Glass Breakage Analysis: System Verification and Validation Plan

Vajiheh Motamer

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1 Revision History

Date	Version	Notes
10/10/27	1.0	Initial Draft

2 Symbols, Abbreviations and Acronyms

The symbols, abbreviations, and acronyms used in this document include those defined in the table below, as well as any defined in the tables found in Section **??** of the Software Requirements Specification (SRS) document.

symbol	**description**
j	index representing a single coordinate
TC	Test Case
VnV	Verification and Validation

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This document outlines the system verification and validation plan for the software. General information regarding the system under test and the objectives of the verification and validation activities is provided in Section 3. Overviews of verification plans for the SRS, design, and implementation are given in Section 4, along with a summary of the validation plan for the software. Section 5 details specific system test cases for verifying the requirements outlined in Section **??** of the SRS. A summary of planned static verification activities can be found in Section 6 of this document.

3 General Information

3.1 Summary

The software being tested is the Glass Breakage Analysis Program (GlassBR). Based on user-defined glass type and blast properties, GlassBR interprets the inputs to give out the outputs which predict whether the glass slab can withstand the blast under the given conditions. The blast under consideration is a type of blast load. Software is helpful to efficiently and correctly predict the blast risk involved with the glass slab using an intuitive interface.

3.2 Objectives

The purpose of the verification and validation activities is to confirm that GlassBR exhibits desired software qualities. The primary objective is to build confidence in the correctness of the software. The tests described in this document cannot definitively prove correctness, but they can build confidence by verifying that the software is correct for the cases covered by tests. Other important qualities to be verified are the portability and reusability of the software.

3.3 References

Extensive information about the purpose and requirements of GlassBR can be found in the SRS document. This System VnV Plan is complemented by the System VnV Report, where the results of the tests planned in this document are discussed. For more details on test cases specific to the implementation of GlassBR, consult the Unit VnV Plan document. The latest

documentation for GlassBR can be found on GitHub, at
https://github.com/smiths/caseStudies/tree/master/CaseStudies/glass.

4 Plan

4.1 Verification and Validation Team

4.2 SRS Verification Plan

The verification and validation team consists of one member: Vajiheh Motamer.

4.3 Design Verification Plan

The design of GlassBR s documents will be verified by getting feedback from Dr. Spencer Smith and my CAS 741 classmates.

4.4 Implementation Verification Plan

4.5 Software Validation Plan

There is no validation plan for GlassBR.

5 System Test Description

System testing for the GlassBR ensures that the correct inputs produce the correct outputs. The test cases in this section are derived from the instance models and the requirements detailed in the tool's SRS. These values were taken from the' Test Documentation' for this project . Individual test cases will reference the table as input but specify new values for any input parameter that should have a different value than specified by the table.

5.1 Tests for Functional Requirements

5.1.1 User Input Tests

Valid User Input
The following set of test cases is intended to cover different forms of valid

user input.

TC1: Tst_Pb_DefaultValues

Control: Automatic

Initial State: New session

Input: As described in Table 1.

Output:

$P_b = (1.301524590203718e-04) < P_{b_{\text{tol}}}$,
$Demand(q) = (3.258285992018616e+00)$,
$Capacity(LR) = (6.843002155788037e+00) > q$,
is_safePb = True and is_safeLR = True, The glass is considered safe.

How test will be performed: Unit testing using PyUnit.

Test Case Derivation: **??** and **??** in SRS.

Input	**Value**	**Unit**
a	1600	m
b	1500	m
g	HS	-
$P_{b_{\text{tol}}}$	0.008	-
SD_x	0	m
SD_y	1.5	m
SD_z	11.0	m
t	10.0	mm
TNT	1.0	-
w	10.0	kg

Table 1: Inputs for Tst_Pb_DefaultValues

TC2: Tst_ Pb_ SmallDimensionValues

Control: Automatic

Initial State: New session

Input: As described in Table 2.

Output:

$P_b = (1.824662149424894e-03) < P_{b_{\text{tol}}}$,
$Demand(q) = (3.658003449421614e+00)$,
$Capacity(LR) = (4.916016610996773e+00) > q$,
is_safePb = True and is_safeLR = True, The glass is considered safe.

How test will be performed: Unit testing using PyUnit.

Test Case Derivation: **??** and **??** in SRS.

Input	**Value**	**Unit**
a	1200	m
b	1000	m
g	AN	-
$P_{b_{\text{tol}}}$	0.010	-
SD_x	0	m
SD_y	2.0	m
SD_z	10.0	m
t	8.0	mm
TNT	1.0	-
w	10.0	kg

Table 2: Inputs for Tst_ Pb_ SmallDimensionValues

TC3: Tst_Pb_LargeDimensionValues

Control: Automatic

Initial State: New session

Input: As described in Table 3.

Output:

$P_b = (3.459068155453604e-04) < P_{b_{\text{tol}}}$,
$Demand(q) = (5.777809021268771e+00)$,
$Capacity(LR) = (1.092974208994522e+01) > q$,
is_safePb = True and is_safeLR = True, The glass is considered safe.

How test will be performed: Unit testing using PyUnit.

Test Case Derivation: **??** and **??** in SRS.

Input	**Value**	**Unit**
a	1600	m
b	1500	m
g	HS	-
$P_{b_{\text{tol}}}$	0.010	-
SD_x	0	m
SD_y	1.5	m
SD_z	11.0	m
t	10.0	mm
TNT	1.0	-
w	10.0	kg

Table 3: Inputs for Tst_ Pb_ LargeDimensionValues

TC4: Tst_ Pb_ LowPbTol

Control: Automatic

Initial State: New session

Input: As described in Table 4.

Output:

$P_b = (1.301524590203718e-04) > P_{b_{\text{tol}}}$,
$Demand(q) = (3.258285992018616e+00)$,
$Capacity(LR) = (3.124424950223241e+00) \not> q$,
is_safePb = False and is_safeLR = False, The glass is NOT considered safe.

How test will be performed: Unit testing using PyUnit.

Test Case Derivation: **??** and **??** in SRS.

Input	**Value**	**Unit**
a	1600	m
b	1500	m
g	HS	-
$P_{b_{\text{tol}}}$	0.008	-
SD_x	0	m
SD_y	2.5	m
SD_z	6.0	m
t	10.0	mm
TNT	1.0	-
w	10.0	kg

Table 4: Inputs for Tst_ Pb_ LowPbTol

TC5: Tst_ Pb_ DiffSDValues

Control: Automatic

Initial State: New session

Input: As described in Table 5.

Output:

$P_b = (1.185574651484522e-02) > P_{b_{\text{tol}}}$,
$Demand(q) = (7.377747177423622e+00)$,
$Capacity(LR) = (6.843002155788037e+00) \not> q$,
is_safePb = False and is_safeLR = False, The glass is NOT considered safe.

How test will be performed: Unit testing using PyUnit.

Test Case Derivation: **??** and **??** in SRS.

Input	**Value**	**Unit**
a	1600	m
b	1500	m
g	HS	-
$P_{b_{\text{tol}}}$	0.008	-
SD_x	0.0	m
SD_y	2.5	m
SD_z	6.0	m
t	0.008	mm
TNT	1.0	-
w	10.0	kg

Table 5: Inputs for Tst_ Pb_ DiffSDValues

TC6: Tst_ Pb_ HighChgWght

Control: Automatic

Initial State: New session

Input: As described in Table 6.

Output:

$P_b = (2.497577817262034e-01) > P_{b_{\text{tol}}}$,
$Demand(q) = (1.428204355548630e+01)$,
$Capacity(LR) = (6.843002155788037e+00) \not> q$,
is_safePb = False and is_safeLR = False, The glass is NOT considered safe.

How test will be performed: Unit testing using PyUnit.

Test Case Derivation: **??** and **??** in SRS.

Input	**Value**	**Unit**
a	1600	m
b	1500	m
g	HS	-
$P_{b_{\text{tol}}}$	0.008	-
SD_x	0	m
SD_y	1.5	m
SD_z	11.0	m
t	10.0	mm
TNT	1.0	-
w	60.0	kg

Table 6: Inputs for Tst_ Pb_ HighChgWght

TC7: Tst_ Pb_ LowThickness

Control: Automatic

Initial State: New session

Input: As described in Table 7.

Output:

$P_b = (2.528418262282350e-01) > P_{b_{\text{tol}}}$,
$Demand(q) = (3.258285992018616e+00)$,
$Capacity(LR) = (1.716982174845693e+00) \not> q$,
is_safePb = False and is_safeLR = False, The glass is NOT considered safe.

How test will be performed: Unit testing using PyUnit.

Test Case Derivation: **??** and **??** in SRS.

Input	**Value**	**Unit**
a	1600	m
b	1500	m
g	HS	-
$P_{b_{\text{tol}}}$	0.008	-
SD_x	0	m
SD_y	1.5	m
SD_z	11.0	m
t	3.0	mm
TNT	1.0	-
w	10.0	kg

Table 7: Inputs for Tst_ Pb_ LowThickness

Invalid User Input

The test cases described in Table 8 are intended to cover all invalid input possibilities. Invalid input is input that defies the data constraints described in Section **??** of the SRS. These test cases are identical to each other with the exception of their input. The input for each is specified in Table 8. For each test case, the inputs which have not been specified in this table, have

been specified in Table 1. Besides,The expected output has been specified for each test case and the control method for these test cases is automatic. The initial state for each is a new session. The tests will be performed as automated tests on the PyUnit.

Table 8: TestCheckConstraints

Test Case	Test Name	Significant Input	Expected Output
TC8	checkAPositiveTest	a = -1600	InputError: a and b must be greater than 0
TC9	checkBPositiveTest	b = -1500	InputError: a and b must be greater than 0
TC10	checkSmallAspectRTest	b = 2000	(a/b=0.8<1); InputError: a/b must be between 1 and 5
TC11	checkLargeAspectRTest	b = 200	(a/b=8>5); InputError: a/b must be between 1 and 5
TC12	checkValidThicknessTest	t = 7	InputError: t must be in [2.5,2.7,3.0,4.0,5.0,6.0,8.0, 10.0,12.0,16.0,19.0,22.0]
TC13	checkLowerConstrOnWTest	w = 3	InputError: wtnt must be between 4.5 and 910
TC14	checkUpperConstrOnWTest	w = 1000	InputError: wtnt must be between 4.5 and 910
TC15	checkTNTPositiveTest	tnt = -2	InputError: TNT must be greater than 0
TC16	checkLowerConstrOnSDTest	sdx = 0; sdy = 1.0; sdz = 2.0	InputError: SD must be between 6 and 130
TC17	checkUpperConstrOnSDTest	sdx = 0; sdy = 200; sdz = 100	InputError: SD must be between 6 and 130
TC18	incorrectA0Test	a = 0	InputError: a and b must be greater than 0
TC19	incorrectB0Test	b = 0	InputError: a and b must be greater than 0
TC20	incorrectTNT0Test	tnt = 0	InputError: TNT must be greater than 0
TC21	incorrectAspectREqLwrBndTest	a = 1500; b = 1500	(a/b = 1); "Encountered an unexpected exception"
TC22	incorrectAspectREqUpprBndTest	a = 7500; b = 1500	(a/b = 5); "Encountered an unexpected exception"
TC23	incorrectWEqLwrBndTest	w = 4.5	"Encountered an unexpected exception"
TC24	incorrectWEqUpprBndTest	w = 910	"Encountered an unexpected exception"
TC25	incorrectSDEqLwrBndTest	sdx = 0; sdy = 6; sdz = 0	"Encountered an unexpected exception"
TC26	incorrectWEqUpprBndTest	sdx = 130; sdy = 0; sdz = 0	"Encountered an unexpected exception"

5.1.2 Output Tests

Test Derived Values

The following set of test cases are intended to verify initial inputs have been correctly converted into derived quantities. These test cases follow term definitions and equations from Data Definitions in Section **??** of the SRS.. For each test case, one input column references to the specified input table. Besides,The expected output has been specified for each test case and the control method for these test cases is automatic. The initial state for each is a new session. The tests will be performed as automated tests on the PyUnit.

Table 9: TestDerivedValues

Test Case	Test Name	Input Table	AR Expected	SD Expected	LDF Expected	wTNT Expected	h Expected	GTF Expected
TC27	TstDrvdVals_HSGlTy	Table 1	1.0666666666666667	11.10180165558726	0.2696493494752911	10.0	9.02	2
TC28	TstDrvdVals_ANGlTy	Table 2	1.2	10.198039027185569	0.2696493494752911	10.0	7.42	1
TC29	TstDrvdVals_FTGlTy	Table 3	1.25	9.093404203047394	0.2696493494752911	15.0	9.02	4

5.2 Tests for Nonfunctional Requirements

5.2.1 Portability test

TC8: test-portability

Type: Manual

Initial State:There is a completed implementation of GlassBR

Input/Condition: -

Output/Result:-

How test will be performed: Running GlassBR on Mac, Windows and Linux operating systems

5.2.2 Reusability test

TC9: test-reusability

Type: Manual

Initial State: There is a completed implementation of GlassBR

Input/Condition: -

Output/Result: An alternative version of GlassBR that uses the input code. All modules in the alternative version should be identical to the existing GlassBR modules, with the exception of the Input Module.

How test will be performed: If only the Input Module is changed from the existing version, then the test passes and confidence in the reusability of GlassBR's modules is increased. If other modules need to be changed, the test fails and the other modules must be modified to be completely reusable.

5.3 Traceability Between Test Cases and Requirements

The purpose of the traceability matrix shown in Table 10 is to provide easy references on which requirements are verified by which test cases, and which test cases need to be updated if a requirement changes. If a requirement is changed, the items in the column of that requirement that are marked with an "X" may have to be modified as well.

	R??	R??	R??	R??	R??
TC1 - TC7	X				
TC?? - TC??		X			
TC?? - TC??			X	X	
TC??					
TC??					
TC??					
TC??					
TC??					
TC??					
TC?? - TC??					X

Table 10: Traceability Matrix Showing the Connections Between Requirements and Test Cases

6 Static Verification Techniques

Static verification of theGlassBR library implementation will performed using code review with Dr. Spencer Smith and my CAS 741 classmates.