U.S.Department
of Transportation

**Federal Highway
Administration**

400 Seventh St., S.W.
Washington, D.C. 20590

November 20, 1996
Refer to: HNG-14

Brian G. Pfeifer, P.E.
Research Associate Engineer
Midwest Roadside Safety Facility
University of Nebraska Lincoln
1901 'Y' Street, Building C
Lincoln, Nebraska 68588-0601

Dear Mr. Pfeifer:

Your October 28 letter to Mr. Gerald L. Eller transmitted copies of a final report dated October 28, 1996, entitled "NCHRP Report 350 Compliance Testing of the Best System." This report and the accompanying videotapes document testing that was done at the Midwest Roadside Safety Facility to qualify the BEST as an NCHRP Report 350 test level 3 (TL-3) w-beam guardrail terminal.

The BEST was accepted as a National Cocperative Highway Research Program (NCHRP) Report 230 terminal in my letter to you dated November 10, 1994. Minor design changes were noted and accepted in a second letter from me dated August 22, 1995.

We note that several additional changes were made during the 350 compliance testing. The most significant ones include: (1) shortening the first section of rail to span four 1905-mm post spaces rather than five and increasing its upstream extension off post 1 by 152 mm (Shortening of the section was done to improve its transportability and increasing the overhang at the end was done to ensure that post number 1 fractures and releases the cable anchor before the impact head reaches the cable-to-rail connection.); (2) shortening the length of the rough-cut (150-mm x 203-mm) CRT posts (posts 3 through 7) by 50 mm to reduce embedment of the posts by that amount for the purpose of increasing lateral rotation and reducing brittle fracture of the posts under lateral impacts; and (3) increasing the distance between the impact face and the rail outlet area in the impact-cutter head to minimize blocking of the outlet area by an impacting vehicle. The final design is shown in Enclosure 1.

The following tests were run to demonstrate acceptable performance under the NCHRP Report 350 evaluation criteria:

BEST - 8 (NCHRP Test 3-30)
BEST - 9 (NCHRP Test 3-31)
BEST - 10 (NCHRP Test 3-32)
BEST - 3 (NCHRP Test 3-35)
BEST - 11 (NCHRP Test 3-39)

Enclosure 2 contains summaries of each of these tests. All the NCHRP Report 350 evaluation criteria were met in each test.

You noted in your report that test 3-34 was not run. This test requires an 820-kg car impacting the terminal at post number 2 at 15 degrees and 100 km/h. You referred instead to a test conducted by the Texas Department of Transportation (test 9429A-1) on a similar design. After reviewing the earlier design and crash test results, we agree that test 9429A-1 is a reasonable substitute for test 3-34 and that the latter need not be rerun.

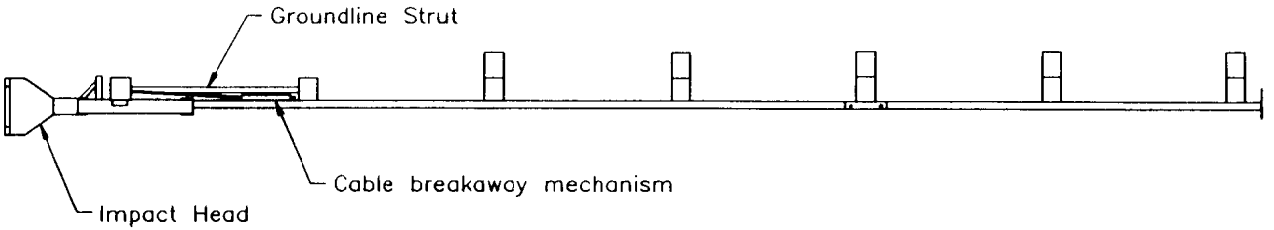
Based on the above, we consider the BEST to be acceptable for use on the National Highway System (NHS) as a TL-3 w-beam barrier terminal when such use is requested by a highway agency. Since it is a proprietary device, its use on Federal-aid projects, except exempt, non-NHS projects, is subject to the conditions stated in Title 23, Code of Federal Regulations, Section 635.411.

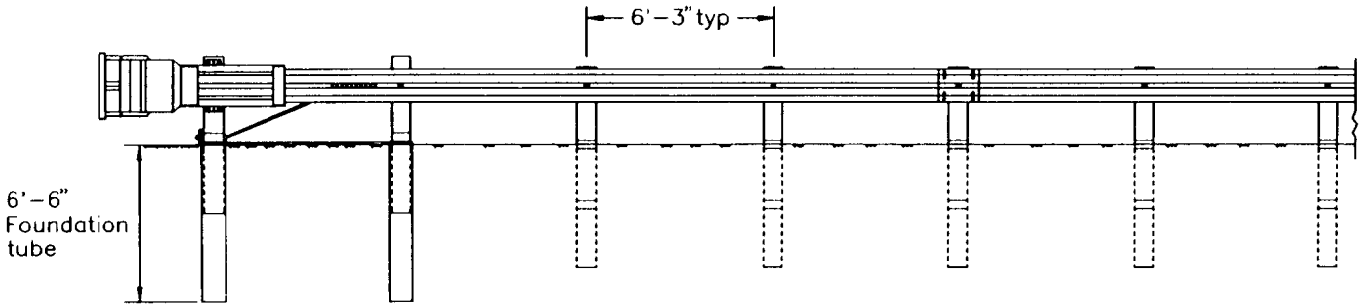
Sincerely yours,

Seppo I. Sillan, Acting Chief
Federal-Aid and Design Division

2 Enclosures

FHWA:HNG-14:RPowers:sr:61320:11/19/96:Pfeifer
cc:
HPD-1 HNG-1 HNG-10 HNG-14 RA's HFL-1
HHS-10 HRS-20 HNG-20 Reader 3128 File 3128
Geometric and Roadside Design Acceptance Letter CC-36 37

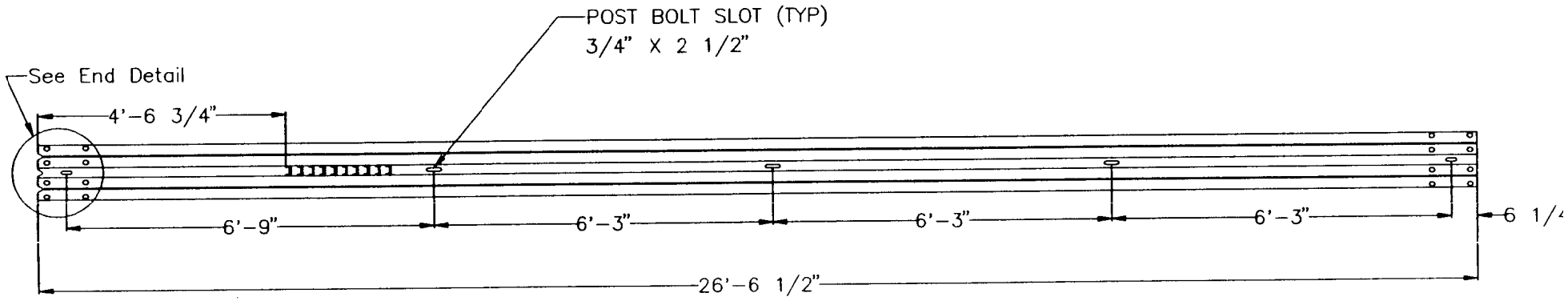


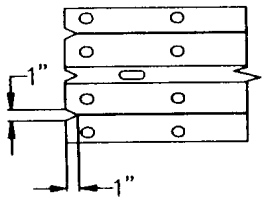


MwRSF University of Nebraska C.E. Department

BEST

DATE: 10-22-96		
SCALE:		system01
DR'N: KPR		





End Detail

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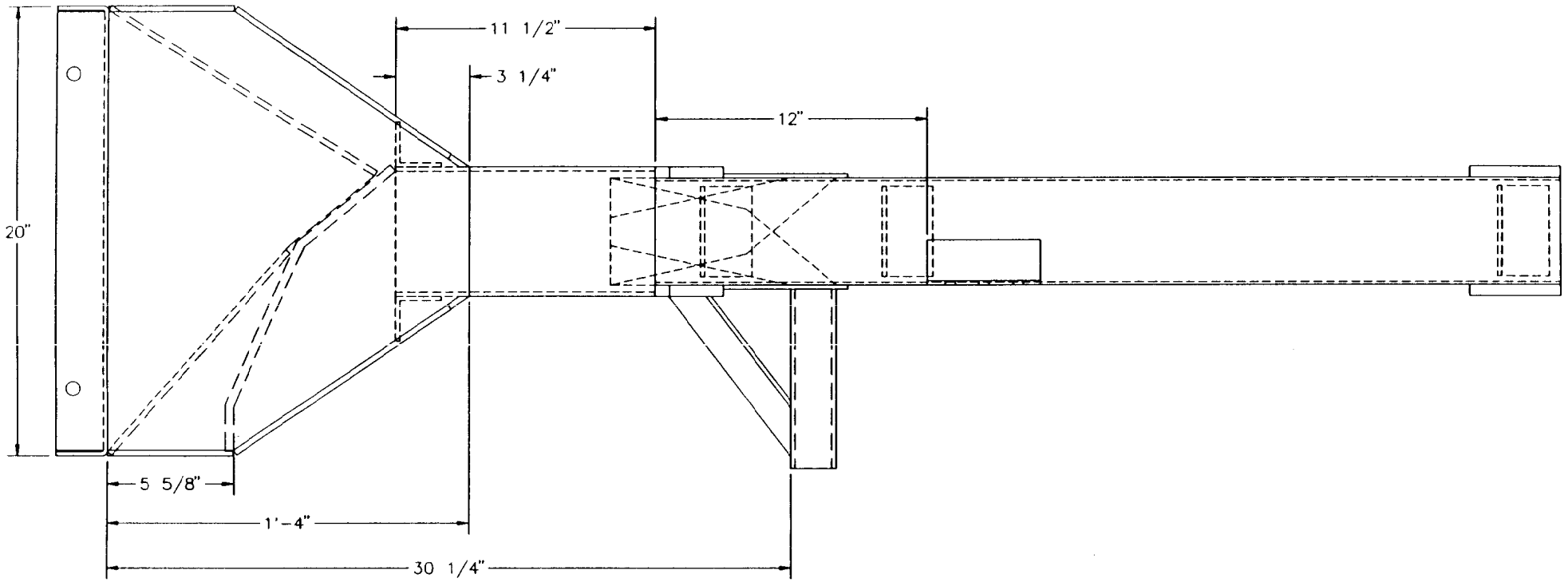
BEST

DATE:	9-16-96		
SCALE:	none		BPRAIL
DR'N:	BWB		



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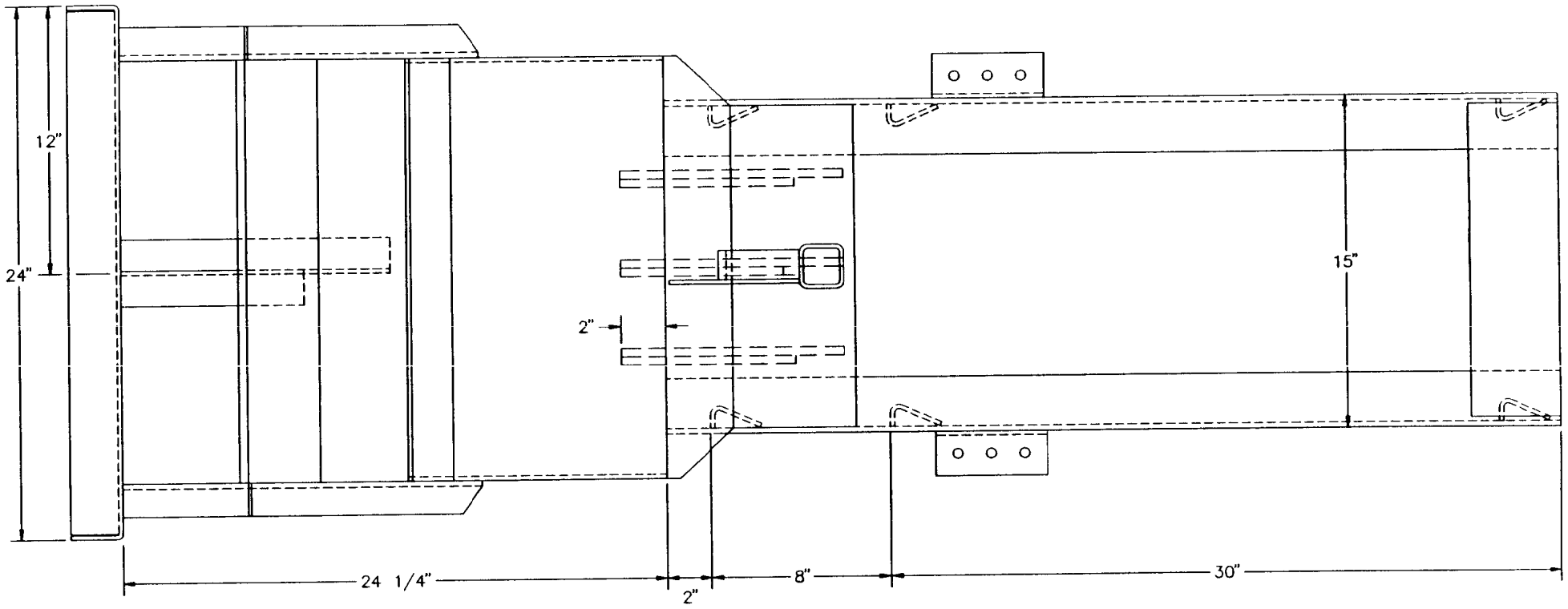
BEST

DATE: 10-22-96		
SCALE: none		350top01



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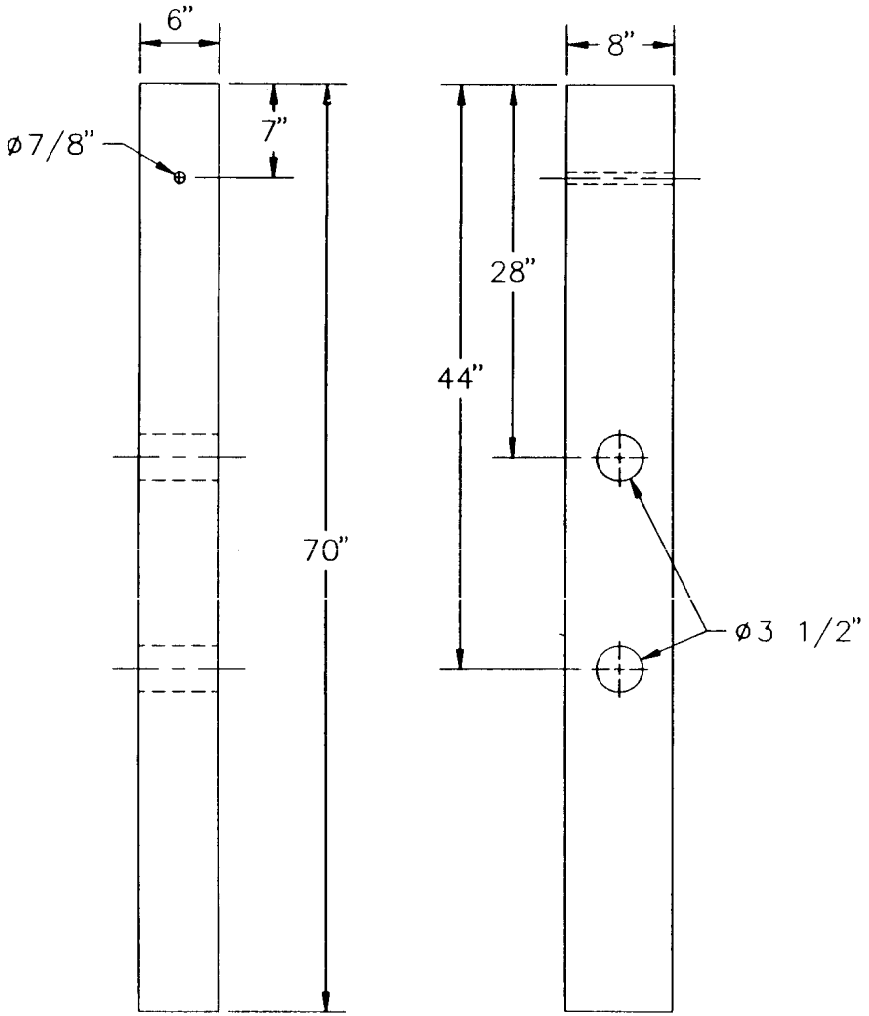
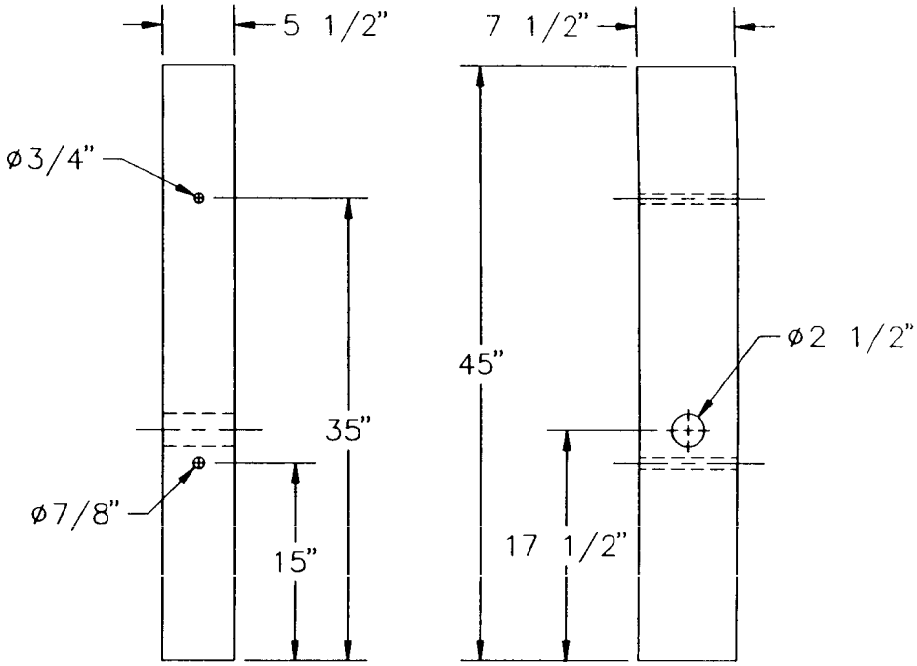
BEST

DATE: 10-22-96		
SCALE: none		350side1
DR'N: EAK		

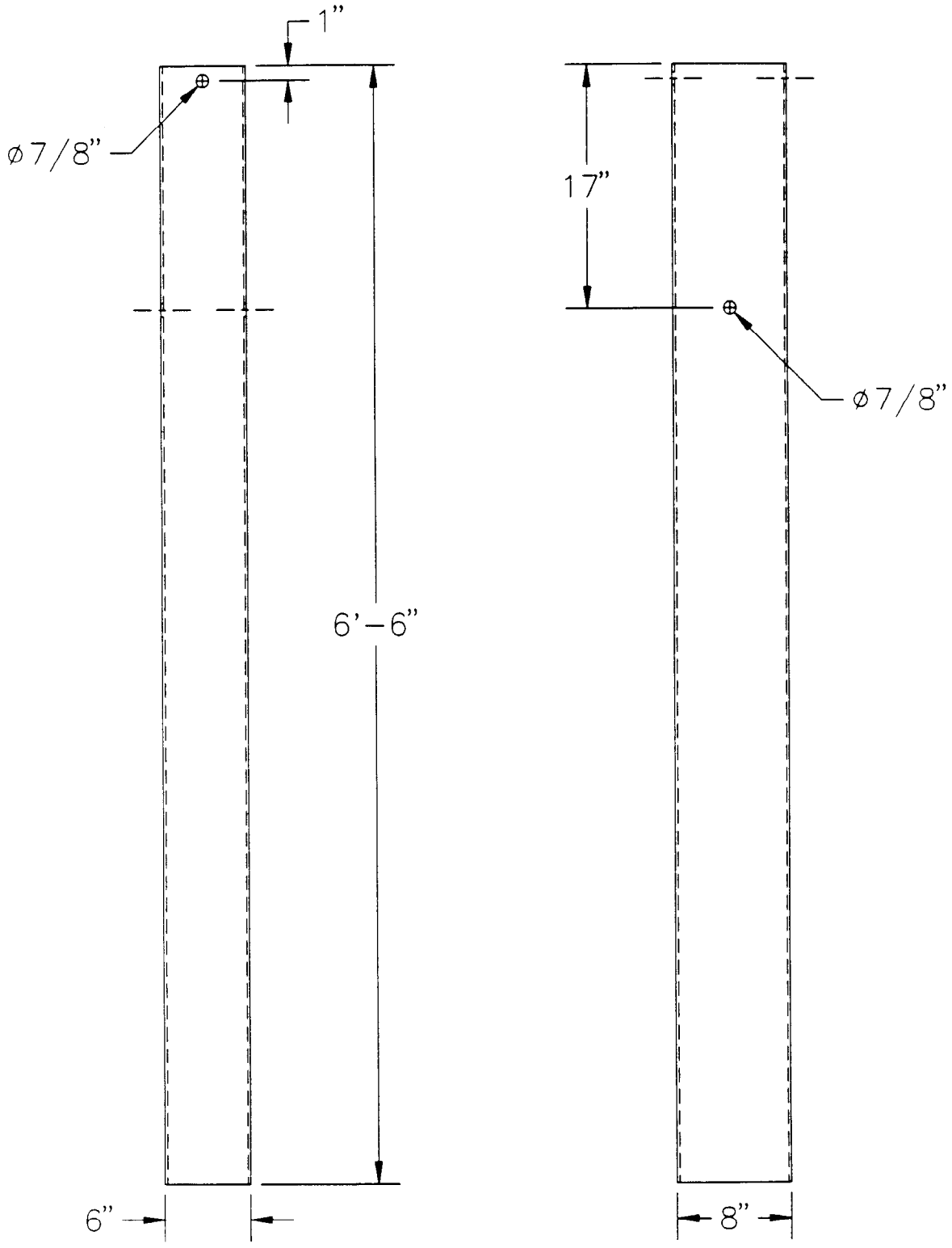


Post Nos. 3-7



Post Nos. 1&2

MwRSF	University of Nebraska C.E. Department	
BEST		
DATE: 10-23-96		posts
SCALE: none		
DR'N: EAK		



Foundation Tube
TS 8"x6"x3/16"

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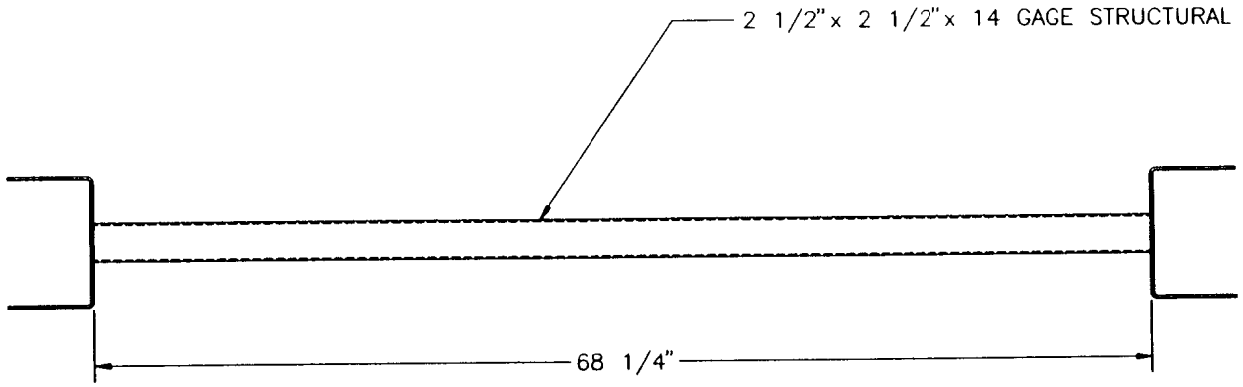
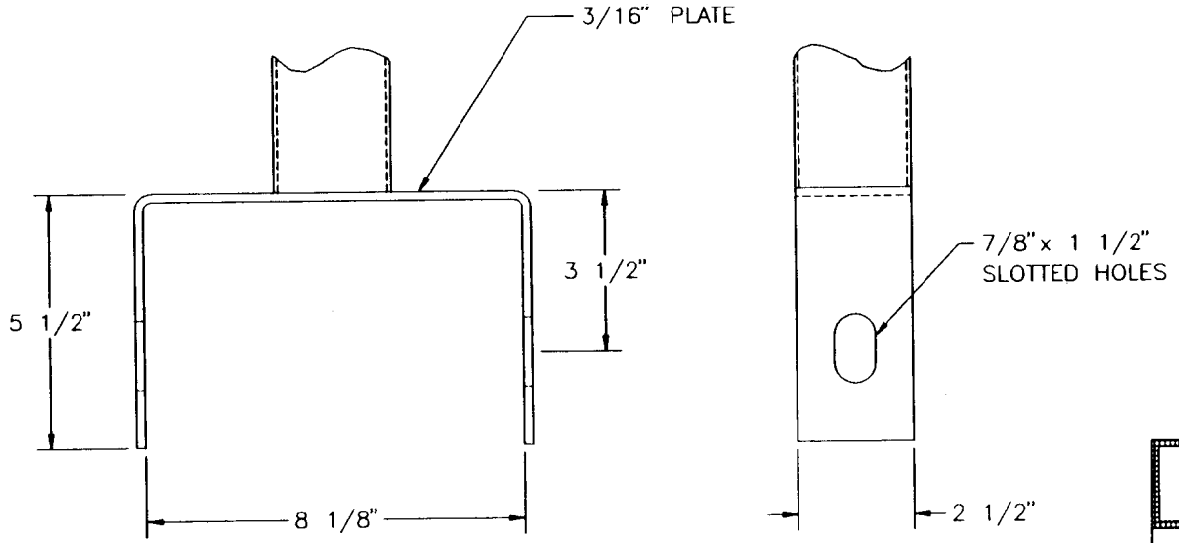
BEST

DATE: 10-23-96		
SCALE: none		tube
DR'N: EAK		



STRUT DETAIL



YOKE DETAILS

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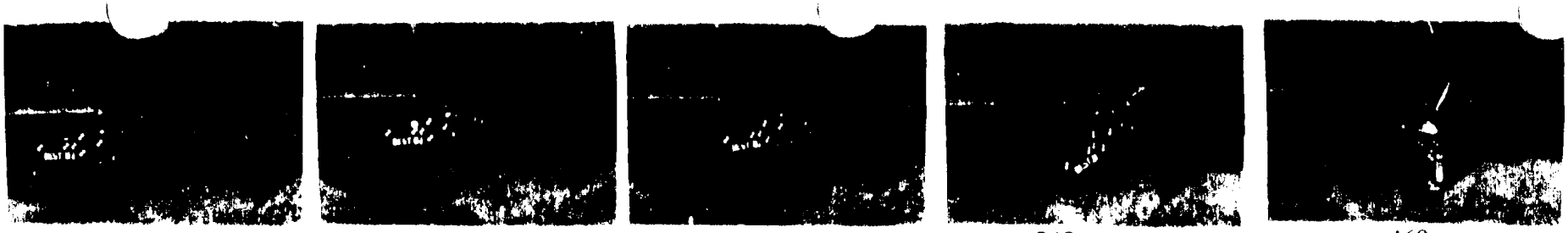
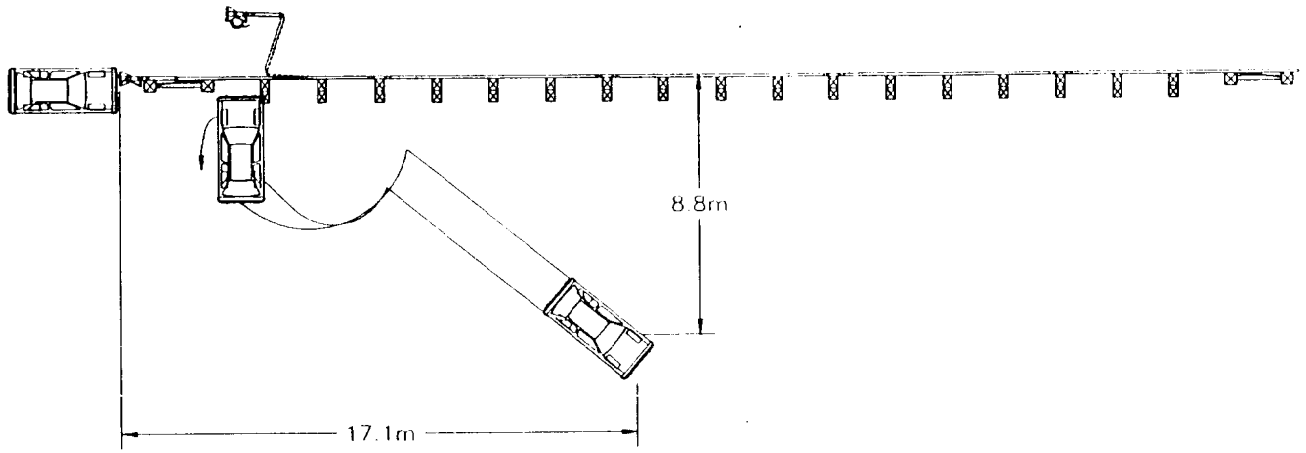
BEST

DATE: 9-13-96		
SCALE: none		STRUT
DR'N: BWB		

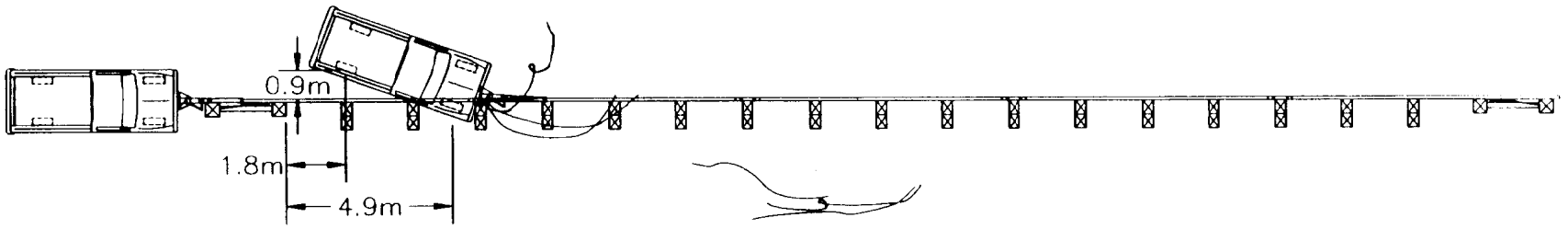




Test Number	BEST-8
Date	10/3/96
Installation	BEST System
Length of Installation	46 m
Vehicle Model	1990 Ford Festiva
Vehicle Weight	
Curb	781 kg
Test Inertial	817 kg
Gross Static	892 kg
Vehicle Impact Speed	100.4 km/h
Vehicle Impact Angle	0.6 deg
Vehicle Impact Location	Head-on, offset quarterpoint
Normalized Occupant Impact Velocity	
Longitudinal	10.1 m/s
Lateral	2.8 m/s
Occupant Ridedown Accelerations	
Longitudinal	16.7 Gs
Lateral	4.9 Gs
Vehicle Damage Classification	
TAD	12FYEN2
VDI	12-FL-3
Amount of rail fed through cutter	1.83 m

Conversion Factor: 1 ft = 0.3048 m 1 lb = 0.4536 kg

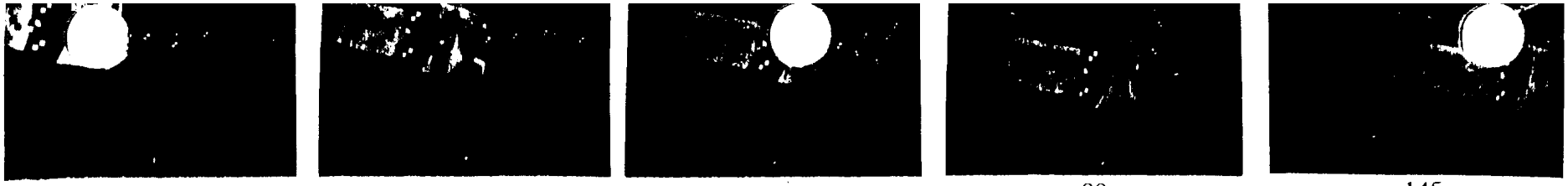
Figure 32. Summary of Test BEST-8.



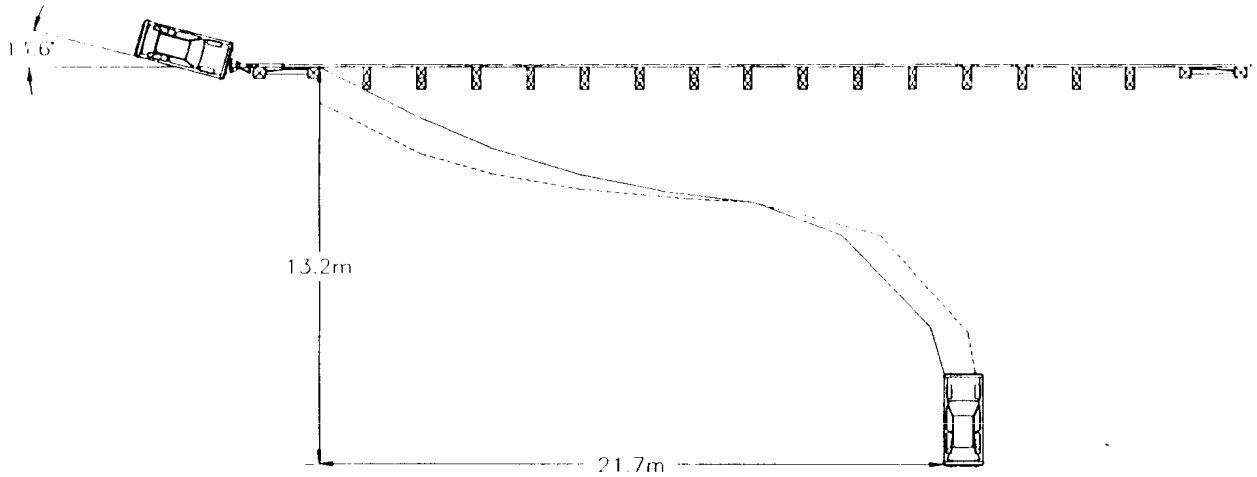
Test Number	BEST-9
Date	10/8/96
Installation	BEST System
Length of Installation	46 m
Vehicle Model	1990 Chevy ¾ ton pickup
Vehicle Weight	
Curb	1960 kg
Test Inertial	2005 kg
Gross Static	2005 kg
Vehicle Impact Speed	101.0 km/h
Vehicle Impact Angle	1.2 deg
Vehicle Impact Location	Center of Impact Head
Normalized Occupant Impact Velocity	
Longitudinal	6.9 m/s
Lateral	1.0 m/s
Occupant Ridedown Accelerations	
Longitudinal	13.3 Gs
Lateral	2.8 Gs
Vehicle Damage Classification	
TAD	12FCEN2
VDI	12-FC-4
Amount of rail fed through cutter	8.91 m

Conversion Factor: 1 ft = 0.3048 m 1 lb = 0.4536 kg

Figure 38. Summary of Test BEST-9.



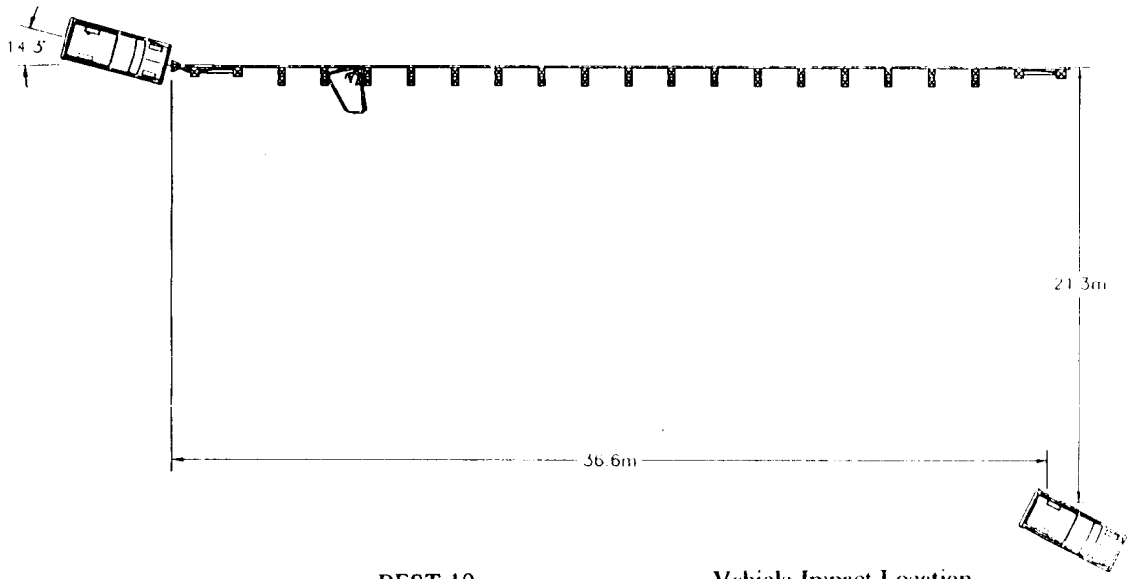
Impact 22 ms 44 ms 80 ms 145 ms



Test Number	BEST-4
Date	8/2/96
Installation	BEST System
Length of Installation	30.5 m
Vehicle Model	1991 Ford Festiva
Vehicle Weight	
Curb	819 kg
Test Inertial	820 kg
Gross Static	896 kg
Vehicle Impact Speed	101.7 km/h
Vehicle Impact Angle	13.6 deg
Vehicle Impact Location	Center of Impact Head
Occupant Impact Velocity	
Longitudinal	10.0 m/s
Lateral	1.2 m/s
Occupant Ridedown Accelerations	
Longitudinal	12.0 Gs
Lateral	4.7 Gs
Vehicle Damage Classification	
TAD	1-FC-4
VDI	12FCEN2
Amount of rail fed through cutter	1.28 m

Conversion Factor: 1 ft = 0.3048 m 1 lb = 0.4536 kg

Figure 23. Summary of Test BEST-4.

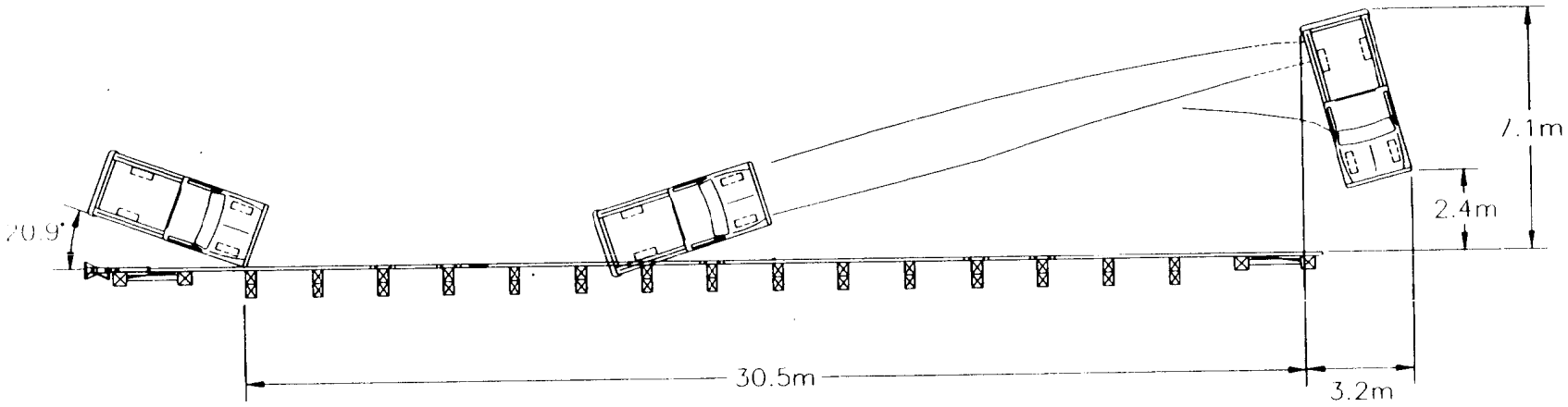


Test Number	BEST-10
Date	10/11/96
Installation	BEST System
Length of Installation	46 m
Vehicle Model	1990 Chevy ¾ ton pickup
Vehicle Weight	
Curb	1924 kg
Test Inertial	2003 kg
Gross Static	2003 kg
Vehicle Impact Speed	102.1 km/h
Vehicle Impact Angle	14.3 deg

Vehicle Impact Location	Center of Impact Head
Normalized Occupant Impact Velocity	
Longitudinal	6.2 m/s
Lateral	2.3 m/s
Occupant Ridedown Accelerations	
Longitudinal	17.5 Gs
Lateral	10.0 Gs
Vehicle Damage Classification	
TAD	01FCEN1
VDI	1-FC-3
Amount of rail fed through cutter	2.16 m

Conversion Factor: 1 ft = 0.3048 m 1 lb = 0.4536 kg

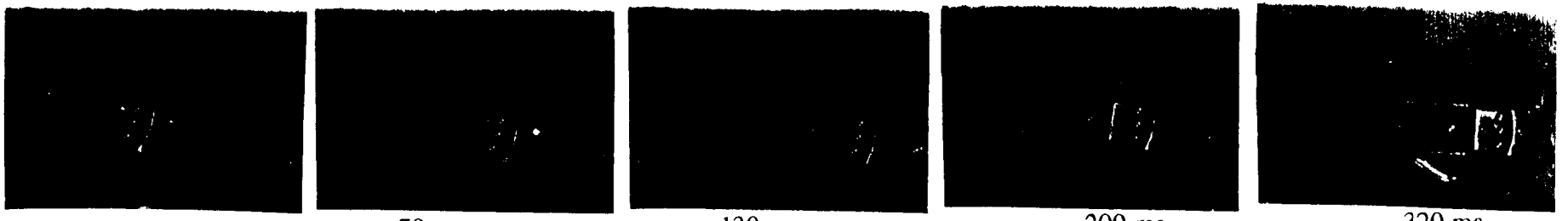
Figure 44. Summary of Test BEST-10.

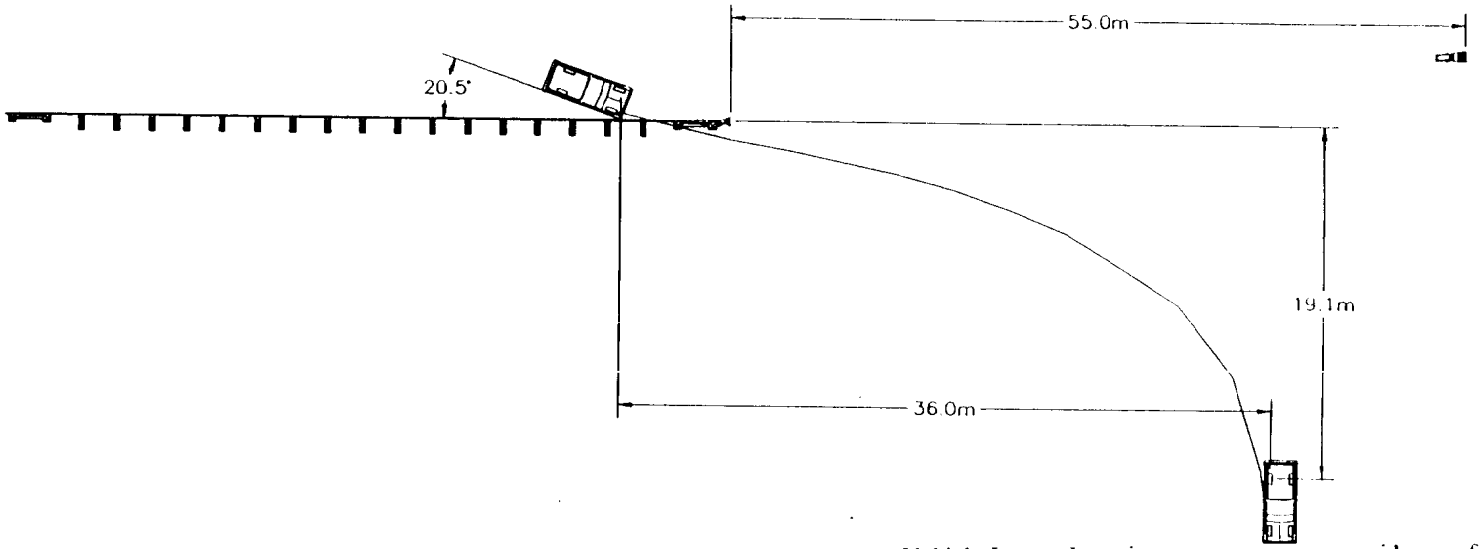


Test Number	BEST-3
Date	7/30/96
Installation	BEST System
Length of Installation	30.5 m
Vehicle Model	1992 Chevy ¾ ton pickup
Vehicle Weight	
Curb	1905 kg
Test Inertial	2000 kg
Gross Static	2000 kg
Vehicle Impact Speed	102.7 km/h
Vehicle Impact Angle	20.9 deg
Vehicle Impact Location	Center of post no. 3
Normalized Occupant Impact Velocity	
Longitudinal	6.5 m/s
Lateral	4.2 m/s
Occupant Ridedown Accelerations	
Longitudinal	10.5 Gs
Lateral	10.1 Gs
Vehicle Damage Classification	
TAD	1-RFQ-5
VDI	01RFES2
Maximum rail deflection	
Dynamic	1097 mm @ midspan of post nos. 5 & 6
Permanent Set	758 mm @ post no. 6

Figure 17. Summary of Test BEST-3.

Conversion Factor: 1 ft = 0.3048 m 1 lb = 0.4536 kg





Test Number	BEST-11
Date	10/17/96
Installation	BEST System
Length of Installation	46 m
Vehicle Model	1990 GMC ¾ ton pickup
Vehicle Weight	
Curb	1780 kg
Test Inertial	2000 kg
Gross Static	2000 kg
Vehicle Impact Speed	101.6 km/h
Vehicle Impact Angle	20.5 deg
Vehicle Impact Location	midspan of posts 3 and 4
Normalized Occupant Impact Velocity	
Longitudinal	7.2 m/s
Lateral	4.1 m/s
Occupant Ridedown Accelerations	
Longitudinal	10.5 Gs
Lateral	4.1 Gs
Vehicle Damage Classification	
TAD	01RFES2
VDI	1-RFQ-4

Figure 50. Summary of Test BEST-11.

Conversion Factor: 1 ft = 0.3048 m 1 lb = 0.4536 kg