1
00:01:00,550 --> 00:00:58,660
the Lewis flight Propulsion Laboratory

2
00:01:02,770 --> 00:01:00,560
of the national advisory committee for

3
00:01:04,420 --> 00:01:02,780
aeronautics has investigated the

4
00:01:06,790 --> 00:01:04,430
problems of survival in light airplane

5
00:01:08,380 --> 00:01:06,800
accidents because this type of accident

6
00:01:11,320 --> 00:01:08,390
is responsible for many of the

7
00:01:12,880 --> 00:01:11,330
casualties of civil aviation it was the

8
00:01:14,910 --> 00:01:12,890
purpose of this work to determine how

9
00:01:16,810 --> 00:01:14,920
people are injured during such crashes

10
00:01:19,480 --> 00:01:16,820
in order to obtain the desired

11
00:01:21,880 --> 00:01:19,490
information on crash survival several

12
00:01:27,100 --> 00:01:21,890
small tamdan to place light airplanes

13
00:01:29,830 --> 00:01:27,110

were crashed a stall spin accident was

14
00:01:31,870 --> 00:01:29,840
chosen for study such an accident occurs

15
00:01:33,820 --> 00:01:31,880
when an airplane stalls and enters into

16
00:01:36,010 --> 00:01:33,830
a spin during a landing approach the

17
00:01:38,980 --> 00:01:36,020
airplane is too close to the ground to

18
00:01:41,800 --> 00:01:38,990
recover from the spin a survey made by

19
00:01:43,749 --> 00:01:41,810
Cornell crash injury research indicated

20
00:01:45,340 --> 00:01:43,759
that this type of accident is a frequent

21
00:01:48,910 --> 00:01:45,350
source of fatalities in light airplane

22
00:01:51,550 --> 00:01:48,920
crashes to simulate such a crash the

23
00:01:53,350 --> 00:01:51,560
axis of the crash was rotated the ground

24
00:01:55,510 --> 00:01:53,360
was simulated by a mound of Earth and

25
00:01:57,760 --> 00:01:55,520
the airplane ran along the ground in a

26
00:02:01,270 --> 00:01:57,770
level attitude to strike the mound of

27
00:02:03,310 --> 00:02:01,280
earth the mound was located so that the

28
00:02:05,649 --> 00:02:03,320
airplanes left wing tip left landing

29
00:02:08,020 --> 00:02:05,659
wheel and the cell would strike at the

30
00:02:09,669 --> 00:02:08,030
same time in the same manner as in the

31
00:02:12,789 --> 00:02:09,679
stall spin accidents that were being

32
00:02:15,250 --> 00:02:12,799
simulated two dummies were installed in

33
00:02:17,259 --> 00:02:15,260
the airplane the dummy in the front seat

34
00:02:19,479 --> 00:02:17,269
was a standard Air Force dummy used in

35
00:02:21,640 --> 00:02:19,489
the testing of parachutes in the

36
00:02:23,410 --> 00:02:21,650
construction of this dummy no attempt

37
00:02:25,330 --> 00:02:23,420
was made to simulate the resilience of

38
00:02:27,280 --> 00:02:25,340

the human body although the mass

39
00:02:30,100 --> 00:02:27,290
distribution of the component parts was

40
00:02:31,840 --> 00:02:30,110
similar to that of a human being an Air

41
00:02:34,390 --> 00:02:31,850
Force anthropomorphic dummy was

42
00:02:36,130 --> 00:02:34,400
installed in the rear seat this dummy is

43
00:02:38,890 --> 00:02:36,140
a reasonable replica of the human body

44
00:02:42,699 --> 00:02:38,900
in both mass distribution and resilience

45
00:02:44,560 --> 00:02:42,709
of human tissues motion pictures were

46
00:02:47,080 --> 00:02:44,570
taken from various vantage points around

47
00:02:48,820 --> 00:02:47,090
the crash site these motion pictures

48
00:02:50,979 --> 00:02:48,830
show how the dummy passengers moved

49
00:02:53,710 --> 00:02:50,989
during the crash and how the airplane

50
00:02:55,720 --> 00:02:53,720
structure deforms meanwhile the

51
00:02:58,030 --> 00:02:55,730
telemeter transmitting station carried

52
00:02:59,970 --> 00:02:58,040
in the airplane radioed the crash loads

53
00:03:02,460 --> 00:02:59,980
measured on the passengers and in

54
00:03:04,199 --> 00:03:02,470
not fit the transmitted data were

55
00:03:08,520 --> 00:03:04,209
recorded by a receiving station at the

56
00:03:10,920 --> 00:03:08,530
crash site three crashes were made in

57
00:03:12,720 --> 00:03:10,930
this investigation the airplanes were

58
00:03:14,550 --> 00:03:12,730
propelled by their own power along a

59
00:03:17,430 --> 00:03:14,560
runway toward the crash barrier a

60
00:03:19,949 --> 00:03:17,440
slipper mounted on a monorail guided

61
00:03:21,660 --> 00:03:19,959
each airplane into the barrier the speed

62
00:03:26,100 --> 00:03:21,670
of the airplane at impact in the three

63
00:03:31,020 --> 00:03:26,110

crashes was 60 47 and 42 miles per hour

64
00:03:32,699 --> 00:03:31,030
the motion pictures obtained verify that

65
00:03:35,339 --> 00:03:32,709
most of the injuries that result from

66
00:03:37,050 --> 00:03:35,349
light airplane accidents are caused by

67
00:03:39,660 --> 00:03:37,060
the occupant striking part of the

68
00:03:42,390 --> 00:03:39,670
airplane inside the cockpit these

69
00:03:44,640 --> 00:03:42,400
injuries occur in two ways when the

70
00:03:46,740 --> 00:03:44,650
airplane structure collapses and strikes

71
00:03:50,839 --> 00:03:46,750
the occupant this happens to the

72
00:03:55,979 --> 00:03:53,520
the occupant can also be injured when he

73
00:03:58,410 --> 00:03:55,989
is improperly restrained and moves from

74
00:04:00,599 --> 00:03:58,420
his normal position to strike objects in

75
00:04:03,390 --> 00:04:00,609
the cockpit as illustrated here by the

76
00:04:05,220 --> 00:04:03,400
occupant in the rear seat the next

77
00:04:07,680 --> 00:04:05,230
motion picture sequence of the 60

78
00:04:09,809 --> 00:04:07,690
mile-per-hour crash shows how the front

79
00:04:12,539 --> 00:04:09,819
of the airplane collapses and crushes

80
00:04:19,050 --> 00:04:12,549
the dummy in the front seat now watch

81
00:04:20,849 --> 00:04:19,060
the dummy in the front seat the red

82
00:04:22,890 --> 00:04:20,859
liquid that obscures the airplane in the

83
00:04:27,140 --> 00:04:22,900
latter part of the pictures was used to

84
00:04:31,560 --> 00:04:29,670
there is little chance that the occupant

85
00:04:36,719 --> 00:04:31,570
in the front seat would survive such a

86
00:04:38,250 --> 00:04:36,729
crash the lower part of the dummy was

87
00:04:42,719 --> 00:04:38,260
trapped in the collapsing airplane

88
00:04:44,969 --> 00:04:42,729

structure the instrument panel moved

89
00:04:48,409 --> 00:04:44,979
rearward and the dummy's head hit it

90
00:04:51,480 --> 00:04:48,419
with sufficient force to leave a dent

91
00:04:54,210 --> 00:04:51,490
even if the estimate panel is not pushed

92
00:04:56,909 --> 00:04:54,220
rearward an improperly restrain document

93
00:04:58,560 --> 00:04:56,919
may hit it with his head this is

94
00:05:00,990 --> 00:04:58,570
illustrated in the next motion picture

95
00:05:03,900 --> 00:05:01,000
sequence of a crash which takes place at

96
00:05:06,000 --> 00:05:03,910
42 miles per hour even though the

97
00:05:08,100 --> 00:05:06,010
fuselage force structure was not pushed

98
00:05:09,300 --> 00:05:08,110
back into the front dummies lap the

99
00:05:11,640 --> 00:05:09,310
dummy struck the instrument panel

100
00:05:13,679 --> 00:05:11,650
because he was restrained only by a

101
00:05:16,559 --> 00:05:13,689
seatbelt and his torso was

102
00:05:24,089 --> 00:05:16,569
free to move again what's the dummy in

103
00:05:25,769 --> 00:05:24,099
the front seat as before the dummy in

104
00:05:31,649 --> 00:05:25,779
the front seat struck the instrument

105
00:05:33,929 --> 00:05:31,659
panel the neck of the dummy in the rear

106
00:05:36,299 --> 00:05:33,939
seat broke because of an imperfection in

107
00:05:44,429 --> 00:05:36,309
its construction injuries of this type

108
00:05:49,159 --> 00:05:44,439
are not likely in an actual crash here

109
00:05:53,819 --> 00:05:51,989
these results explain why the survey

110
00:05:56,459 --> 00:05:53,829
conducted by quenelle crash injury

111
00:05:59,309 --> 00:05:56,469
research found so many head injuries in

112
00:06:00,839 --> 00:05:59,319
actual crashes this survey found that

113
00:06:05,279 --> 00:06:00,849

head injuries were inflicted in

114
00:06:07,019 --> 00:06:05,289
eighty-eight percent of the accidents if

115
00:06:09,049 --> 00:06:07,029
an occupant is not to be injured when

116
00:06:11,489 --> 00:06:09,059
wearing only a seat belt for restraint

117
00:06:13,739 --> 00:06:11,499
sufficient space must be clear ahead of

118
00:06:15,809 --> 00:06:13,749
the occupant to allow him to flex over

119
00:06:17,969 --> 00:06:15,819
the seat belt the occupant in this

120
00:06:20,790 --> 00:06:17,979
airplane was restrained by only a seat

121
00:06:23,129 --> 00:06:20,800
belt the front seat and rear control

122
00:06:25,139 --> 00:06:23,139
stick were removed so that there was

123
00:06:28,049 --> 00:06:25,149
sufficient room for complete flexure of

124
00:06:30,449 --> 00:06:28,059
the dummy's torso the torso of the dummy

125
00:06:34,709 --> 00:06:30,459
moved forward and downward until the

126
00:06:36,449 --> 00:06:34,719
chest contacted the thighs it is

127
00:06:38,939 --> 00:06:36,459
apparent that if injuries resulting from

128
00:06:40,919 --> 00:06:38,949
contact with solid structure are to be

129
00:06:43,859 --> 00:06:40,929
avoided when using only a seat belt for

130
00:06:45,989 --> 00:06:43,869
restraint a distance of about 45 inches

131
00:06:48,989 --> 00:06:45,999
ahead of the seat must be free of any

132
00:06:56,189 --> 00:06:48,999
solid objects this much of a clear space

133
00:06:57,989 --> 00:06:56,199
is seldom available in an airplane this

134
00:07:00,239 --> 00:06:57,999
dangerous movement is reduced to safe

135
00:07:02,429 --> 00:07:00,249
values when the occupant is properly

136
00:07:04,739 --> 00:07:02,439
restrained by a seatbelt and the

137
00:07:07,079 --> 00:07:04,749
shoulder harness the dummy in the rear

138
00:07:09,809 --> 00:07:07,089

seat in the next crash for a seat belt

139
00:07:11,999 --> 00:07:09,819
and a shoulder harness this dummy moved

140
00:07:14,549 --> 00:07:12,009
forward and out of his seat about eight

141
00:07:16,829 --> 00:07:14,559
to ten inches the forward movement was

142
00:07:19,109 --> 00:07:16,839
limited by the harness in the most

143
00:07:22,049 --> 00:07:19,119
forward position the torso is about

144
00:07:24,809 --> 00:07:22,059
vertical notice this action in these

145
00:07:30,080 --> 00:07:24,819
slow motion pictures of the crash what's

146
00:07:34,350 --> 00:07:32,760
here again the Donnie lost his head due

147
00:07:36,540 --> 00:07:34,360
to a weakness in the next structure of a

148
00:07:47,530 --> 00:07:36,550
dummy this would not have happened to a

149
00:07:52,150 --> 00:07:49,540
if a harness is made of material that

150
00:07:54,510 --> 00:07:52,160
stretches excessively the occupant may

151
00:07:56,830 --> 00:07:54,520
still strike objects inside the cockpit

152
00:07:59,260 --> 00:07:56,840
the harness restraining the rear dummy

153
00:08:00,850 --> 00:07:59,270
in the 60 mile-per-hour crash stretched

154
00:08:02,740 --> 00:08:00,860
sufficiently to allow the dummy's head

155
00:08:05,560 --> 00:08:02,750
to strike the back of the dummy in the

156
00:08:07,360 --> 00:08:05,570
front seat this situation was aggravated

157
00:08:10,090 --> 00:08:07,370
by the collapse of the structure between

158
00:08:12,220 --> 00:08:10,100
the front and rear seats this moved the

159
00:08:19,600 --> 00:08:12,230
front dummy rearward again watch the

160
00:08:21,700 --> 00:08:19,610
dummy in the rear seat unfortunately the

161
00:08:23,490 --> 00:08:21,710
fuel missed obscured the actual impact

162
00:08:26,500 --> 00:08:23,500
of the dummy's head with the front dummy

163
00:08:36,450 --> 00:08:26,510

however a post-crash inspection revealed

164
00:08:41,670 --> 00:08:38,310
here is the position of the dummy's head

165
00:08:43,290 --> 00:08:41,680
when it struck the front dummy it has

166
00:08:45,390 --> 00:08:43,300
been shown that some of the benefits of

167
00:08:47,070 --> 00:08:45,400
a shoulder harness are lost if the

168
00:08:50,970 --> 00:08:47,080
harness stretches excessively in the

169
00:08:54,180 --> 00:08:50,980
crash if the restraining harness is to

170
00:08:56,160 --> 00:08:54,190
serve its purpose it must not break in

171
00:08:58,320 --> 00:08:56,170
order to tell the designer how strong to

172
00:09:03,330 --> 00:08:58,330
make this harness the forces in these

173
00:09:05,460 --> 00:09:03,340
traps were measured in the crashes to

174
00:09:07,320 --> 00:09:05,470
obtain this information tensiometer

175
00:09:09,240 --> 00:09:07,330
zeeeee were located at each end of the

176
00:09:11,730 --> 00:09:09,250
seatbelt and on the common juncture of

177
00:09:13,500 --> 00:09:11,740
the shoulder harness the sum of the

178
00:09:15,180 --> 00:09:13,510
forces on each end of the seatbelt and

179
00:09:17,040 --> 00:09:15,190
the force measured in the shoulder

180
00:09:19,200 --> 00:09:17,050
harness in the 60 mile-per-hour crash

181
00:09:21,600 --> 00:09:19,210
for the dummy in the rear seat are

182
00:09:24,060 --> 00:09:21,610
plotted against time after the impact

183
00:09:26,550 --> 00:09:24,070
with the barrier the seatbelt

184
00:09:28,920 --> 00:09:26,560
restraining force has two peaks one of

185
00:09:32,370 --> 00:09:28,930
four thousand pounds and a second of

186
00:09:35,780 --> 00:09:32,380
3,200 pounds the major seatbelt forces

187
00:09:38,460 --> 00:09:35,790
endured for about one tenth of a second

188
00:09:40,830 --> 00:09:38,470

the combined pole on both shoulder

189
00:09:43,110 --> 00:09:40,840
harness traps is approximately equal to

190
00:09:46,640 --> 00:09:43,120
half that of the seatbelt showing that

191
00:09:49,080 --> 00:09:46,650
the seatbelt supported most of the load

192
00:09:51,000 --> 00:09:49,090
the restraining forces in the seatbelt

193
00:09:53,520 --> 00:09:51,010
were higher when the passenger was

194
00:09:55,890 --> 00:09:53,530
restrained by a seatbelt only even when

195
00:09:59,640 --> 00:09:55,900
the impact speed was reduced from 60 to

196
00:10:01,500 --> 00:09:59,650
47 miles per hour during the 47

197
00:10:04,050 --> 00:10:01,510
mile-per-hour crash in which the dummy

198
00:10:06,870 --> 00:10:04,060
was restrained only by a seatbelt peak

199
00:10:09,960 --> 00:10:06,880
seatbelt forces were 4,400 pounds and

200
00:10:12,330 --> 00:10:09,970
3,000 pounds as compared to a peak of

201
00:10:17,460 --> 00:10:12,340
4,000 pounds for the seat belt for the

202
00:10:19,140 --> 00:10:17,470
60 mile-per-hour crash seatbelts and

203
00:10:21,360 --> 00:10:19,150
harness capable of withstanding these

204
00:10:24,360 --> 00:10:21,370
dynamic loads can be comfortable and

205
00:10:26,760 --> 00:10:24,370
light in weight to summarize the

206
00:10:29,160 --> 00:10:26,770
information presented so far has shown

207
00:10:31,440 --> 00:10:29,170
that injuries and crashes result one

208
00:10:33,240 --> 00:10:31,450
from the cockpit collapses and the

209
00:10:37,800 --> 00:10:33,250
occupant is crushed by the airplane

210
00:10:39,510 --> 00:10:37,810
structure to when the seatbelt in

211
00:10:45,000 --> 00:10:39,520
shoulder harness stretch excessively

212
00:10:47,100 --> 00:10:45,010
under the crash loads and three when the

213
00:10:50,010 --> 00:10:47,110

occupant is restrained by only a

214
00:10:50,400 --> 00:10:50,020
seatbelt even if the structure remains

215
00:10:52,650 --> 00:10:50,410
in

216
00:10:54,960 --> 00:10:52,660
act both seatbelt and shoulder harness

217
00:10:58,410 --> 00:10:54,970
are necessary in small cockpits if

218
00:11:00,030 --> 00:10:58,420
serious body blows are to be avoided the

219
00:11:01,860 --> 00:11:00,040
information presented here has also

220
00:11:06,540 --> 00:11:01,870
indicated the loads produced in the

221
00:11:08,160 --> 00:11:06,550
restraining harness during a crash even

222
00:11:10,889 --> 00:11:08,170
if the occupant is properly restrained

223
00:11:13,860 --> 00:11:10,899
during a crash he may still be injured

224
00:11:15,749 --> 00:11:13,870
by the deceleration she encounters the

225
00:11:18,119 --> 00:11:15,759
severity of the injury received from a

226
00:11:22,769 --> 00:11:18,129
deceleration depends on the magnitude of

227
00:11:24,689 --> 00:11:22,779
the deceleration the rate at which it

228
00:11:29,129 --> 00:11:24,699
increases commonly called the rate of

229
00:11:31,980 --> 00:11:29,139
onset and the duration of the

230
00:11:33,660 --> 00:11:31,990
deceleration these conclusions were

231
00:11:35,540 --> 00:11:33,670
reached from the work of lieutenant

232
00:11:38,629 --> 00:11:35,550
colonel staff in the report entitled

233
00:11:41,730 --> 00:11:38,639
human exposures to linear deceleration

234
00:11:43,829 --> 00:11:41,740
in this study by staff tests were made

235
00:11:45,629 --> 00:11:43,839
with human beings carefully supported by

236
00:11:48,929 --> 00:11:45,639
specially designed seatbelt shoulder

237
00:11:51,300 --> 00:11:48,939
harness and leg straps under such

238
00:11:53,369 --> 00:11:51,310

conditions the experimenter subjected

239
00:11:56,129 --> 00:11:53,379
himself to a deceleration that had a

240
00:11:59,519 --> 00:11:56,139
maximum of forty seven G's the

241
00:12:03,420 --> 00:11:59,529
deceleration endured 4.2 28 seconds and

242
00:12:06,170 --> 00:12:03,430
had a rate of onset of 735 G's per

243
00:12:08,660 --> 00:12:06,180
second the resulting injuries were minor

244
00:12:13,319 --> 00:12:08,670
when the rate of onset increased from

245
00:12:15,960 --> 00:12:13,329
735 to 1550 G's per second signs of

246
00:12:17,370 --> 00:12:15,970
shock were observed to obtain an

247
00:12:18,689 --> 00:12:17,380
indication of the injuries that may

248
00:12:20,009 --> 00:12:18,699
result from the decelerations

249
00:12:22,499 --> 00:12:20,019
encountered in these experimental

250
00:12:25,050 --> 00:12:22,509
crashes the deceleration zuv the rear

251
00:12:26,639 --> 00:12:25,060
dummies chest were measured these

252
00:12:29,309 --> 00:12:26,649
decelerations had about the same

253
00:12:31,439 --> 00:12:29,319
duration and the magnitudes were very

254
00:12:34,860 --> 00:12:31,449
little higher than those reported by

255
00:12:36,660 --> 00:12:34,870
staff a maximum deceleration of 50 G's

256
00:12:40,079 --> 00:12:36,670
was measured in the rear dummies chest

257
00:12:41,850 --> 00:12:40,089
in the 60 mile-per-hour crash the

258
00:12:46,829 --> 00:12:41,860
maximum full of the 47 mile-per-hour

259
00:12:51,259 --> 00:12:46,839
crash was 40 60 s and the maximum for

260
00:12:53,730 --> 00:12:51,269
the 42 mile-per-hour crash was 32 Gees

261
00:12:56,220 --> 00:12:53,740
from the standpoint of magnitude and

262
00:12:58,110 --> 00:12:56,230
duration these decelerations are within

263
00:13:00,780 --> 00:12:58,120

the tolerable limits established by

264
00:13:02,429 --> 00:13:00,790
steps worked however the rate at which

265
00:13:04,050 --> 00:13:02,439
the deceleration increases in these

266
00:13:07,080 --> 00:13:04,060
light airplane crashes

267
00:13:12,090 --> 00:13:07,090
buried from 2200 jeez per second for the

268
00:13:15,420 --> 00:13:12,100
60 mile-per-hour crash to 950 for the 42

269
00:13:17,370 --> 00:13:15,430
mile-per-hour crash it's expected that

270
00:13:20,400 --> 00:13:17,380
these high rates of onset would cause

271
00:13:22,110 --> 00:13:20,410
momentary unconsciousness it may be

272
00:13:23,790 --> 00:13:22,120
concluded therefore that the

273
00:13:26,430 --> 00:13:23,800
decelerations measured in these crashes

274
00:13:30,990 --> 00:13:26,440
are not large enough to fatally injure

275
00:13:32,610 --> 00:13:31,000
the occupant in the rear seat oddly

276
00:13:34,530 --> 00:13:32,620
enough the deceleration of the occupant

277
00:13:36,870 --> 00:13:34,540
during a crash is often higher than that

278
00:13:38,430 --> 00:13:36,880
of the fuselage floor this effect is

279
00:13:40,560 --> 00:13:38,440
shown in the following motion picture

280
00:13:43,320 --> 00:13:40,570
sequence in which the action is slowed

281
00:13:44,880 --> 00:13:43,330
to about one sixtieth of normal graphs

282
00:13:46,920 --> 00:13:44,890
of the deceleration of the chest and

283
00:13:49,410 --> 00:13:46,930
floor are superimposed over the motion

284
00:13:55,920 --> 00:13:49,420
picture these graphs developed in phase

285
00:13:57,480 --> 00:13:55,930
with the airplanes action notice that

286
00:13:59,520 --> 00:13:57,490
during the period that the seatbelt and

287
00:14:01,640 --> 00:13:59,530
harness stretch the dummy decelerates

288
00:14:04,290 --> 00:14:01,650

less than the fuselage floor under him

289
00:14:06,330 --> 00:14:04,300
during this period the dummy acquires

290
00:14:08,700 --> 00:14:06,340
velocity relative to the local airplane

291
00:14:10,770 --> 00:14:08,710
structure when the seatbelt and harness

292
00:14:12,630 --> 00:14:10,780
stretch is complete the passenger is

293
00:14:15,240 --> 00:14:12,640
decelerated rapidly to the speed of the

294
00:14:17,070 --> 00:14:15,250
airplane this causes the dummy to have

295
00:14:19,500 --> 00:14:17,080
larger peak decelerations than the

296
00:14:21,960 --> 00:14:19,510
fuselage floor the deceleration of the

297
00:14:24,720 --> 00:14:21,970
fuselage floor had a peak of 35 G's

298
00:14:28,080 --> 00:14:24,730
whereas the peak for the chest was 50

299
00:14:30,030 --> 00:14:28,090
G's this increase in the chest

300
00:14:32,610 --> 00:14:30,040
deceleration over that of the fuselage

301
00:14:34,650 --> 00:14:32,620
floor was also found in the 47

302
00:14:37,140 --> 00:14:34,660
mile-per-hour crash when the dummy was

303
00:14:39,000 --> 00:14:37,150
restrained only by a seatbelt this

304
00:14:41,460 --> 00:14:39,010
amplification of peak decelerations

305
00:14:43,260 --> 00:14:41,470
maybe even greater if the seatbelt in

306
00:14:46,140 --> 00:14:43,270
shoulder harness our slack when the

307
00:14:48,180 --> 00:14:46,150
crash occurs the slack and stretch in

308
00:14:50,400 --> 00:14:48,190
these members may cause failure of the

309
00:14:52,610 --> 00:14:50,410
seatbelt and harness as a result of the

310
00:14:55,470 --> 00:14:52,620
high crash deceleration loads produced

311
00:14:57,810 --> 00:14:55,480
the deceleration imposed on the occupant

312
00:15:00,840 --> 00:14:57,820
and his restraints depends on the

313
00:15:02,700 --> 00:15:00,850

deceleration of the fuselage floor the

314
00:15:04,800 --> 00:15:02,710
deceleration of the fuselage floor in

315
00:15:06,930 --> 00:15:04,810
turn depends on the strength of the

316
00:15:09,960 --> 00:15:06,940
airplane structure and the distribution

317
00:15:12,060 --> 00:15:09,970
of the airplane wait in the 47

318
00:15:13,920 --> 00:15:12,070
mile-per-hour crash shown at about 140

319
00:15:15,540 --> 00:15:13,930
eighth of normal speed notice how the

320
00:15:17,460 --> 00:15:15,550
deceleration of the fuselage floor

321
00:15:19,170 --> 00:15:17,470
reaches successive Peaks

322
00:15:20,820 --> 00:15:19,180
every time a main structural element

323
00:15:22,860 --> 00:15:20,830
supports the crash load a peak

324
00:15:24,620 --> 00:15:22,870
deceleration occurs when the loaded

325
00:15:27,090 --> 00:15:24,630
structure breaks the deceleration drops

326
00:15:29,400 --> 00:15:27,100
the maximum deceleration of the cockpit

327
00:15:31,500 --> 00:15:29,410
therefore depends directly on the

328
00:15:33,740 --> 00:15:31,510
strength of the structure as long as the

329
00:15:36,330 --> 00:15:33,750
cockpit has not collapsed completely

330
00:15:38,730 --> 00:15:36,340
this is illustrated by a comparison of

331
00:15:45,090 --> 00:15:38,740
the maximum decelerations measured in

332
00:15:48,300 --> 00:15:45,100
the 60 and 47 mile-per-hour crashes with

333
00:15:50,280 --> 00:15:48,310
those of the 42 mile-per-hour crash the

334
00:15:54,210 --> 00:15:50,290
maximum deceleration in all cases is

335
00:15:57,360 --> 00:15:54,220
about the same ranging between 26 and 33

336
00:15:59,280 --> 00:15:57,370
jeans these decelerations represent the

337
00:16:04,440 --> 00:15:59,290
maximum load that the airplane structure

338
00:16:06,990 --> 00:16:04,450

can support the higher kinetic energy of

339
00:16:08,940 --> 00:16:07,000
the higher speed crash is dissipated by

340
00:16:11,490 --> 00:16:08,950
more extensive crushing of this fuselage

341
00:16:13,170 --> 00:16:11,500
force structure this increase in the

342
00:16:15,300 --> 00:16:13,180
crumpling of the fuselage for structure

343
00:16:21,090 --> 00:16:15,310
increases the time during which the

344
00:16:22,410 --> 00:16:21,100
cockpit decelerations exist the extent

345
00:16:24,330 --> 00:16:22,420
to which the crumpling of the fuselage

346
00:16:26,970 --> 00:16:24,340
force structure reduces the deceleration

347
00:16:28,680 --> 00:16:26,980
applied to the cockpit floor can be seen

348
00:16:30,810 --> 00:16:28,690
by comparing the deceleration of the

349
00:16:34,230 --> 00:16:30,820
engine with that of the fuselage floor

350
00:16:36,180 --> 00:16:34,240
in the 60 mile-per-hour crash notice in

351
00:16:38,010 --> 00:16:36,190
the next motion picture sequence that

352
00:16:40,380 --> 00:16:38,020
the engine deceleration Rises

353
00:16:43,050 --> 00:16:40,390
immediately upon impact whereas the

354
00:16:45,060 --> 00:16:43,060
floor deceleration Rises gradually until

355
00:16:48,270 --> 00:16:45,070
extensive crumpling of the fuselage for

356
00:16:50,340 --> 00:16:48,280
structure has taken place this crumpling

357
00:16:52,980 --> 00:16:50,350
of the fuselage absorbs a considerable

358
00:16:54,510 --> 00:16:52,990
portion of the crash energy when the

359
00:16:56,340 --> 00:16:54,520
force structure has crumpled and the

360
00:16:59,310 --> 00:16:56,350
load is applied directly to the fuselage

361
00:17:05,070 --> 00:16:59,320
floor the engine and floor decelerate at

362
00:17:07,680 --> 00:17:05,080
about the same rate the pig deceleration

363
00:17:12,990 --> 00:17:07,690

of the engine was 62 jeez while the

364
00:17:15,360 --> 00:17:13,000
floor had a peak of only 35 G's for this

365
00:17:17,310 --> 00:17:15,370
reason it's desirable to place as much

366
00:17:19,500 --> 00:17:17,320
of the airplane as possible forward of

367
00:17:22,380 --> 00:17:19,510
the cockpit this arrangement has two

368
00:17:24,240 --> 00:17:22,390
principal advantages first it places

369
00:17:26,460 --> 00:17:24,250
much of the airplane structure in front

370
00:17:30,210 --> 00:17:26,470
of the cockpit to crumple and cushion

371
00:17:31,380 --> 00:17:30,220
the crash flow and second it places much

372
00:17:34,860 --> 00:17:31,390
of the airplane mass

373
00:17:37,140 --> 00:17:34,870
front of the cockpit by reducing the

374
00:17:39,660 --> 00:17:37,150
mass behind the cockpit the load on the

375
00:17:41,610 --> 00:17:39,670
cockpit structure is reduced and failure

376
00:17:45,000 --> 00:17:41,620
of this structure is less likely in a

377
00:17:46,860 --> 00:17:45,010
crash it may be concluded therefore that

378
00:17:49,380 --> 00:17:46,870
the chances of surviving a crash are

379
00:17:51,090 --> 00:17:49,390
better if both the seat belt and the

380
00:17:54,000 --> 00:17:51,100
shoulder harness of proper design are

381
00:17:56,430 --> 00:17:54,010
used the chances of impact survival are

382
00:17:58,710 --> 00:17:56,440
also better if the airplane has much of

383
00:18:01,830 --> 00:17:58,720
its structure and mass ahead of the

384
00:18:04,470 --> 00:18:01,840
cockpit the information presented in

385
00:18:07,710 --> 00:18:04,480
this motion picture is reported in NAC a

386
00:18:09,540 --> 00:18:07,720
technical note 2991 entitled

387
00:18:11,820 --> 00:18:09,550
accelerations and passenger harness