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- To: City of Toronto, City Planning Toronto City Hall 18th Floor, 100 Queen St W Toronto, Ontario M5H 2N2
- From: Jamie Kennedy, Hatch Michael Sutherland, Hatch Andrew Middleton, Hatch

October 21, 2022

cc: Christina Glass, Hullmark Developments Jeff Hull, Hullmark Developments

Subject: Assessment of Development Proposal in Proximity to Metrolinx Rail Line 450 Dufferin Street – Proposed Mixed-Use Residential Development

Introduction:

As part of the Zoning By-Law Amendment application (ZBA), HM RK (450 Dufferin) LP (the "Applicant" or "Landowner") has retained Hatch Ltd. to conduct a 'Proximity Review' at 450 Dufferin Street (the "Project" or "Site") with respect to the Metrolinx Weston Subdivision rail corridor, south of the property.

The purpose of this letter is to review the proposed development against the most recent industry guidelines for new development in proximity to rail infrastructure, identify potential hazards and/or risks, and determine whether any measures are required to mitigate these risks.

Site Context:

The site is located at Mile 2.65 of the Metrolinx Weston Subdivision rail corridor and is bound by Dufferin Street to the east, Alma Avenue to the south, and existing development to the north and west. The Metrolinx rail corridor is approximately 130 metres southwest of the property, as illustrated in Figure 1 below.



Figure 1: Context Plan

Metrolinx operates daily passenger service on the Kitchener GO Transit line and Milton GO Transit line; service on both lines is expected to increase in the future as part of the GO Regional Express Rail initiative. The Union-Pearson Express (UPX) also operates daily passenger service between Union Station and Toronto Pearson International Airport along this section of track.



Proposed Development

The development at 450 Dufferin Street is proposed as a 15-storey residential development, with retail units at grade. Renderings of the proposed development are illustrated in Figure 2 below.



Figure 2: 450 Dufferin Street Rendering

Metrolinx Weston Subdivision:

The Metrolinx-owned Weston Subdivision rail corridor is located 130m southeast of the site. In the current condition, there are four existing tracks within the corridor which are straight in alignment. As part of the GO Transit expansion plan, Metrolinx will add four additional tracks to the existing rail corridor, resulting in 8 principal main line tracks in the future.

When Metrolinx acquired the rail corridor from Canadian National Railway (CN) and Canadian Pacific Railway (CP), as part of the purchase and sale agreement, both CN Railway and CP Railway maintained operating rights on their respective tracks. Currently the rail corridor is only used for passenger rail service and freight service is unscheduled and infrequent. However, both rail authorities may operate freight traffic at any time.

The Metrolinx track diagram, illustrated in Figure 3 below, depicts the current track alignment near the property, rail corridor speeds, and identifies notable features within the rail corridor including the closest signal bridges, track crossovers, and grade separations.

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Figure 3: Metrolinx Weston Subdivision Track Diagram

At Mile 2.65, the maximum allowable speeds for passenger trains in the rail corridor is 80mph, and the maximum allowable speed for freight trains is 25mph. Multiple grade separations have been introduced east and west of the property, allowing Metrolinx to operate passenger trains without at-grade interactions, improving the overall risk profile of the rail corridor.

Signal bridges are located further west at Lansdowne Avenue, and further east at King Street and are not anticipated to be affected by the proposed development at 450 Dufferin Street. The track diagram is included in Appendix A – Rail Corridor Details.

Rail Adjacent Development Guidelines:

The 'standard approach' for new developments in proximity to rail corridors, as defined by the Federation of Canadian Municipalities and Railway Association of Canada, is a 30-metre horizontal setback (measured from the rail corridor property line) in combination with a 2.5-metre-high earthen berm. The Metrolinx Adjacent Development Guidelines and the City of Toronto also recommend the same standard measures for new developments adjacent to railways. Additional measures to address noise, vibration, odors, and other risks, are assessed on a site-by-site basis.

Both guidelines also acknowledge that the standard mitigation measures may not be practical or feasible on smaller, urban sites and that alternative mitigation measures may be identified through the Development Viability Assessment.

Specifically, at 450 Dufferin Street the application of a safety barrier is thought to be impractical due to:

- a) The existing setback between the rail corridor property line and the development lands.
- b) The Landowner does not control the properties between the site and the rail corridor, and thus, is unable to construct a standard safety barrier along the rail corridor property line.
- c) The existing buildings between the site and the rail corridor (ie. the intervening land uses) would make the application of a safety barrier on the Landowner's property redundant.

As such, the provision of a safety barrier is not considered for this development as the risk of a train derailment impacting the property is very low.

Notably, as part of the development application, the Landowner will also be asked to enter into an Adjacent Development Agreement with Metrolinx; a standard agreement for new developments within 300 metres of railway facilities. As part of the Adjacent Development Agreement, Metrolinx will also request an environmental easement over the site.

Energy Balance Analysis:

As part of this review, the possibility of a train derailment was considered. Using the methodology outlined in the AECOM Development of Crash Wall Design Loads from Theoretical Train Impact (or 'AECOM Guidelines'), an Energy Balance Analysis was conducted to understand the outcome of a train derailment under specific scenarios (or 'Load Cases').

The results of the Energy Balance Analysis indicate that a train travelling at the maximum allowable speed of 80mph would not reach the subject property line under any of the four load cases.

Furthermore, a derailed train would theoretically have to be travelling more than 225mph (nearly 3x the allowable speed) to reach the property line of site, let alone impact the building. This does not account for any structures or barriers that a derailed train would encounter between the rail corridor and the development lands, which would further act to slow the train.

The Energy Balance Analysis indicates that the risk of derailment at the site is acceptably low, as a derailed train would be expected to lose all momentum prior to reaching the property. The supporting calculations are included in Appendix B – Energy Balance Analysis.

Conclusion:

The Federation of Canadian Municipalities (FCM) and Railway Association of Canada (RAC) *Guidelines for New Development in Proximity to Railway Operations* (2013) and Metrolinx's *Adjacent Development Guidelines* include specific recommendations for development adjacent to or in close proximity to principal main line tracks:

- 1. <u>Setbacks</u>: The recommended setback for new residential development adjacent to principal main line track is 30 metres.
- 2. Safety Barrier: Safety barriers are required for lands up to 120 metres from the rail corridor.
- 3. <u>Noise Mitigation</u>: The recommended minimum noise influence area when undertaking noise studies along a principal main line track is *300 metres*.

The results of this Proximity Review indicate the development proposed at 450 Dufferin Street meets the necessary criteria for development within proximity of an active rail corridor. Specifically:

- 1. The 130-metre setback between the rail corridor property line and the development lands significantly exceeds the standard setback of 30 metres.
- 2. Derailment protection in the form of a safety barrier is not required and is not planned as the development is greater than 120 metres from the rail corridor property line (in accordance with the Metrolinx Adjacent Development Guidelines, and further supported by the Energy Balance Analysis)
- 3. A Noise and Vibration Assessment has been commissioned by the Landowner to evaluate transportation-related noise impacts (including rail) on the development and submitted under separate cover.

We hope this letter adequately summarizes the proposed development plans in the context of the rail adjacent development guidelines. Should you have any further questions or comments, please contact the undersigned.

Sincerely,

Jamie Keńnedy **U** Project Manager, Rail Adjacent Development

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Andrew Middleton, P. Eng. Engineer, Structures and Bridges

Attachment(s) / Enclosures:

- Appendix A: Rail Corridor Details
- Appendix B: Energy Balance

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Appendix A: Rail Corridor Details



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Appendix B: Energy Balance Analysis

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Parameters	-	Freight Load Case 1	Load Case 2	Passen	Inard Case 4	Notes	
	No. of Locomotives	Glancing Blow	Direct/Single Car Impact	Glancing Blow	Direct/Single Car Impact	7	
	Mass of Locomotive	200,000	200,000	132,000	200,00	26	
	Length (m) No. of Cars	17	17	2		1	
	Mass of Cars Length (m)	129,700	129,700	67,120	67,13	26	
	Total Mass (kg)	1,367,300	129,700	668,960	67,12	20	
	Angle of impact (" to wall) Radians	3.5 0.06	See Table 1.0 See Table 1.1	3.0	5 See Table 1.0 5 See Table 1.1	_	
	Speed limits within the corridor:	366 101.56	km/h m/s	36 101.5	6 km/h 5 m/s		
		227.23	mph	227.2	3 mph		
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		0.061	0.000	0.06	0.00		
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EQ [3M, 7M, 8M]							1
Glancing Blow EQ. [3M]	2 (det-1625)		Single Car, Direct Impact				1
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vo^2 = 2a = -9.8*(R+G) =	-10314.4052	7 m/s 5 m/s	EQ.[8M]	$v_A = \frac{2.9\sigma_f}{\sqrt{1 - \cos\theta_f}}$ [m/s]:	tor possenger cars	5-((C)	
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[Anit] J _G = 3/2 Table 13 Intel Number 1 3 3 4 - 5 4 5 4 5 5 6 - 6 - 6 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 16 - 16 - 16 - 16 - 16 - 16 - 16 - 17 - 18 5 10 - 10 - 10 - 10 - 10 - 10 - 11 - 12 - 13 -	$F_{G} = \frac{\frac{66 (m)}{100}}{F_{G}}$	$\begin{array}{c c} Sigk G_{c}, Sink Impact \\ \hline 1100 \\ \hline \\$	$l_A = \frac{.3049}{\sin\theta_T}$ Developing Carlinger register of Marco Transition Torre (See record) record the set of the set of the set record) record the set of the set of the set record the set of the set of the set of the set record the set of the	Two can is according tool used $s = 2 \left[\frac{3.25}{3.25} \sin \theta_t + \frac{3.25}{9} \sin \theta_t + 3.2$	0.5 cos θy Divercifingle Cr Ingent		
[24]	$F_{G} = \frac{\frac{60.00}{100}}{F_{G}}$	$\begin{split} & \begin{array}{c} \text{Single Ge, Done Impact} \\ 11:00 \\ \hline \\ & \begin{array}{c} \text{Franget} \\ \hline \\ & \begin{array}{c} \text{Frank} \\ \text{Frank} \\ \hline \\ \end{array} \\ \hline \\ \hline$	$l_A = \frac{.3049}{\sin \theta_T}$ Dest/Dingle Car Impact Integrit of Marka Impact Tarte for Impact of Marka Impact Tarte for Impact Impact Impact Tarte for Impact Im	The can be according (per target) $s = 2 \left[\frac{3.25}{3.25} \sin \theta_{c} + \frac{3.25}{100} \frac{1}{\theta_{c}} + \frac{3.25}{100} +$	O.5 cos θ(Orec/Single or inspat Orec/Single or inspat move mo		
(a) I _G = 3/0 Table 19 1 1	$F_{G} = \frac{\frac{66.(m)}{0}}{F_{G}}$	$\begin{split} & \frac{\log d (x_{G}, \operatorname{Dote Impact})}{f \log d (x_{G}, \operatorname{Dote Impact})} \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ & \frac{1}{2} m (v_{G} \sin \theta_{G})^{2} \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impact})}{g \log d (x_{G}, \operatorname{Dote Impact})} \\ \\ & \frac{f \log d (x_{G}, \operatorname{Dote Impac})}{g \log d (x_{G}, Dote Imp$	$l_A = \frac{.3049}{\sin \theta_T}$ Description of the sequence of the	The car is accertion (but used) $s = 2 \left[\frac{3.25}{3.25} \sin \theta_{t} + \frac{3.25}{9} \sin \theta_{t} + 3.$	0.5 cos θγ		
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[Anit] J _G = 3/0 Table 19 Image: Second S	$\frac{6049}{686g}$ $\frac{6660}{9}$ $F_G =$ $F_G =$ F	$\begin{split} & \frac{\log d (x_{G}, \log n) \log \log 1}{1000} \\ & \frac{1000}{1000} $	$l_A = \frac{.3049}{\sin \theta_T}$ Description of the second secon	Two can is according lost used $s = 2 \left[\frac{3.25}{3.25} \sin \theta_{f^+} \right]$ The case is a constrained of the case of th	0.5 cos θy		
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[Anit] J _G = 3/0 Table 13 Image: State 14 Image: State 14 Image: State 14 State 2 Calculating One pin forces State 3 State 4 Image: State 14 Image: State 14 Image: State 14 </td <td>$F_{G} = \frac{\frac{66 (m)}{10}}{F_{G}}$</td> <td>$\begin{array}{c c} Single Ge, Done Impact \\ 1100 \\ \hline \\$</td> <td>$b_A = \frac{.3048}{\sin \theta_T}$ Development Car input regist of Mana Imput Torus in Beneformed Car input Regist of Mana Imput Torus in Beneformed Torus Imput Regist of Mana Imp</td> <td>The case is according lost used $s = 2 \left[\frac{3.2}{2} \sin \theta_{1} + \frac{1}{2} + \frac{1}{2} \sin \theta_{2} + \frac{1}{2} + \frac{1}$</td> <td>0.5 cos θy 0.6 cos θy 0.7 cos θy 0.7 cos θy 0.8 cos θy 0</td> <td></td> <td></td>	$F_{G} = \frac{\frac{66 (m)}{10}}{F_{G}}$	$\begin{array}{c c} Single Ge, Done Impact \\ 1100 \\ \hline \\$	$b_A = \frac{.3048}{\sin \theta_T}$ Development Car input regist of Mana Imput Torus in Beneformed Car input Regist of Mana Imput Torus in Beneformed Torus Imput Regist of Mana Imp	The case is according lost used $s = 2 \left[\frac{3.2}{2} \sin \theta_{1} + \frac{1}{2} + \frac{1}{2} \sin \theta_{2} + \frac{1}{2} + \frac{1}$	0.5 cos θy 0.6 cos θy 0.7 cos θy 0.7 cos θy 0.8 cos θy 0		
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(a) (b) (c) ($\frac{600}{600} = \frac{\frac{600}{100}}{\frac{100}{100}} = \frac{\frac{600}{100}}{\frac{100}{100}} = \frac{100}{100} = \frac{100}{100$	$\begin{split} & \begin{array}{c} & \text{Single Ge, Done Impact} \\ & \text{Single} \\ \hline \\ & \begin{array}{c} & \text{Frequely} \\ \hline \\ \hline \\ & \begin{array}{c} & \text{Frequely} \\ \hline \\ \hline \\ & \begin{array}{c} & \text{Frequely} \\ \hline \\ \hline \\ \hline \\ & \begin{array}{c} & \text{Frequely} \\ \hline \\ $	$b_{A} = \frac{.3048}{\sin \theta_{T}}$ Descriptings Car Inquist Descriptings Car Inquist Descriptings Car Inquist Descriptings	The case is according lost used $s = 2 \left[\frac{3.2}{2} \sin \theta_{c} + $	0.5 cos θy Deed/High Ce Inget Biologia Ce Inget	NET NET Net of plants deformation in and monomer and per the strange of the strange of the strange of the st	direct midden c car to car to car to
[24] J _G = 3/2 Table 19 Intermediate Table 19 Intermediate Step 4 Calculating besign forces Calculating besign forces C (16) (17) Intermediate Provides of definition (27) Calculating besign forces C (16) (17) Intermediate Provides of definition (27) Calculating besign forces C (28) (17) Intermediate C (28) (17) Calculating besign forces	$F_{G} = \frac{\frac{6.00}{100}}{\frac{100}{100}}$ $F_{G} = \frac{6.00}{100}$	$\begin{split} & \begin{array}{c} & & & & & & & & & & & & & & & & & & &$	$b_A = \frac{.3049}{\sin \theta_T}$ Deck/Direct Car Impact Deck/Direct Car Impact Deck/Dimpact Deck/Dimpact Deck/Direct Car Impact	The car is according bot used $S = 2 \left[\frac{3.25}{3.25} \sin \theta_t + \frac{3.25}{100} \theta_t + 3.25$	O.5 cos θγ Orect/Single Cer Impair Orect/Sin	Form	direct graphic states and state
[A04] <i>J G G</i> Table 12 Table 12 Step 5 Clocksting Design Forces Schoold Section Step 5 Clocksting Design Forces Schoold Section Step 5 Clocksting Design Forces Schoold Section Step 5 Clocksting Design Forces Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section Step 5 Force along the length of 1 Schoold Section <tr< td=""><td>$\frac{4242}{636_{0}}$</td><td>$\begin{array}{c c} Single Ge, Bone Impact 1100 1100$</td><td>$l_A = \frac{.3049}{\sin \theta_T}$ Developing Corr Input The set of the set of the</td><td>The car is accertain (pet used) $S = 2 \left[\frac{3.25}{3.25} \sin \theta_{f^{+}} \right]$ Transmer Obvious flow 0 Units flow $F_{A} = \frac{\frac{1}{2}m(v_{A} \cos \theta_{f}}{d_{A}}$ Transmer $F_{A} = \frac{\frac{1}{2}m(v_{A} \cos \theta_{f}}{d_{A}}$ Transmer Transmer 0 Units flow 0 Units flow</td><td>O.5 cos θy</td><td>The: The second second</td><td>diret spitialo</td></tr<>	$\frac{4242}{636_{0}}$	$\begin{array}{c c} Single Ge, Bone Impact 1100 1100 $	$l_A = \frac{.3049}{\sin \theta_T}$ Developing Corr Input The set of the	The car is accertain (pet used) $S = 2 \left[\frac{3.25}{3.25} \sin \theta_{f^{+}} \right]$ Transmer Obvious flow 0 Units flow $F_{A} = \frac{\frac{1}{2}m(v_{A} \cos \theta_{f}}{d_{A}}$ Transmer $F_{A} = \frac{\frac{1}{2}m(v_{A} \cos \theta_{f}}{d_{A}}$ Transmer Transmer 0 Units flow 0 Units flow	O.5 cos θy	The: The second	diret spitialo
(a) (b) (c) ($F_{G} = \frac{65 \text{ (m)}}{100}$ $\frac{65 \text{ (m)}}{100$	$\begin{split} & \begin{array}{c} & \text{Single Ge, Done Impact} \\ & \text{Single} \\ \hline & & \text{Single} \\ \hline \\ \\ \hline \\ \hline \\ & & \text{Single} \\ \hline \\ \hline \\ \hline \\ \hline \\ & & \text{Single} \\ \hline \\ \hline \\ \hline \\ \hline \\ \hline \\ & & \text{Single} \\ \hline \\ $	$b_{A} = \frac{.3048}{\sin \theta_{T}}$ Descripting Car Impact The Control of the second of th	The car is according (set used) $S = 2 \left[\frac{3.2}{2.5} \sin \theta_{c} + $	-0.5 cos θy -0.5 cos	Nor Nor The sequent of plant dedonation is and project to be deformed as and able the sequent of additional to be add and a sequent of additional to be add the sequent of additional to be add the sequent of additional to be add the sequent of additional to be add at the sequen	direc reptioner and the second s
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[Alig] J _G = 3/0 Table 19	$\frac{449}{686_{0}}$	$\begin{array}{c c} Single Ge, Done torquest \\ 1100 \\ \hline \\ \hline \\ 1100 \\ \hline \\$	b.a. = 3.01 8/2 Development Car Impact Terrege of Allocation Impact Terres (in 2007/2010) Terres (in 2007/2010) Stage Car Impact 2007/2010 Terres (in 2007/2010) Stage Car Impact 2007/2010 Terres (in 2007/2010) Stage Car Impact 2007/2010 Terres (in 2007/2010) Development Car Impact 2007/2010 Terres (in 2007/2010) action Car Impact 2007/2010 Terres (in 2007/2010) action Car Impact 2007/2010 Terres (in 2007/2010) action Car Impact 2007/2010 Terres (in 2007/2010) action Car Impact 2007/2010	The case is according lost used $S = 2 \left[\frac{3.2}{2.5} \sin \theta_{1} + \frac{1}{2} + \frac{1}{2} \sin \theta_{2} + \frac{1}{2} + \frac{1}{2} \sin \theta_{1} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} \sin \theta_{1} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} \sin \theta_{1} + \frac{1}{2} $	O.5 cos θy	Kor: More: Mo	director and the second se
[24] <i>J G G</i> Table 19 Table Note: Stage 2 Calcular, Deciping Force: S <i>S S</i>	$F_{G} = \frac{66 \text{ (m)}}{10}$ $\frac{66 \text{ (m)}}{10}$	$\begin{split} & \begin{array}{c} \text{Single for, these topped} \\ & \begin{array}{c} \text{Single} \\ \hline \\ \hline \\ & \begin{array}{c} \text{Single} \\ \hline \\ \hline \\ & \begin{array}{c} \text{Single} \\ \hline \\ \hline \\ \hline \\ & \begin{array}{c} \text{Single} \\ \hline \\ $	$b_A = \frac{.3048}{\sin \theta_T}$ Descripting of Kind Properties of the sould array of the sould	The car is according lost used $S = 2 \left[\frac{3.25}{2.5} \sin \theta_{c} + \frac{3.25}{2} \sin \theta_{c} + 3.25$	-0.5 cos θ(direct direct data is data
(a) <i>μ</i> ₀ = 3/2 Table 13 14 - 1 1	$\frac{60.09}{60.05}$	$\begin{split} & \begin{array}{c} & & & & & & & & & & & & & & & & & & &$	$b_A = \frac{.3049}{\sin \theta_T}$ Dest/Dropt Car is part and a final direct force in any of the final direct force in the any of the final direct in any of the final	The car is according (set used) $S = 2 \left[\frac{3.25}{3.25} \sin \theta_{f^+} + \frac{3.25}{6} \sin \theta_{f^+} $	0.5 cos θγ		direct spito
[24] <i>μ</i> ₀ = 3/2	$\frac{600}{600}$	$\begin{array}{c c} Single Ge, Done torquest \\ 1100 \\ \hline \\$	LA = (3048) Sin 0/r Deat/Maps Car Impat Integrit of All and Impat Torus (in BROW) Impat Torus (in BROW) Strip Car Impat Integrit of All and Impat Torus (in BROW) Impat Torus (in BROW) Strip Car Impat Integrit of All and Impat Torus (in BROW) Impat Torus (in BROW) Strip Car Impat Integrit of All and Impat Torus (in BROW) Impat Torus (in BROW) Strip Car Impat Integrit of All and Impat Torus (in BROW) Impat Torus (in BROW) Deat/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deat/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deat/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deat/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deat/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deate/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deate/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deate/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deate/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deate/Single Car Impat Integrit of All and BROW) Impat Torus (in BROW) Deate/Single Car Impat Integrit of All and BRO	The car is according lost used $s = 2 \left[\frac{3.2}{2} s \sin \theta_{1} + \frac{1}{2} \right]$ Parameter Glancing free Glancing free Glancing free Fragment of the second	O.5 cos θy		direct spitial data ta tha spital data ta tha spital data data data data data data data d
μαί <i>μ</i> _G = 3/2 Table 19	$F_{G} = \frac{1}{100}$	$\begin{split} & \begin{array}{c} \text{Single Ge, Done Impact} \\ & \begin{array}{c} \text{Single} \\ \hline \\ \\ $	LA = 3048 Descriptings Car impact might of Mandel Impact Tartes (in might of Mandel Impact Tartes (i	The car is according lost used $S = 2 \left[\frac{3.25}{2.5} \sin \theta_{c^+} + \frac{3.25}{0.0} \sin \theta_{c^+} + 3$	O.5 cos θ(direct register ad the ad the
[24] <i>μ</i> ₀ = 3/2 Table 13 Table 13 Step 4 Calculating breage forces Table 14 Table 14 Table 14 Table 14 Table 14 Table 14 Step 5 Force adapted from table 3 Table 14 Table 14 Step 5 Force adapted break theory 6 Calcularity break theory 6	$\frac{60.09}{100}$	$\begin{split} & \begin{array}{c} \text{Single for, Done torquest} \\ & \begin{array}{c} \text{Single} \\ \hline \\ \text{Single} \\ \hline \\ \hline \\ \\ \text{Single} \\ \hline \\ \hline \\ \hline \\ \hline \\ \\ \hline \\ \\ \hline \\ \\ \hline \\ \hline \\ \\ \hline \\ \hline \\ \\ \hline \\ \hline \\ \hline \\ \hline \\ \\ \hline \hline \\ \hline \\ \hline \\ \hline \hline \hline \\ \hline \hline \\ \hline \hline \\ \hline \hline \hline \\ \hline \hline \hline \\ \hline \hline \hline \hline \\ \hline \hline \hline \hline \hline \\ \hline \hline \hline \hline \hline \hline \\ \hline \hline \hline \hline \hline \hline \hline \hline \\ \hline \hline$	$b_{A} = \frac{.3049}{\sin \theta_{T}}$ Deschörage Car Ingust and Ingust of Anima Ingust Care Ingust and Ingust of Anima Ingust Care Ingust and Ingust of Anima Ingust Care Ingust and Ingust of Anima Ingust and Ingust of Anima Ingust and Ingust of Anima Ingust and Ingust of Anima Ingust and Ingust and Ingust of Anima Ingust and Ingust and Ingust of Anima Ingust and	The car is according (part used) $S = 2 \left[\frac{3.25}{2.5} \sin \theta_{f^+} \right]$ Factorizer Glucolog Barrow Glucolog Barrow Fraction of applied force Fraction of applied force Passenger Glucolog Barrow Control Control Contro Control Control Control	O.5 cos θy Orec75ingle Car Impair		director insidedata te that data data data data data data data
[24] <i>μ</i> _G = 3/2 Table 13	$\frac{600}{600}$	$\begin{array}{c c} Sight Ge, Done topped: \\ 1100 \\ \hline \\ \hline \\ 100 \\ \hline \\$	LA = (3048) Sin 0/r. Dect/Maple Car Impact Response of the sector of the sector Response of the sector of the sector of the sector Response of the sector of the sector of the sector Response of the sector of the sector Response of the sector of the sector of the sector of	The car is according lost used $s = 2 \left[\frac{3.2}{2.5} \sin \theta_{c} + \frac$	0.5 cos θy 0.6 cos θy 0.7 cos θy 0.8 cos θy 0		director professional de la constance de la constance de la constance de la constance de la constance de la constance de la constance presente de la constance de la constance de la constance de la constance de la constance de la constance de la constance de la constance de la constance
[A04] <i>μ</i> _G = ² / ₀ Table 19 Table 19 Step 4 Calculary being forcer <i>σ</i> = 1 <i>σ</i> =	$F_{G} = \frac{66 m }{100}$	$\begin{split} & \begin{array}{c} \text{Single Ge, Done Impact} \\ 1100 \\ \hline \\ & \begin{array}{c} \text{Fingle} \\ \hline \\ \hline \\ & \begin{array}{c} \text{Fingle} \\ \hline \\ \hline \\ \hline \\ \hline \\ & \begin{array}{c} \text{Fingle} \\ \hline \\ $	LA = 3048 Descriptings Car impact might of Mandel Impact Tartes (in might of Mandel Impact Tartes (i	The car is according lost used $S = 2 \left[\frac{3.25}{2.5} \sin \theta_{c^+} + \frac{3.25}{100} \theta_{c^+} + $	O.5 cos θy OrecTringle or impair		director instalador e carsar is i instalador ga sobo ga sobo s



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