license requirements. Crane operators who have slewing crane licences, but do not have adequate experience with articulated crane operation can lead to serious safety issues.

6. CICA Position

Articulated crane design, manufacturing and testing are regulated by Australian standards, safety regulations and industrial code of practices. Numerous modern technology and materials are applied and used on the articulated cranes by crane manufacturers to make sure these sophisticated, state of the art machines are safe to operate under different conditions.

Articulated cranes can be operated by a crane operator with a slewing crane licence under current licencing system, but as discussed above, articulated crane operators need to be familiar with the behaviour of articulated cranes and follow manufacturer's instructions to perform safe lifting operations with articulated cranes.

CICA recommends that although crane operators with slewing type crane licences (C2, C6, C1, and C0) are deemed to be competent to operate articulated cranes, if the operator does not normally work with articulated types of cranes, specific training and familiarization training including technical and theoretical information and practical demonstrations should be conducted under supervision.

CICA training pack "Safe use of Articulated Pick & Carry Cranes" is developed by CICA technical committee with contributions from crane manufacturers and experienced crane operators and assessors. The training pack may be used as refresher training materials for crane operators, dogging and rigging crews and supervisors for training and competency assessment.

7. Reference

1. Safety Alert, Using mobile cranes in 'pick and carry' operations, WorkCover NSW
2. Crane and Hoist Operators, What you need to know about certificates of competency, WorkSafe VIC
3. Crane Rating Manual Model AT-20, Hydraulic All Terrain Pick & Carry Crane, Terex Australia PTY LTD.
4. Mobile Crane Code of Practice, 2006, Workplace Health and Safety Queensland.
5. Fact Sheet, High Risk Work Licensing – Hierarchy of Crane Licences, SafeWork SA.
6. Safe use of articulated pick & carry cranes, 2009, CICA.

8. Further Information

This Position Paper contains summary information only and further information and a listing of CICA recognised Crane Engineers is available by contacting The Crane Industry Council of Australia:

Contact details

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Appendix A – Side Slope Deration

Figure A-1 is an example of an articulated crane lifting load on side slope. Lifting on a side slope induces a side load as the load swings down the slope and this affects the tipping line of the crane. Any deviation to firm level conditions requires the rated capacity to be reduced accordingly to the manufacture’s recommendations.

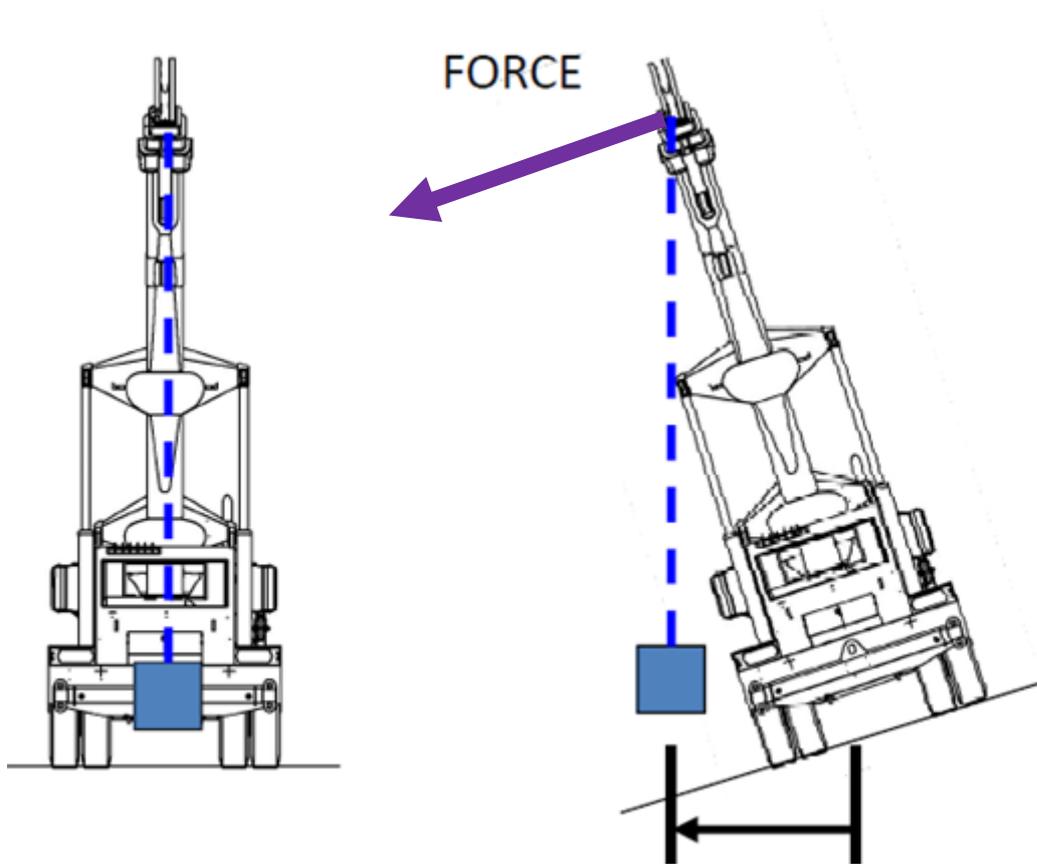


Figure A-1: Articulated crane travel on side slope

Figure A-2 is an example of a crane capacity deration chart. The deration load charts are provided by manufacturers to guide the operator how to calculate the rated capacity reduction when a side slope is encountered. Crane operators shall follow the deration percentage specified on the chart to calculate the appropriate crane rated capacity for their lifting configuration and environment.

If a crane with a deration load chart below has a rated capacity of 4000kg (operating at 10m working radius with a boom angle of 30°), when it’s operating on a side slope up to 5°, according to the chart, the crane capacity shall reduce 40% to:

$$4000\text{kg} - 4000\text{kg} \times 40\% = 2400 \text{ kg (point (1))}$$

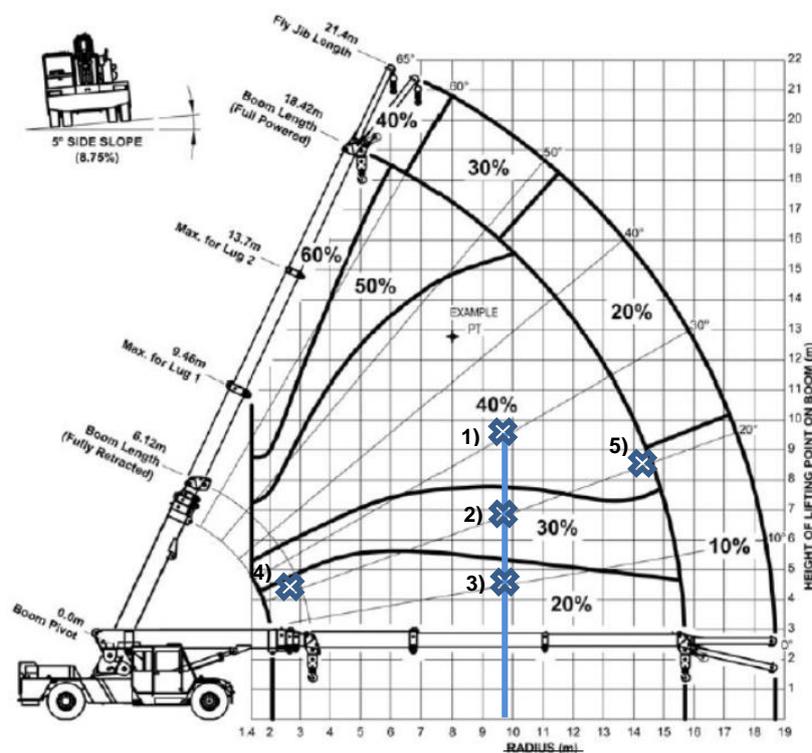


Figure A-2: Example crane capacity deration chart

According to Figure A-2, when a crane is operating at 10m working radius on a surface with a side slope up to 5°:

- 1) If the boom is operating at 30° angle, the rated capacity of the crane shall be reduced by 40%.
- 2) If the boom is operating at 20° angle, the rated capacity of the crane shall be reduced by 30%.
- 3) If the boom is operating at 10° angle, the rated capacity of the crane shall be reduced by 20%.

When the crane is operating at 20° boom angle on a surface up to a 5° side slope:

- 4) If the boom length is 6.12m, the rated capacity of the crane shall be reduced by 20%
- 5) If the boom length is 18.42m, the rated capacity of the crane shall be reduced by 40%.

It is important to keep the boom length and angle to a minimum when operating on side slope.

Appendix B – Crane Articulation

Crane stability changes during crane articulation. The position of crane weight gets closer to the axis of rotation which causes the moment from the crane weight to be reduced (Figure B-1)

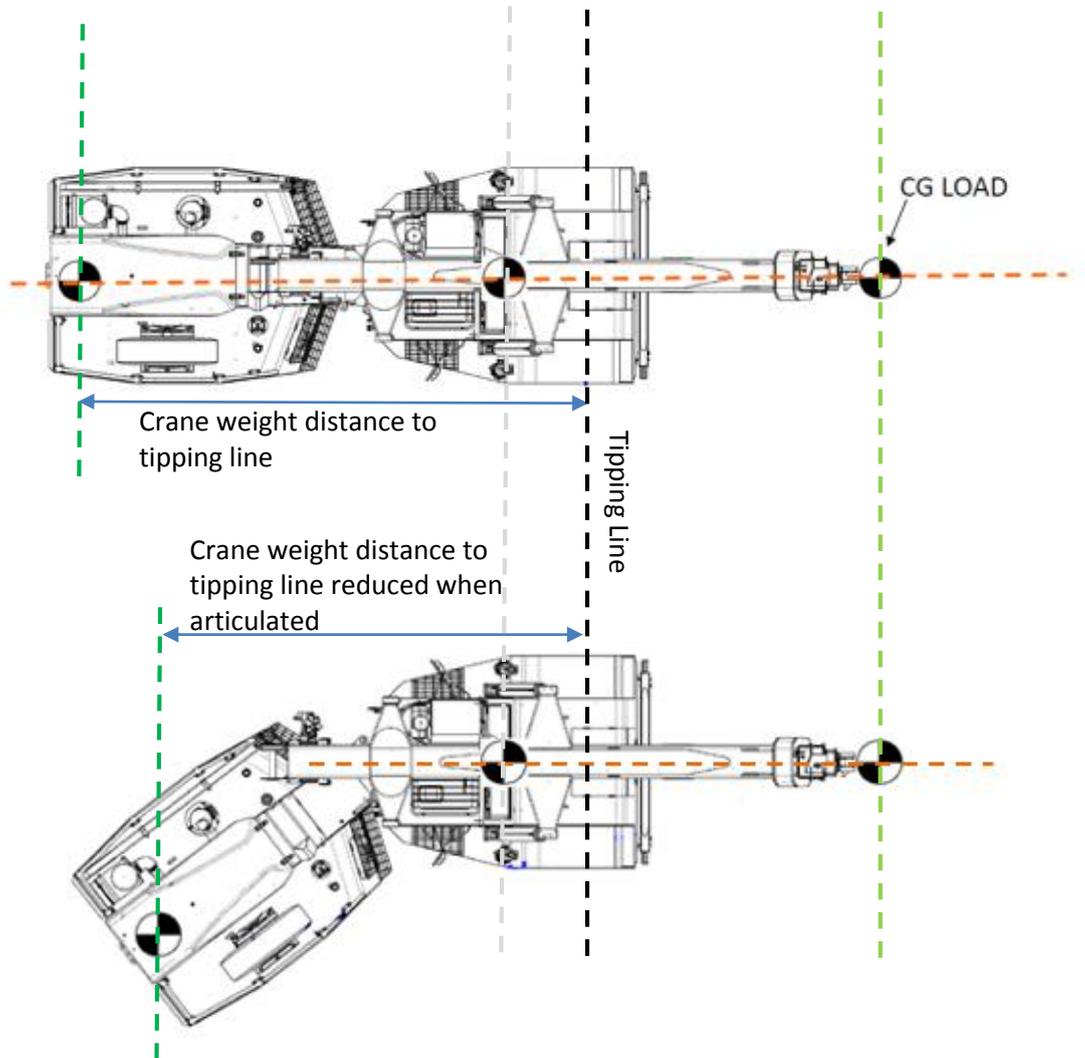
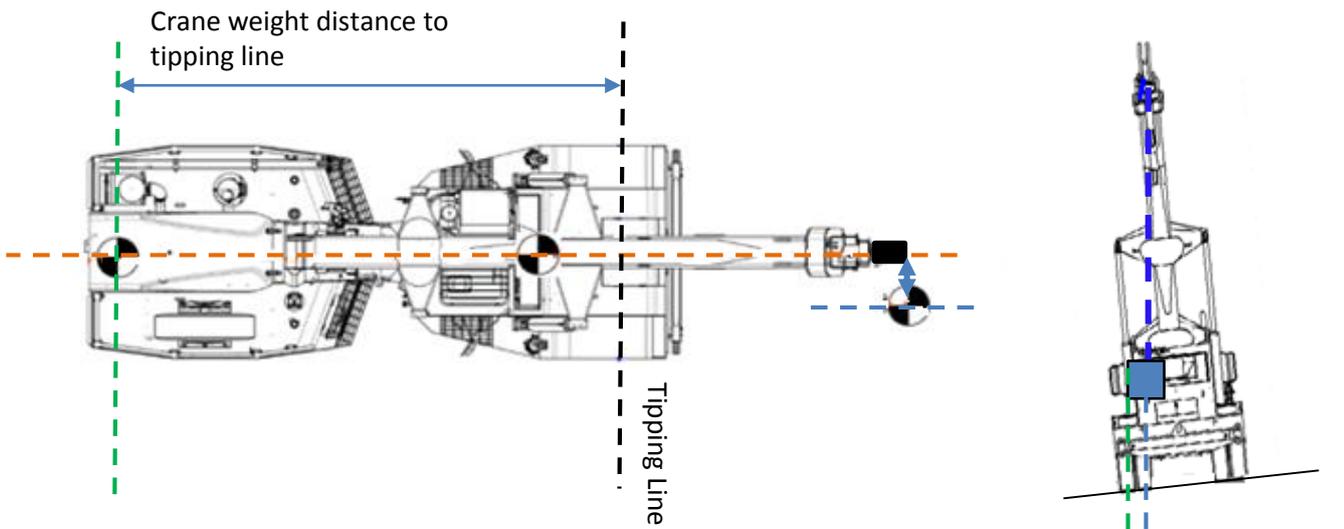
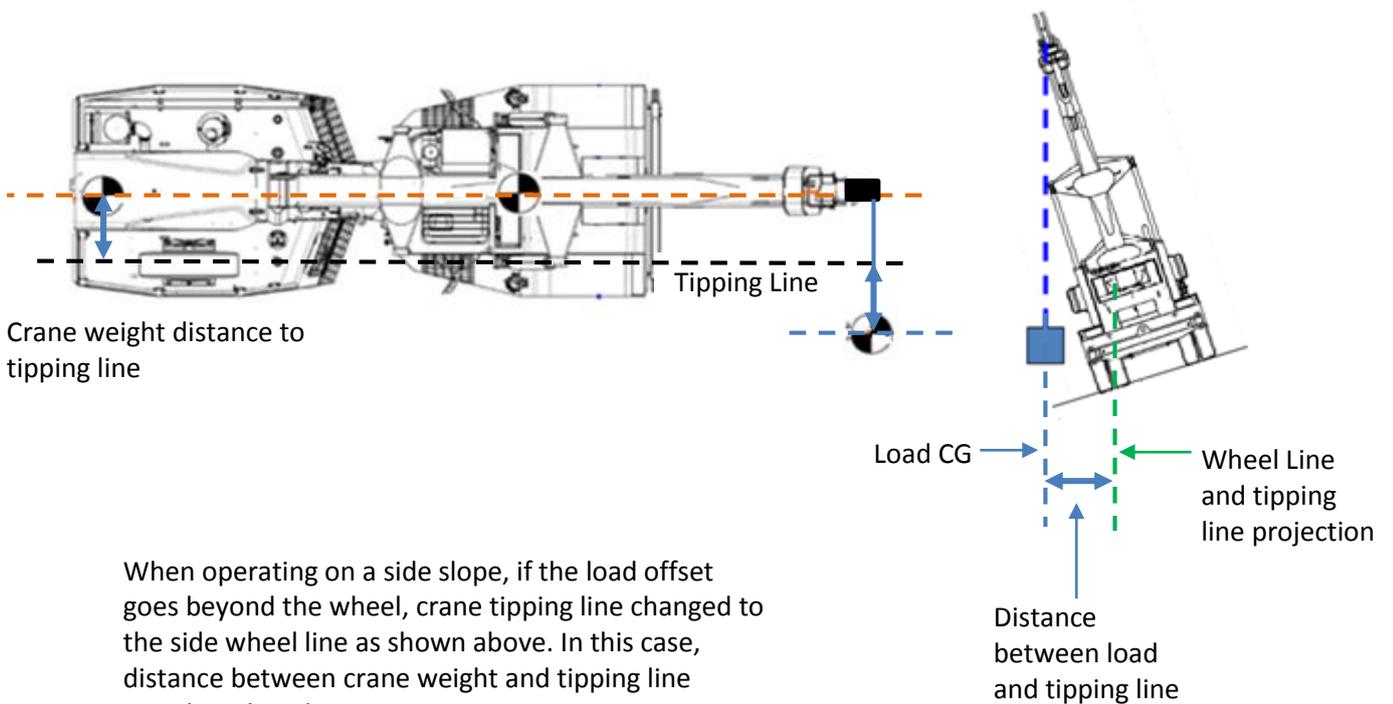


Figure B-1: Articulated crane in non-articulation and articulation configuration on a flat surface

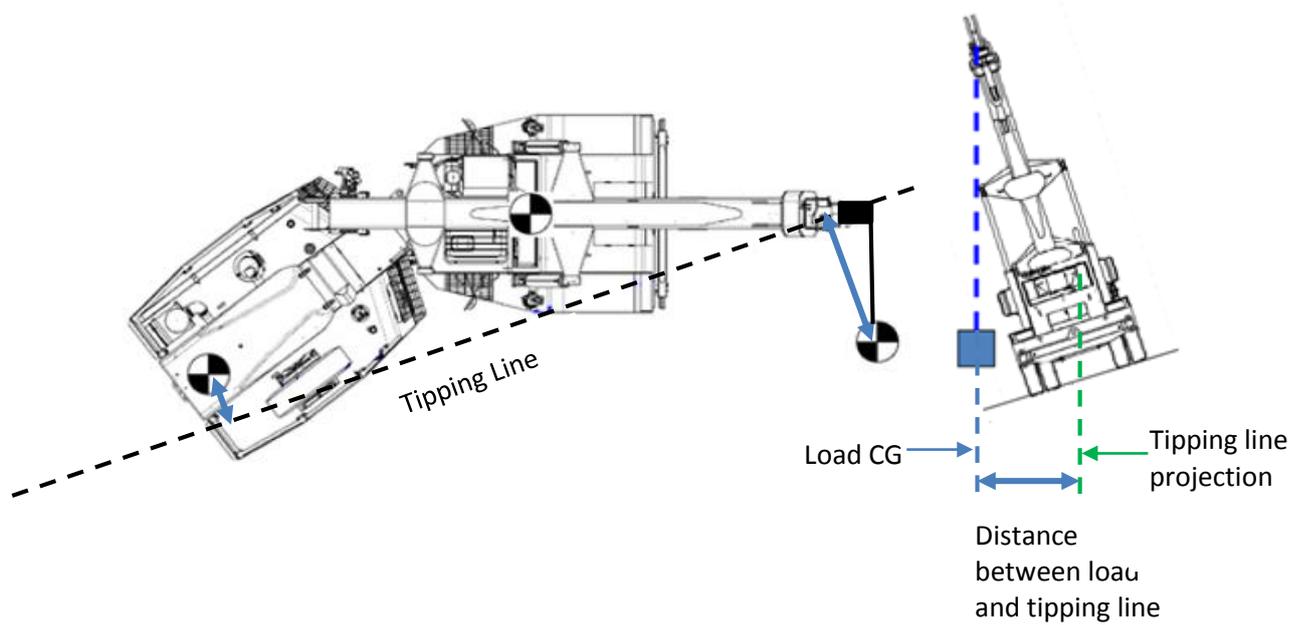


When operating on a side slope, if the load offset does not go beyond the wheel, crane tipping line is still the front wheel.



When operating on a side slope, if the load offset goes beyond the wheel, crane tipping line changed to the side wheel line as shown above. In this case, distance between crane weight and tipping line greatly reduced.

Figure B-2: Articulated crane in non-articulation on a side slope



When operating on a side slope in articulated configuration, the crane tipping line changed to the side wheel line. In this case, distance between crane weight and tipping line greatly reduced and distance between load and tipping line increased.

Figure B-3: Articulated crane in articulation configuration on a side slope

Refer to the example articulated crane load chart below. In the chart, crane rated capacity for crane articulation angle less than 10° (in green) and crane articulation angles greater than 10° (in yellow) are listed. Stability reduces the rated capacity of the crane when the crane articulates more than 10°.

RADIUS	BOOM LENGTH (m)																	
	5.67	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	13.85
1.6	16800	16250	15450	14900														
	12600	12600	12600	12600														
2.0	16800	16800	16500	15700	15100	14700	14350											
	12600	12600	12600	12600	12600	12600	12600											
2.5	13900	13900	13900	13850	13850	13850	13850	13200	3000									
	12150	12150	12100	12100	12100	12100	12100	12050	2050									
3.0	11450	11450	11450	11400	11400	11400	11400	11400	1400	11150	10250							
	9950	9950	9950	9950	9950	9950	9900	9900	9900	9900	9900							
3.5	9650	9650	9650	9650	9650	9650	9650	9650	9650	9650	9500	8150	7500					
	8400	8400	8400	8400	8400	8400	8400	8400	8350	8350	8350	8150	7500					
4.0	9450	8650	8350	8350	8350	8350	8350	8350	8300	8300	7600	7000	6700	6450				
	8200	7450	7250	7250	7250	7250	7250	7250	7200	7200	7200	7200	7000	6700	6450			
4.5			6500	6350	6350	6350	6350	6350	6300	6300	6300	6300	6300	6250	6050	5800	5650	
			(4.40)	19	27	34	38	42	45	48	50	52	54	56	58	59	60	
5.0			5750	5600	5600	5600	5600	5600	5600	5600	5600	5600	5600	5600	5600	5600	5600	5150
			(4.90)	18	27	33	37	41	44	47	49	51	53	55	56	58	59	
6.0			5950	5350	5250	5250	5250	5250	5250	5250	5250	5250	5250	5250	5050	4850	4700	4600
			(5.40)	(5.90)	17	25	31	35	39	42	45	47	49	51	53	54		
7.0			4850	4450	4400	4400	4400	4400	4400	4400	4400	4350	4350	4350	4200	3950		
			(6.40)	(6.90)	16	24	29	34	37	40	43	45	47	48				
8.0			4100	3750	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3600	
			(7.40)	(7.90)	15	23	28	32	36	38	41	43						
9.0			3500	3250	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
			(8.40)	(8.90)	15	22	27	31	34	36								
10.0			3000	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800	2800
			(9.40)	(9.90)	14	21	26	29										
11.0			2650	2500	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450	2450
			(10.40)	(10.90)	13	18												
11.75			2350	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250	2250
			(11.40)	(11.75)														

SWL (KG) LESS THAN 10 DEG ARTICULATION
 SWL (KG) GREATER THAN 10 DEG ARTICULATION
 BOOM ANGLE

Weight of slings & hook block to be added to load
 Read and understand warning notes before operating crane
 Loads above bold red line are structural

Figure B-3: Example articulated crane load chart

When crane is operating with a 9 meter boom at 4 meter radius,

- 1) Rated capacity of the crane is 8350kg when the crane is articulated less than 10°, or
- 2) Rated capacity of the crane is 7250kg when the crane is articulated more than 10°, boom angle is 47° for both cases.