# ISRM Suggested Method for Reporting Rock Laboratory Test Data in Electronic Format

Hong Zheng, Xia-Ting Feng, Zuyu Chen, J. A. Hudson, and Yujie Wang

## 1 Introduction

The ISRM Suggested Methods for rock characterization, testing and monitoring have been widely established and included in the Blue Book (ISRM 2007). A following book on the new and updated ISRM Suggested Methods, released between 2007 and 2013, will be published soon in the ISRM Book Series. This will be called the Orange Book. However, the reports of testing results using these ISRM Suggested Methods are individually somewhat different, because they have different contents. The output format of the test data from different testing machines also varies considerably.

It should be noted that usually the reporting of testing results is currently only retained by the tester or published in journal or conference papers. Thus, it is not easy to use and compare the testing results for the same rock type from different sites or indeed different rock types (Toll and Cubitt 2003; Toll 2007, 2008; Weaver et al. 2008). Therefore, it is important to develop an approach leading to a digital standardised format for the storage and reporting of rock testing results for the same rock type and for different rock types conducted worldwide (Exadaktylos et al. 2007; Chen 2009; Zheng et al. 2010; Li et al. 2012). In order to use the format across the world, a Web style is required (AGS 1999, 2004, 2005; Swift et al. 2004; see the Websites for GADML, eEarth, XMML, GeoSciML, NEES, RockLab, Rockware, DIGGS). This should be suitable not only for the existing ISRM Suggested Methods but also for new and upgraded ISRM Suggested Methods. Also, it should be independent of any specific language environment and sufficiently extendable to satisfy the requirements of new ISRM Suggested Methods incorporating different items and parameters. In this way, such reporting will be useful for data integration and comparative analysis of remote data resources and improving the reliability and accuracy of complex engineering problem solving methods.

Hence, the purpose of the ISRM Suggested Method (SM) for reporting rock laboratory test data in electronic format is to provide a method for the reporting of results for the ISRM Suggested Methods for rock laboratory tests in a digitally standardised format. Such a report could include one or more of the following:

1. The original testing data and results obtained from different testing machines as guided by an ISRM Suggested Method (for example, the ISRM Suggested Method for determination of the uniaxial compressive strength of rock materials) which is stored in a standard electronic format.
2. A group of laboratory tests for the same rock type at the same project site (for example, a report for testing results for the uniaxial compressive strength of several specimens of marble at the Jinping II hydropower station site in China) which is stored and reported in a standard electronic format with local and Web output.

Please send any written comments on this ISRM Suggested Method to Prof. Resat Ulusay, President of the ISRM Commission on Testing Methods, Hacettepe University, Department of Geological Engineering, 06800 Beytepe, Ankara, Turkey.

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3. The results of laboratory tests for the same rock type at different project sites (for example, reports of testing results for different marble stratum types following the same ISRM Suggested Method). These would be stored and reported in a standard electronic format with local and Web output.
4. The results of laboratory tests for different rock types at different/or the same project sites (for example, reporting of testing results for Jinping marble, Longyou sandstone, Inada granite, etc., following the corresponding ISRM Suggested Methods, stored and reported in a standard electronic format with local and Web output).

With a standard electronic format, users in different locations in the world can upload the information and can store their own testing data, including tables, photographs and figures, on the Web file. Researchers and engineers around the world can look at the testing results through the Web. In this way, testing results for the same rock type from the project, the same rock type from different project sites, and different rock types from the same or different project sites can be compared. Thus, the reporting of testing results can be shared worldwide.

As a first step, the electronic formats for reporting of the ISRM Suggested Methods for rock laboratory tests have been developed. This strategy can later be extended to all ISRM Suggested Methods for rock characterization and monitoring.

## 2 Standardisation of the Reporting Structure of the ISRM Suggested Methods for Rock Laboratory Testing

In order to develop a series of electronic formats for all ISRM Suggested Methods for rock laboratory testing, the basic features of the Suggested Methods have firstly been analysed. Each Suggested Method for laboratory testing includes five categories, i.e. "Scope", "Apparatus", "Procedures", "Calculations" and "Reporting of Results". However, the different Suggested Methods for laboratory testing have different parameters for each category (Table 1). A standardisation method is required to describe the contents of each category. Also, the category "Reporting of Testing" includes four sub-categories, i.e., description of the test equipment, description of the test object, description of the test process and description of the test results. The latter category for a group of testing results on the same rock type includes a description of general information which is a description of the testing equipment, rock and specimens, and a description of the specific information, which is a description of testing results for a set of specimens. The descriptions for these sub-categories and their general and individual information vary within the Suggested Methods. Therefore, three-step strategies are developed to standardise overall testing reports and the testing result format (Fig. 1). The first step is the standardisation of the five categories. The second step is the standardisation of four sub-categories for the category "Reporting of Results". The third step is to standardise the testing result format for the sub-category "Description of the Test Results".

The details for the three steps are further developed and shown in Fig. 2. The standardisation of contents for the first four categories, shown in Fig. 2, is performed via the overall standardisation strategy. The four sub-categories for the category "Reporting of Results" are further detailed in Fig. 2. The apparatus type and description of rock in the field can be considered as general information, indicating that the same rock type is tested in the same equipment. The description of testing specimens, testing process and testing results varies and can be considered as individual specific information.

According to the developed standardisation method, an overall structure tree of the data structure document has been constructed, as shown in Fig. 3. This includes 'parent nodes' such as "Apparatus Information", "Rock Information", "Sample Source" and "Specimen"; 'middle nodes' such as "Specimen Size", "Failure Pattern" and "Result Parameters"; and 'children nodes' such as "Apparatus Name",…, "Number of Specimen", "Specimen No.", "Diameter", "Height", "Ends Flatness",…, "Loading Rate", "Failure Type", "Failure Photo" "Tested by",…, "Remarks".

The parent node "Specimen" as a repeated node can be repeatedly used according to the number of specimens. For example, if five specimens are to be used for the same tests, it will be repeated five times to represent "Specimen 1", "Specimen 2", "Specimen 3", "Specimen 4" and "Specimen 5" successively.

The middle node "Geographic Location" can be explicitly represented by its three children nodes, such as "X-coordinate", "Y-coordinate", and "Z-coordinate", which are established by users to distinguish the sample source. In detail, the "X-coordinate" and "Y-coordinate" are the projection plane coordinates of the sample source with respect to the same project site; the "Z-coordinate" means the depth of the sample source. If the user wishes to use the conventional drill hole survey notation, it can be represented by the drill hole ID and its down-hole position in metres.

The middle node, "Result Parameters", can be subdivided into several children nodes according to the number of parameters in the testing results. For example, for the report of testing results for triaxial compression, the result parameters include "triaxial compressive strength" as

**Table 1** Basic features of the ISRM Suggested Methods for laboratory testing

| Name of testing method | Scope and introduction | Apparatus | Procedures | Calculations | Reporting of results |
|---|---|---|---|---|---|
| Determining point load strength index | Test purpose, use instructions, requirements and limitations of the test object and apparatus | The components of apparatus: loading system, load measuring system, distance measuring system | Specimen selection and preparation, calibration, the diametral test, the axial test, the block and irregular lump tests; anisotropic rock | Uncorrected point load strength index, size correction, mean value calculation, Point load strength anisotropy index | The sample number, source location and rock type, and the nature and in situ orientation of any planes of anisotropy or weakness. The water content of the rock at the time. The loading directions; failure load; distance between the two platen contact points; uncorrected point load strength index; corrected point load strength index |
| Determining the indentation hardness index of rock materials | Use instructions, requirements and limitations of test object and apparatus | The components of apparatus: loading system; load measuring system; penetration measuring system | Specimen preparation; storage environment; load rate; indentation process | The peak load; the corresponding penetration; the indentation hardness index | Source of sample; lithologic description of the rock; number of specimens tested; orientation of the axis of loading with respect to specimen anisotropy; specimen diameter and height; water content and degree of saturation at time of test; test duration and load rate; the mode of failure; the peak load; the corresponding penetration, the indentation hardness index with the average results for each rock sample |
| Determining the block punch strength index | Test purpose, use instructions, requirements of test object and apparatus | The components of apparatus; punching block; base support; Ram | Specimen preparation; testing | Uncorrected block punch strength index; size-corrected block punch strength index; strength index in the strongest direction | Lithological description of the rock; orientation of the axis of loading with respect to specimen anisotropy; the sample number, source location, sampling depth; number of specimens tested; water content at time of test; date of testing; failure pattern; specimen diameter and height; Failure load; corrected block punch strength index; strength index in the strongest direction |

(continued)

**Table 1** (continued)

| Name of testing method | Scope and introduction | Apparatus | Procedures | Calculations | Reporting of results |
|---|---|---|---|---|---|
| Determining the uniaxial compressive strength and deformability of rock material | Test purpose, Use instructions, requirements and limitations of test object and apparatus | The components of the apparatus and the function of each system | Specimen preparation; loading rate | Uniaxial compressive strength; axial strain; diametric strain; compressive stress; axial Young's modulus; Poisson's ratio; volumetric strain | Lithologic description of the rock; orientation of the axis of loading with respect to specimen anisotropy; source of sample; number of specimens tested; specimen diameter and height; water content and degree of saturation at time of test; test duration and loading rate; date of testing and type of testing machine; mode of failure; any other observations or available physical data; uniaxial compressive strength; values of applied load, stress and strain; Young's modulus; Poisson's ratio; method of determination of Young's modulus and at what axial stress level or levels determined |
| Determining the strength of rock materials in triaxial compression | Test purpose, use instructions, requirements of test object and apparatus | General testing equipment; loading device; triaxial cell; device for applying confining pressure; equipment for measuring and recording | Specimen preparation; the different procedures of three types (individual test, multiple failure state test, continuous failure state test) | Axial stress; peak strength; residual strength; internal friction angle; cohesion | Source of sample; lithological description of the rock; methods of specimen preparation, also the history and environment of test specimen storage; Orientation of the axis of loading with respect to specimen anisotropy; water content and degree of saturation at time of test; description of testing machine; data of testing; specimen diameter and height; test duration and stress and displacement rates; mode of failure; confining pressure and axial strength; Internal friction angle; cohesion; any other observations |

(continued)

**Table 1** (continued)

| Name of testing method | Scope and introduction | Apparatus | Procedures | Calculations | Reporting of results |
|---|---|---|---|---|---|
| Determining shear strength | Test purpose, use instructions, requirements of test object and apparatus | Equipment for taking specimens of rock; equipment for mounting the specimen; testing equipment | Specimen preparation; consolidation; shearing | Peak strength; normal displacement; shear displacement; normal stress; shear stress | Data of testing; type of apparatus; methods of drilling and testing; geological description of the intact rock, sheared surface, filling and debris preferably accompanied by relevant index test data; source of sample; size of specimen; test duration; peak and residual shear strength; normal displacement; shear displacement; normal stress; shear stress; shear strength parameters |
| Determining tensile strength of rock materials | Test purpose, use instructions, requirements of test object and apparatus | The components of the apparatus and the function of each system | Specimen preparation; storage environment; load rate | For direct tensile strength tests: the maximum load; tensile strength<br>For indirect tensile strength tests: the load at failure; diameter; thickness; tensile strength | Lithological description of the rock; orientation of the axis of loading with respect to specimen anisotropy; source of sample; number of specimens tested; specimen diameter and height; water content and degree of saturation at time of test; test duration and load rate; data of testing; type of apparatus; mode of failure; any other observations; tensile strength |
| Laboratory testing of swelling rocks | Test purpose, use instructions, requirements of test object and apparatus | The components of the apparatus and the function of each system | Sampling; storage environment; specimen preparation; loading temperature; load rate | The area of cross-section; axial stress; compensated swelling strain; non-compensated swelling strain | A unique identification of the sample and of each individual specimen; date and method of sampling; method of sealing and storage; method of specimen preparation for testing; orientation of the axis of loading with respect to specimen anisotropy; dimensions of the test specimen; density, water content, grain density and degree of saturation of the test specimen before and after the swelling test; test temperature; applied seating-load; specification of water used for immersion; axial stress; axial swelling strain; total compensated swelling strain |

(continued)

**Table 1** (continued)

| Name of testing method | Scope and introduction | Apparatus | Procedures | Calculations | Reporting of results |
|---|---|---|---|---|---|
| Complete stress–strain curve for intact rock in uniaxial compression | Test purpose, use instructions, requirements of test object and apparatus | The component of apparatus: loading system, hydraulics, Spherically seated platen and specimen platen; control system; Strain measurement transducer; data acquisition | Specimen preparation; the testing procedure of specimens that generally exhibit ductile behaviour and specimens that generally exhibit brittle behaviour | Axial strain; diametric strain; compressive stress; circumferential strain; Young's modulus(Tangent Young's modulus; average Young's modulus, secant Young's modulus); Poisson's ratio; volumetric strain | Lithologic description of the rock; orientation of the axis of loading with respect to specimen anisotropy; source of sample; number of specimens tested; specimen diameter and height; water content and degree of saturation at time of test; test duration and load rate; date of testing and type of testing machine; mode of failure; any other observations or available physical data; values of applied load, stress and strain; pre-peak Young's modulus; Poisson's ratio; method of determination of pre-peak Young's modulus and at what axial stress level or levels determined |
| Determining the fracture toughness of rock | Test purpose, use instructions, requirements of test object and apparatus | The component of apparatus: specimen preparation equipment; testing machine and load fixtures; specimen alignment aids; displacement measuring equipment; recording | Specimen selection and preparation; calibration; setting up; testing | Loading rate; slope values; fracture toughness; correction of fracture toughness for non-linearity; additional quantities; Young's modulus; Poisson's ratio; total work of fracture | Sample number; source location and rock type and the nature and in situ orientation of any planes of anisotropy or weakness; core axis with respect to in site geology and structures and in case of sub-samples, the direction of loading; storage history and environment, water content and degree of saturation at the time of testing; Index properties obtained by other types of testing and physical data; specimen dimensions; level of testing and the appropriate loading rate; maximum load; the load at the evaluation point; the fracture toughness; auxiliary parameters |

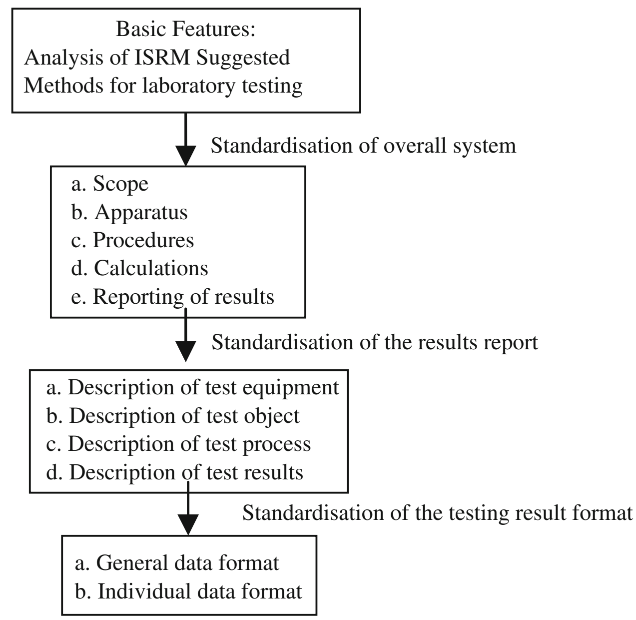



**Fig. 1** Standardisation steps for the ISRM suggested methods for laboratory rock testing

"Parameter 01", "Confining Pressure" as "Parameter 02", "Internal friction angle" as "Parameter 03", and "Cohesion" for "Parameter 04". However, for uniaxial compressive tests, it includes "Uniaxial Compressive Strength" as "Parameter 01", "Young's modulus" as "Parameter 02", "Poisson's ratio" as "Parameter 03", "Modulus Method" as "Parameter 04" and "Axial Level" as "Parameter 05".

Moreover, the middle node "Original Testing Data" and "Other Observations" can also be sub-divided into several children nodes which are truncated here for brevity. "Original Testing Data" is used to store the testing data of each specimen. And its children nodes are different for each of the Suggested Methods for laboratory testing. For example, the middle node "Original Testing Data" includes "Time", "Pressure", "Axial Strain", "Lateral Strain" and "Stress" for uniaxial compression testing. However, it includes "Time" and "Value of strain" for creep testing. And "Other Observations" is used for extending nodes. Some information could be included in this middle node, such as "SEM image", "CT image", "Microseismic events distribution map", "Microseismic data", etc.

The overall structure tree shown in Fig. 3 and includes the items in the existing Suggested Methods (ISRM 2007). This may need to be extended or modified according to the content of future new Suggested Methods. However, it is easy to implement such modifications.

## 3 Digitisation of the Reporting Structure for the ISRM Suggested Methods for Rock Laboratory Testing

The data structure shown in Fig. 3 needs to be digitised. The digitisation of the data structure includes three types of documents: data structure document, data storage document and data display document. This has the key features shown in Fig. 4, as in the following list:

(a) The data structure document, categories and nodes should be capable of being extendable.
(b) It should be easy to store and find data in the nodes with large memory and good compression.
(c) Data storage should be divorced from the environment. This means that a language environment should not be necessary to access data.
(d) Data types should be customisable. The users should be able to define their own data types.
(e) There should be data display flexibility.
(f) The data should be able to be shared and transmitted by network.

With the application of network language technology in the Extensible Markup Language, three types of documents including data structure document (XSD), data storage document (XML) and data display document (XSL), are developed to digitise the data structure in Fig. 3.

### 3.1 The Data Structure Document

The basic digitised data structure can be defined according to the structure in Fig. 3. It has different digitised data structures for each type of node.

All root nodes, parent nodes and middle nodes are of "complex type" because they have their own children nodes. The digitised data structures for these three nodes can be defined as the structure of the "complex type" which includes each secondary node as "element ref". For instance, the root node "Test" has its secondary nodes—such as "Apparatus Information", "Rock Information", "Sample Source" and "Specimen". The repeated node "Specimen" is marked as 'maxOccurs = unbounded'. Therefore, the digitised data structure for the root node "Test" in Fig. 3 can be defined in Appendix 1.

The children nodes can be in the value type of "selection", "decimal" or "string". The digitised data structures of children nodes are defined in Appendixes 2, 3 and 4, respectively. For example, the children nodes whose value is selected, i.e., "Failure Type", can be defined in Appendix 2. The children nodes, which are decimal, for example, "Diameter", can be defined in Appendix 3. The children

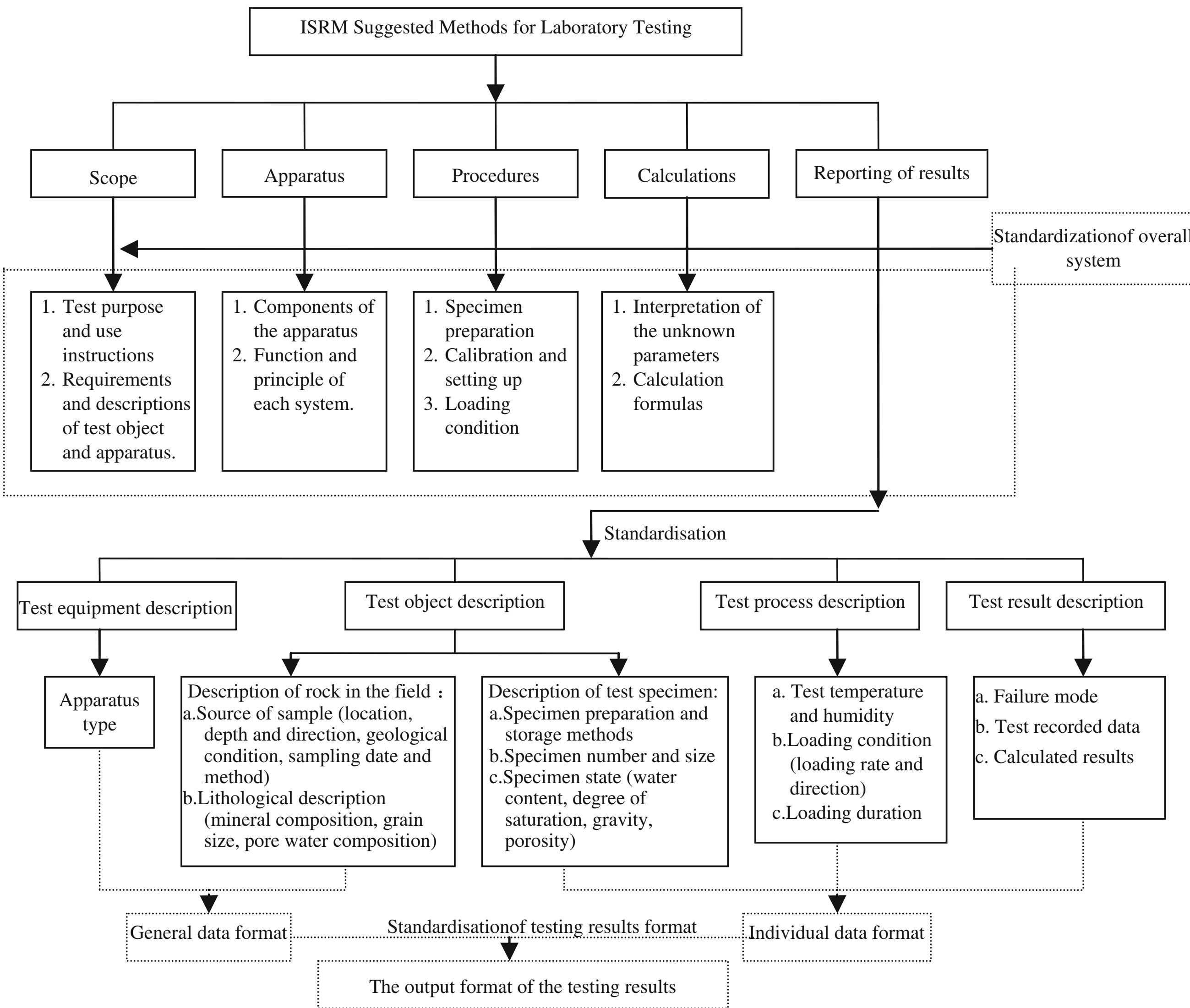



**Fig. 2** The standard items for the ISRM suggested methods for laboratory testing

nodes which are a string, for example, “Apparatus Name”, can be defined in Appendix 4.

There is a data structure document for each ISRM Suggested Method. The data structure document for UCS testing, for example, can be named as “UCS.xsd”.

## 3.2 The Data Storage Document

The data storage document is to define the storage format of the data having the structure in Fig. 3. It should have the following advantages:

1. Good compression to enable the storage of a large number of test data.
2. Convenience for the integration of structured test data with different sources.
3. Ability for updates through this digital format. If any part of the data changes, the document can be automatically updated without resending the entire structured data.

XML, as a digital format, is very effective for these requirements (Bowman 1998; Wang 2001; Durant 2003; Nance and Hay 2005; Byron and Lysandros 2006; Caronna 2006; Chandler et al. 2006; Madria et al. 2008; Bardet and Zand 2009). According to the data structure in Fig. 3, the data can be stored in their own nodes. For example, for the data for the node *<SpecimenNo>*, the datum “1” is stored as *<SpecimenNo> 1</SpecimenNo>*. It is a text format which is independent of the language (see an example in Appendix 5).

The testing results can be input by using the user interface (see Fig. 5 for input interface, an example for uniaxial compressive strength tests, UCS). Photographs of specimen

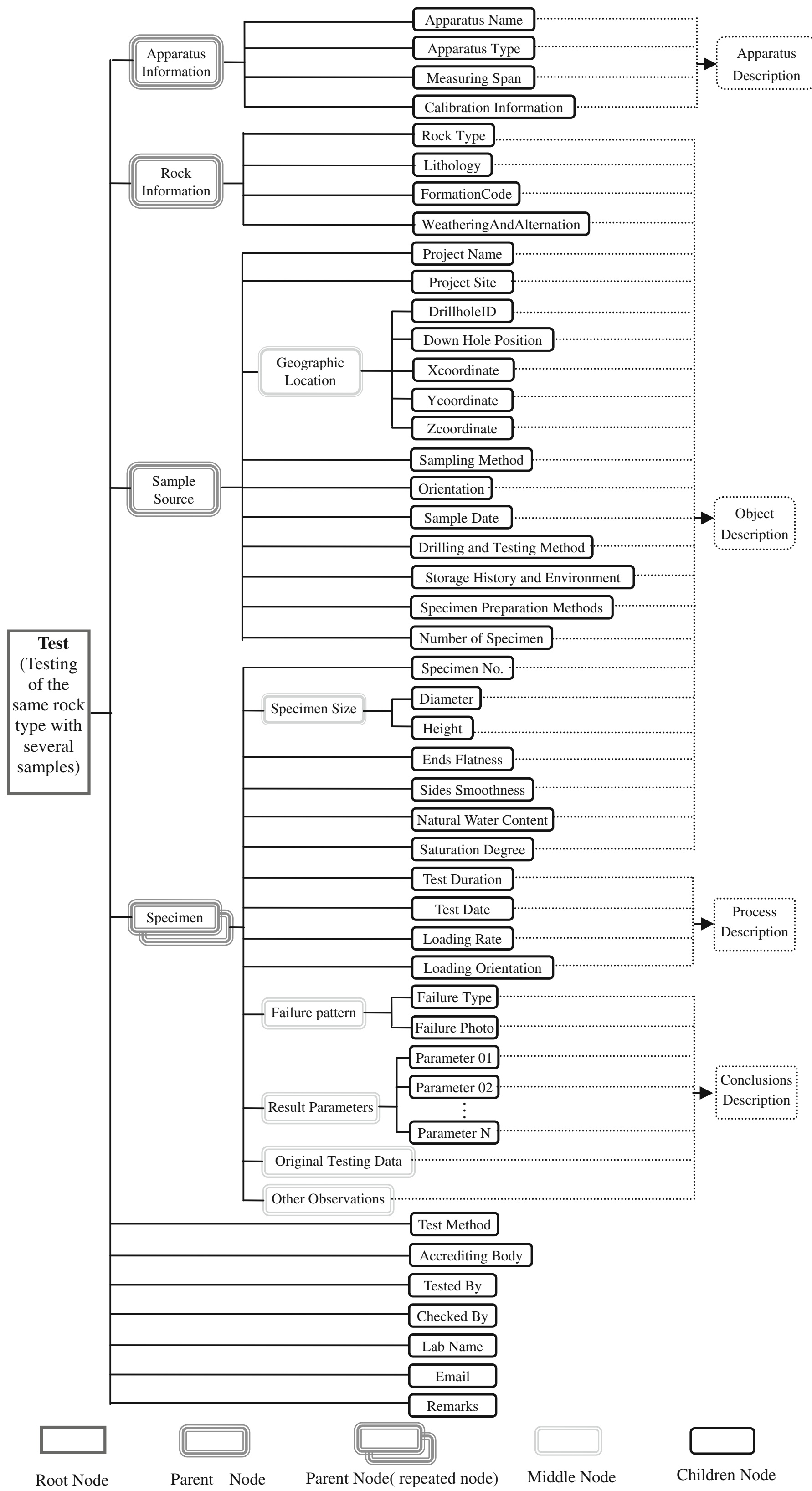



**Fig. 3** The overall structure tree in the data structure document

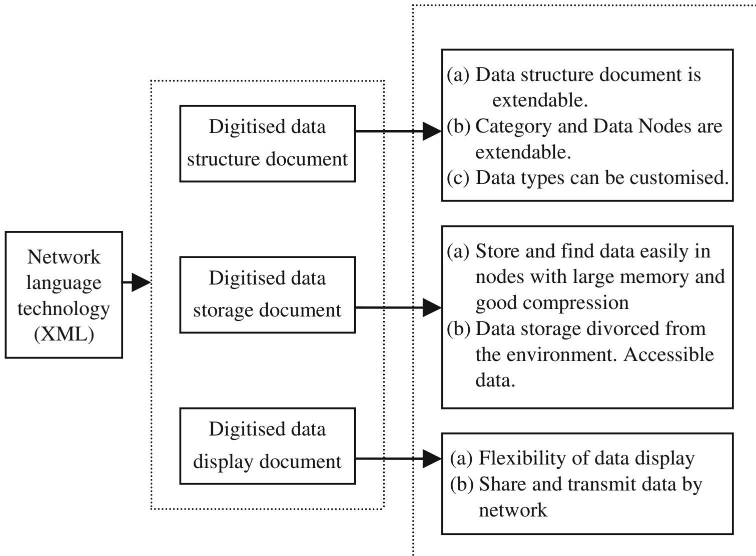



**Fig. 4** Digitisation of the ISRM suggested methods for rock laboratory testing

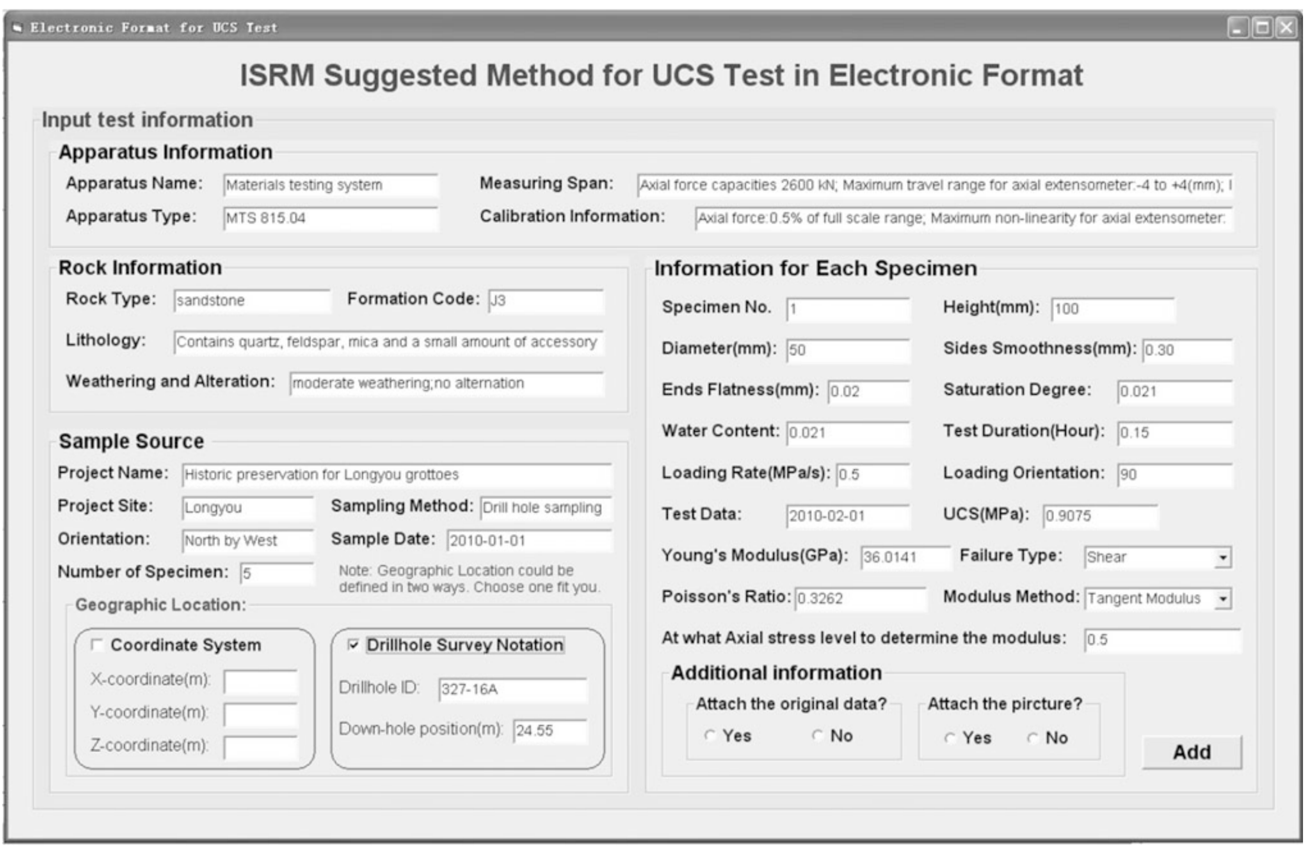



**Fig. 5** An example of the interface for user input

failure and testing curves, etc. can be uploaded and added in the report of testing results (see Fig. 6 as an example). Moreover, the type of the attached pictures can be chosen in the user interface (Fig. 7). The recorded data may have different formats according to the testing system. The original testing data recorded by the testing system for each

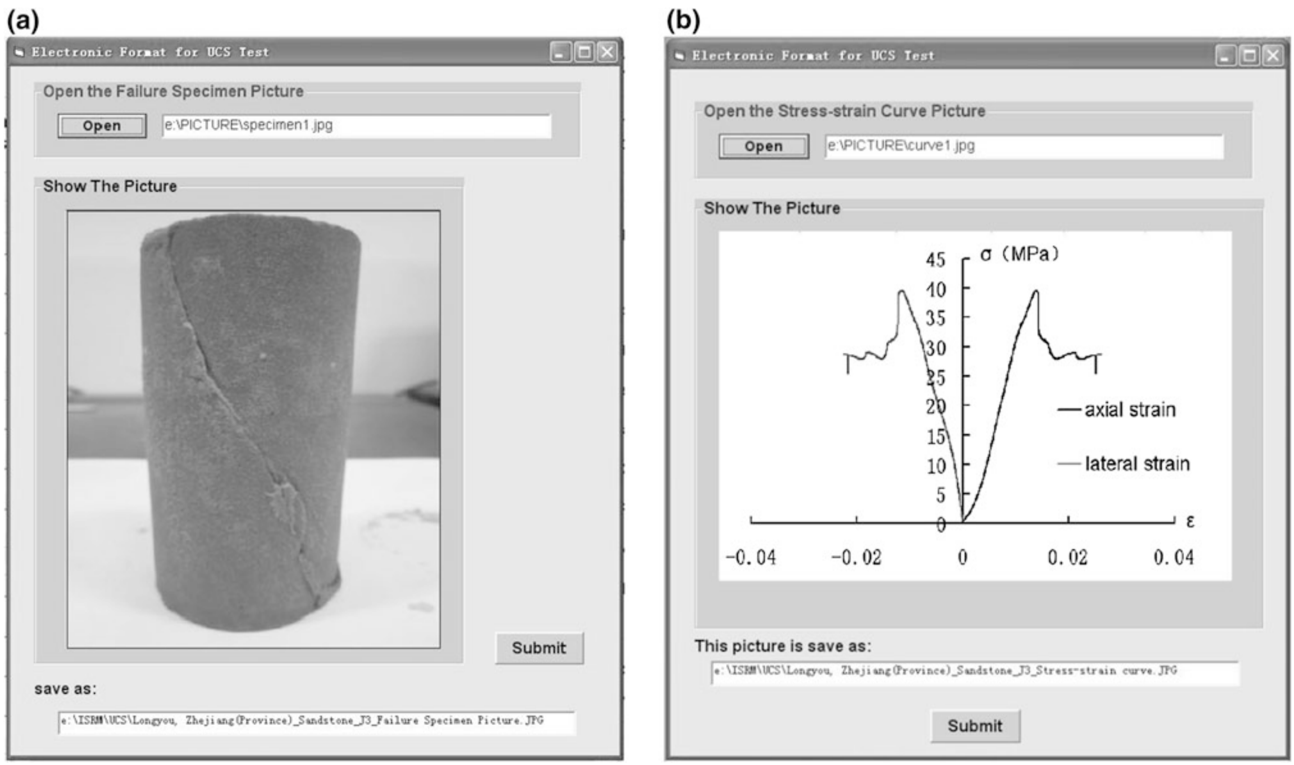



**Fig. 6** An example of uploading of **a** failure specimen picture and **b** stress–strain curve

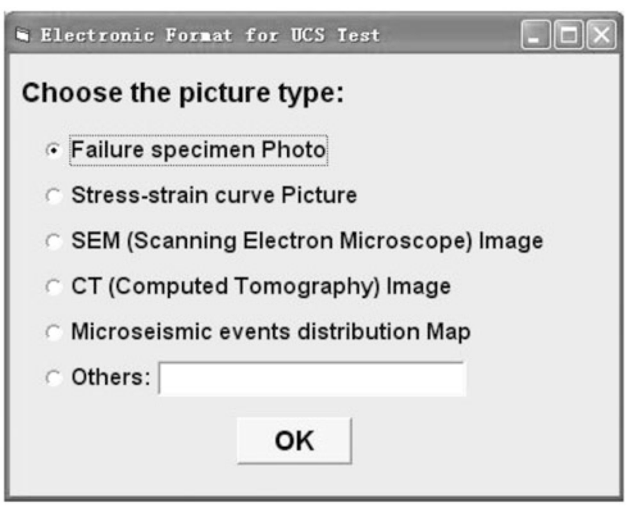



**Fig. 7** The choose window for the attached picture

rock specimen can also be transferred into the standard format shown by children nodes of the middle node "OriginalTestingData" and stored as an attached node. The calculation equations included in the Suggested Method can be also displayed to obtain the testing results (see Fig. 8 for an example of calculation of the UCS).

The testing results are stored in the user's name, i.e., the name of the rock type with project site, formation code and testing method. For example, the determination of the UCS testing for sandstone of late Jurassic, J3, at Longyong Grottoes, the data storage document can be named as "Longyong_Sandstone_J3_UCS.xml".

## 3.3 The Data Display Document

The purpose of the data display document is to define the display format of the data described by the data structure document and the storage document. XSL, Extensible Style sheet Language, can be used to present the XML data in a readable format. Each test parameter's unit could be specified in this data display document (XSL). The data are displayed in a tabular format. The photographs and testing curves can also be included by inserting the data for the attached nodes. The data of the node "Specimen" are displayed in rows of the number of the specimens, one row for the testing results of each specimen. The data display document is defined in the corresponding file ".xsl", for example, "xxx_xxx_xxx_UCS.xsl" for the data display document of the testing result report in the UCS test and "xxx_xxx_xxx_(Original)UCS.xsl" for the data display document of the original test data in the UCS test. Moreover, its flexibility in display patterns allows bespoke design by referring to the user's requirement. The testing results report can be stored at the users' local computer (Fig. 9a) and uploaded on the ISRM Website (Fig. 9b) to enable data

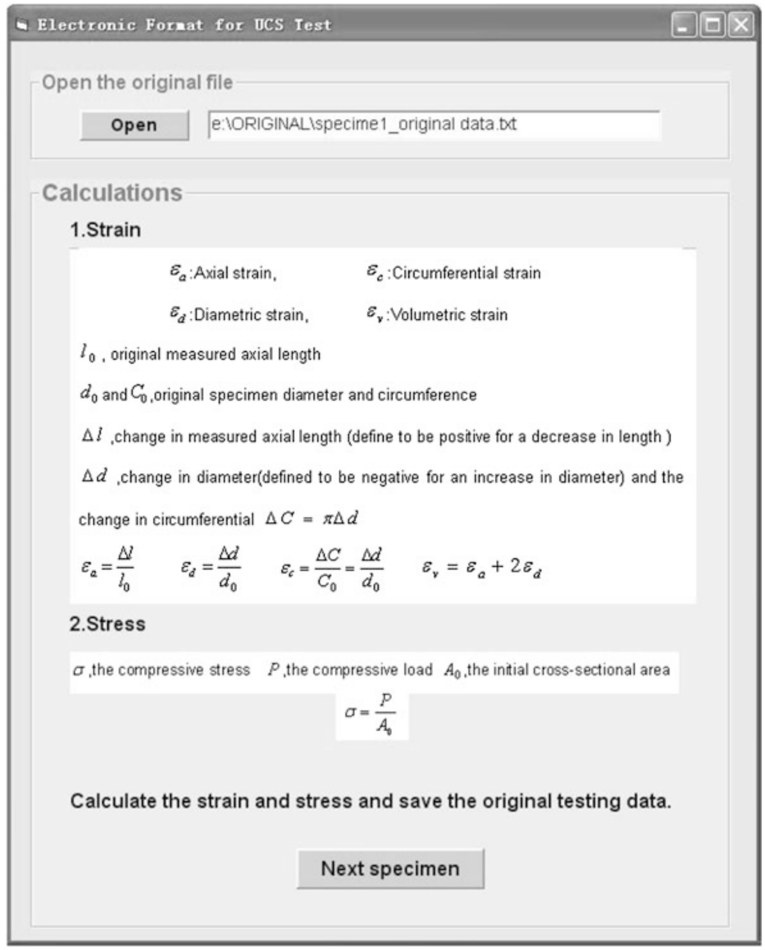



**Fig. 8** An example of the calculation equations for the recorded test data leading to the actual test results

sharing around the world. The reporting of the testing results can include photographs and curves (Fig. 10). The original testing data can also be displayed, e.g., for specimen 1 in Fig. 11.

## 4 Notes and Recommendations for the Electronic Formats for Different ISRM Suggested Methods

Based on the standardisation and digitisation methods mentioned above, each ISRM Suggested Method has its own data structure and its own three files, including the data structure document with ".xsd", data storage document with ".xml", and data display document with ".xsl". The data structure for a given ISRM Suggested Method can be generated by modifying Fig. 3 according to its data items. The corresponding three files, including the data structure document, the data storage document and the data display document, can be changed accordingly. For example, the data structure and three files, UCS.xsd, UCS.xml, and UCS.xsl, for reporting of UCS testing have been established in Appendix 5.

A code has been developed to perform the process of the electronic format for storage and reporting of the testing data and results for the existing ISRM Suggested Methods for rock laboratory tests, including uniaxial compressive strength, shear strength, triaxial compressive strength, point load strength index, and tensile strength, etc. The original testing data from the Suggested Methods recorded from the testing system can be transferred into the standard format. The testing results can be calculated by using the equations and methods given in the ISRM Suggested Methods. The testing results can be stored automatically from the calculation, uploading of the calculated results or with input from the interface. The reporting of the testing results can be displayed on a personal computer or through the Web.

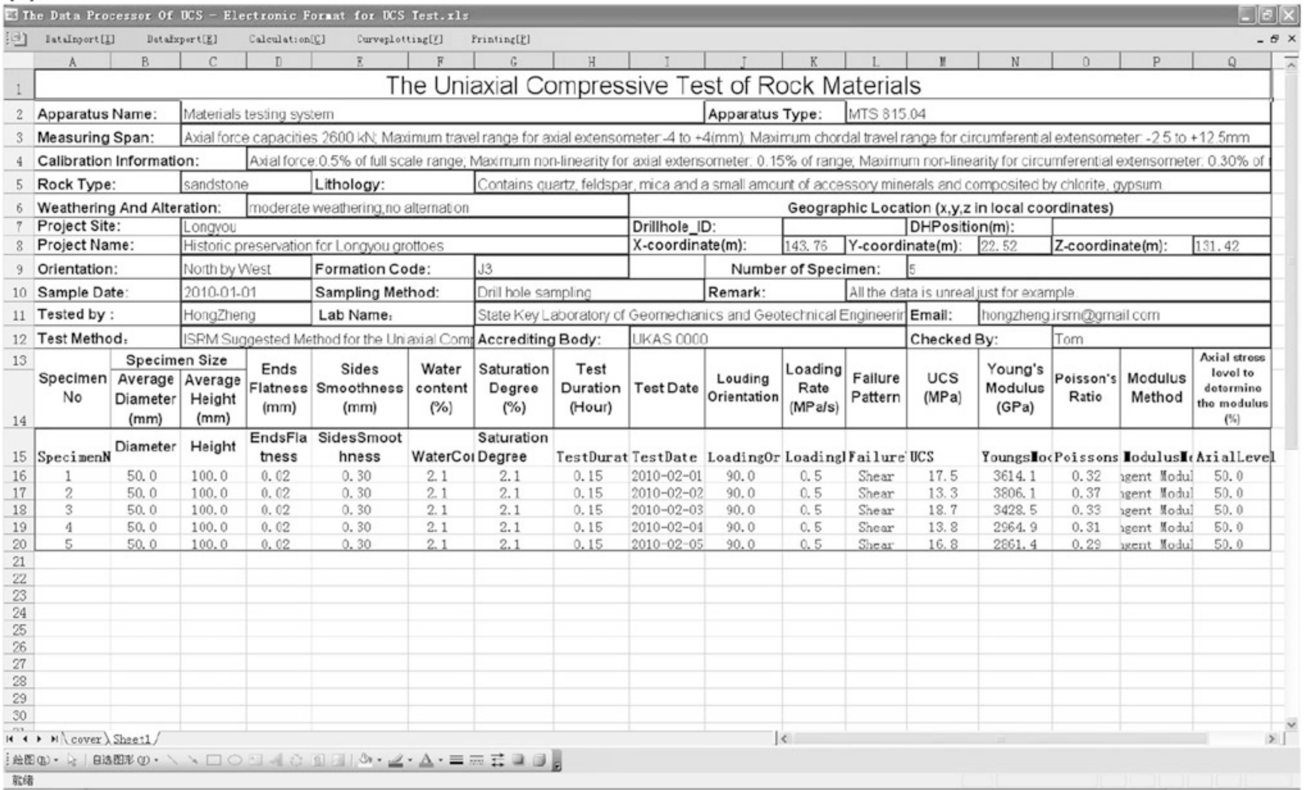
The procedure is outlined for practical implementation as follows (by taking reporting of Longyou sandstone UCS as an example).

Step 1: Run the code LabTestElectronicformat.exe.

Step 2: Click the ISRM Suggested Method for testing, e.g., UCS (Fig. 12).

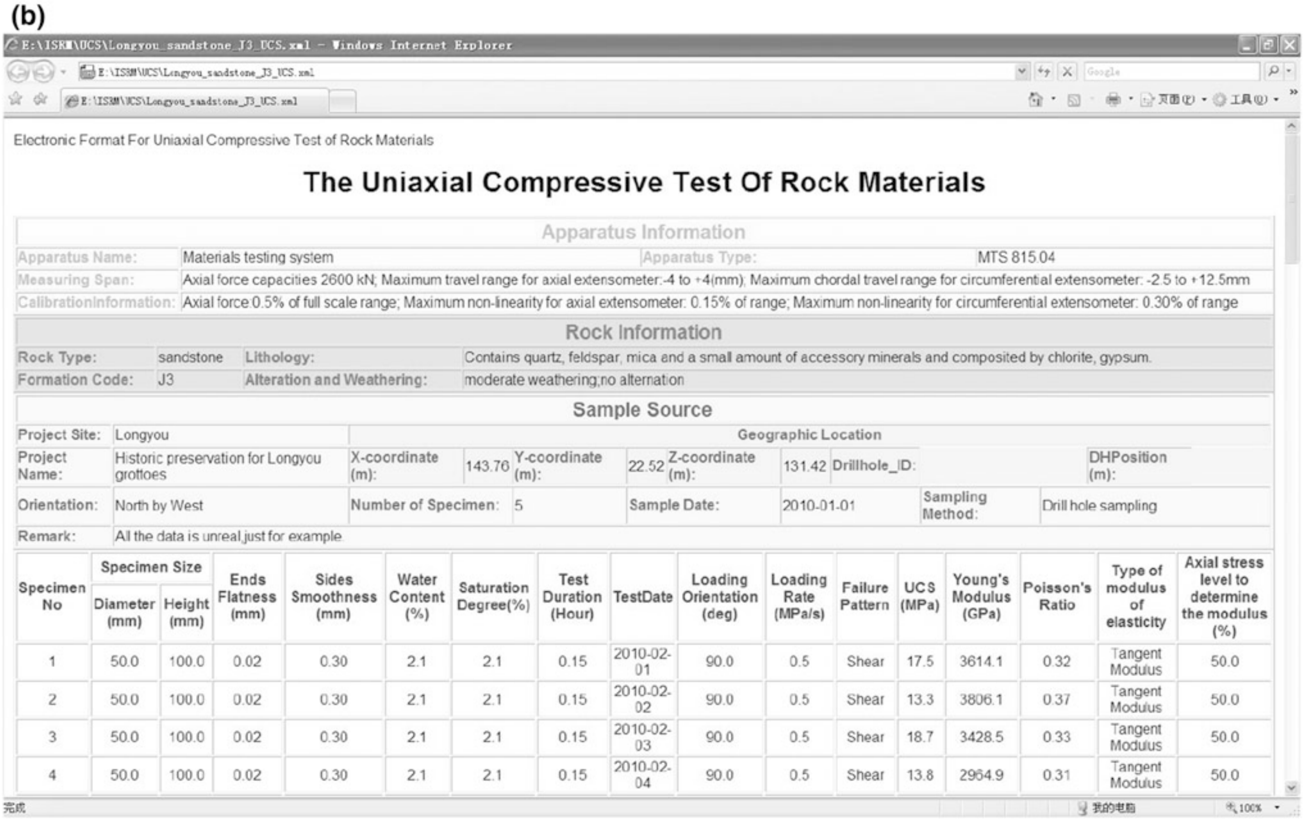
Step 3: Designate the storage path for the digitised files and create the data structure document for testing, e.g., UCS (see Fig. 13).

(a)




| Specimen No | Average Diameter (mm) | Average Height (mm) | Ends Flatness (mm) | Sides Smoothness (mm) | Water content (%) | Saturation Degree (%) | Test Duration (Hour) | Test Date | Louding Orientation | Loading Rate (MPa/s) | Failure Pattern | UCS (MPa) | Young's Modulus (GPa) | Poisson's Ratio | Modulus Method | Axial stress level to determine the modulus (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SpecimenN | Diameter | Height | EndsFlatness | SidesSmoothness | WaterCo | Saturation Degree | TestDurat | TestDate | LoadingOr | LoadingI | Failure | UCS | YoungsMo | Poissons | ModulusM | AxialLevel |
| 1 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-01 | 90.0 | 0.5 | Shear | 17.5 | 3614.1 | 0.32 | ngent Modul | 50.0 |
| 2 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-02 | 90.0 | 0.5 | Shear | 13.3 | 3806.1 | 0.37 | ngent Modul | 50.0 |
| 3 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-03 | 90.0 | 0.5 | Shear | 18.7 | 3428.5 | 0.33 | ngent Modul | 50.0 |
| 4 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-04 | 90.0 | 0.5 | Shear | 13.8 | 2964.9 | 0.31 | ngent Modul | 50.0 |
| 5 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-05 | 90.0 | 0.5 | Shear | 16.8 | 2861.4 | 0.29 | ngent Modul | 50.0 |

(b)




| Specimen No | Diameter (mm) | Height (mm) | Ends Flatness (mm) | Sides Smoothness (mm) | Water Content (%) | Saturation Degree(%) | Test Duration (Hour) | TestDate | Loading Orientation (deg) | Loading Rate (MPa/s) | Failure Pattern | UCS (MPa) | Young's Modulus (GPa) | Poisson's Ratio | Type of modulus of elasticity | Axial stress level to determine the modulus (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-01 | 90.0 | 0.5 | Shear | 17.5 | 3614.1 | 0.32 | Tangent Modulus | 50.0 |
| 2 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-02 | 90.0 | 0.5 | Shear | 13.3 | 3806.1 | 0.37 | Tangent Modulus | 50.0 |
| 3 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-03 | 90.0 | 0.5 | Shear | 18.7 | 3428.5 | 0.33 | Tangent Modulus | 50.0 |
| 4 | 50.0 | 100.0 | 0.02 | 0.30 | 2.1 | 2.1 | 0.15 | 2010-02-04 | 90.0 | 0.5 | Shear | 13.8 | 2964.9 | 0.31 | Tangent Modulus | 50.0 |

**Fig. 9** An example of reporting of testing results in the format of **a** local computer and **b** the Web

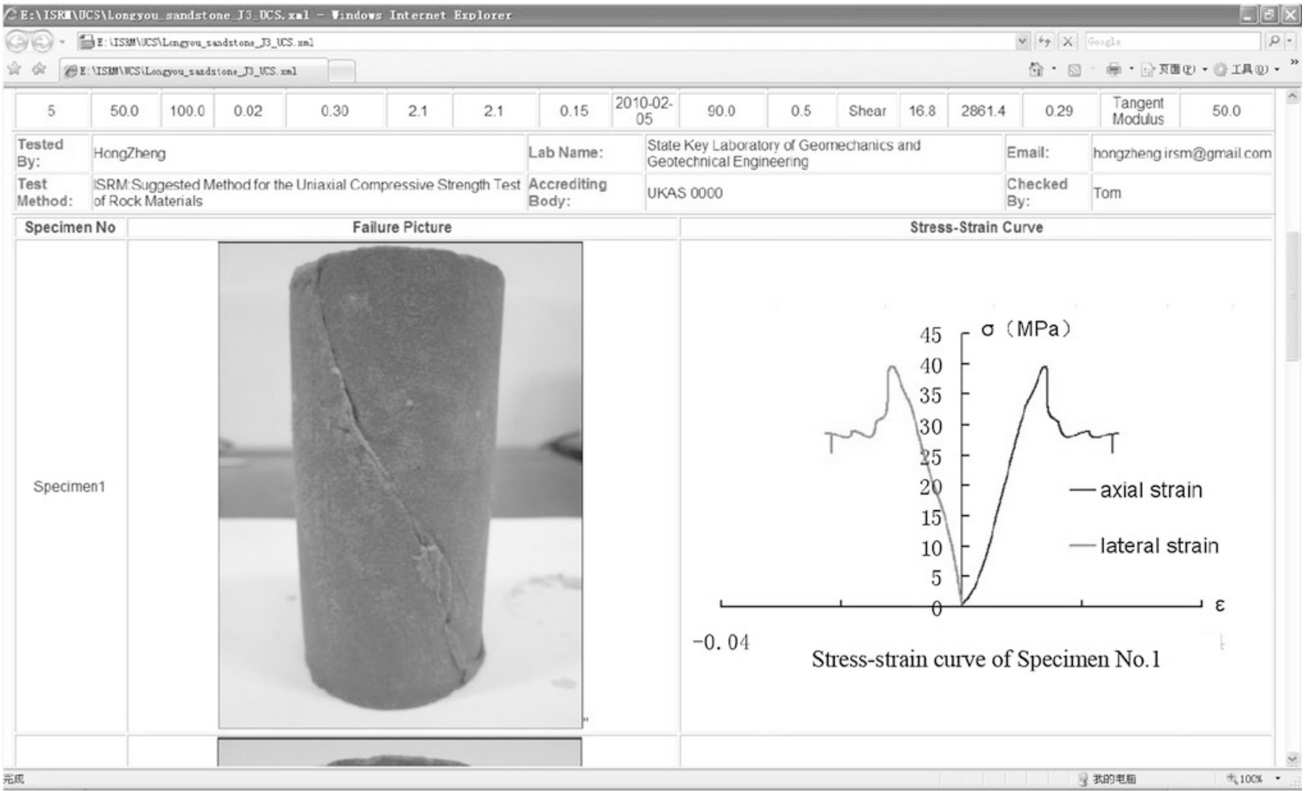
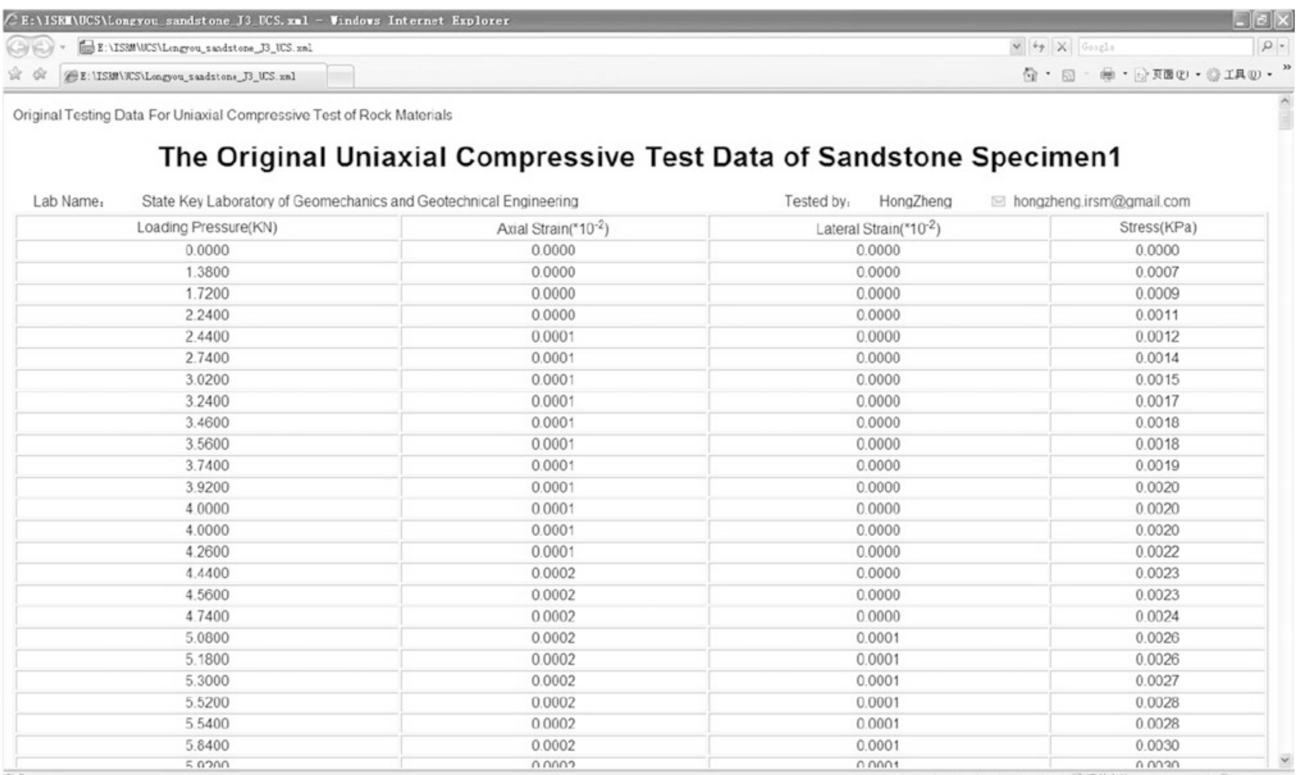



**Fig. 10** Reporting of the testing results including photograph and figures




Original Testing Data For Uniaxial Compressive Test of Rock Materials

The Original Uniaxial Compressive Test Data of Sandstone Specimen1

Lab Name: State Key Laboratory of Geomechanics and Geotechnical Engineering Tested by: HongZheng hongzheng.irsm@gmail.com

| Loading Pressure(KN) | Axial Strain(*10$^{-2}$) | Lateral Strain(*10$^{-2}$) | Stress(KPa) |
|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1.3800 | 0.0000 | 0.0000 | 0.0007 |
| 1.7200 | 0.0000 | 0.0000 | 0.0009 |
| 2.2400 | 0.0000 | 0.0000 | 0.0011 |
| 2.4400 | 0.0001 | 0.0000 | 0.0012 |
| 2.7400 | 0.0001 | 0.0000 | 0.0014 |
| 3.0200 | 0.0001 | 0.0000 | 0.0015 |
| 3.2400 | 0.0001 | 0.0000 | 0.0017 |
| 3.4600 | 0.0001 | 0.0000 | 0.0018 |
| 3.5600 | 0.0001 | 0.0000 | 0.0018 |
| 3.7400 | 0.0001 | 0.0000 | 0.0019 |
| 3.9200 | 0.0001 | 0.0000 | 0.0020 |
| 4.0000 | 0.0001 | 0.0000 | 0.0020 |
| 4.0000 | 0.0001 | 0.0000 | 0.0020 |
| 4.2600 | 0.0001 | 0.0000 | 0.0022 |
| 4.4400 | 0.0002 | 0.0000 | 0.0023 |
| 4.5600 | 0.0002 | 0.0000 | 0.0023 |
| 4.7400 | 0.0002 | 0.0000 | 0.0024 |
| 5.0800 | 0.0002 | 0.0001 | 0.0026 |
| 5.1800 | 0.0002 | 0.0001 | 0.0026 |
| 5.3000 | 0.0002 | 0.0001 | 0.0027 |
| 5.5200 | 0.0002 | 0.0001 | 0.0028 |
| 5.5400 | 0.0002 | 0.0001 | 0.0028 |
| 5.8400 | 0.0002 | 0.0001 | 0.0030 |
| 5.9200 | 0.0002 | 0.0001 | 0.0030 |

**Fig. 11** An example of the display of the original test data

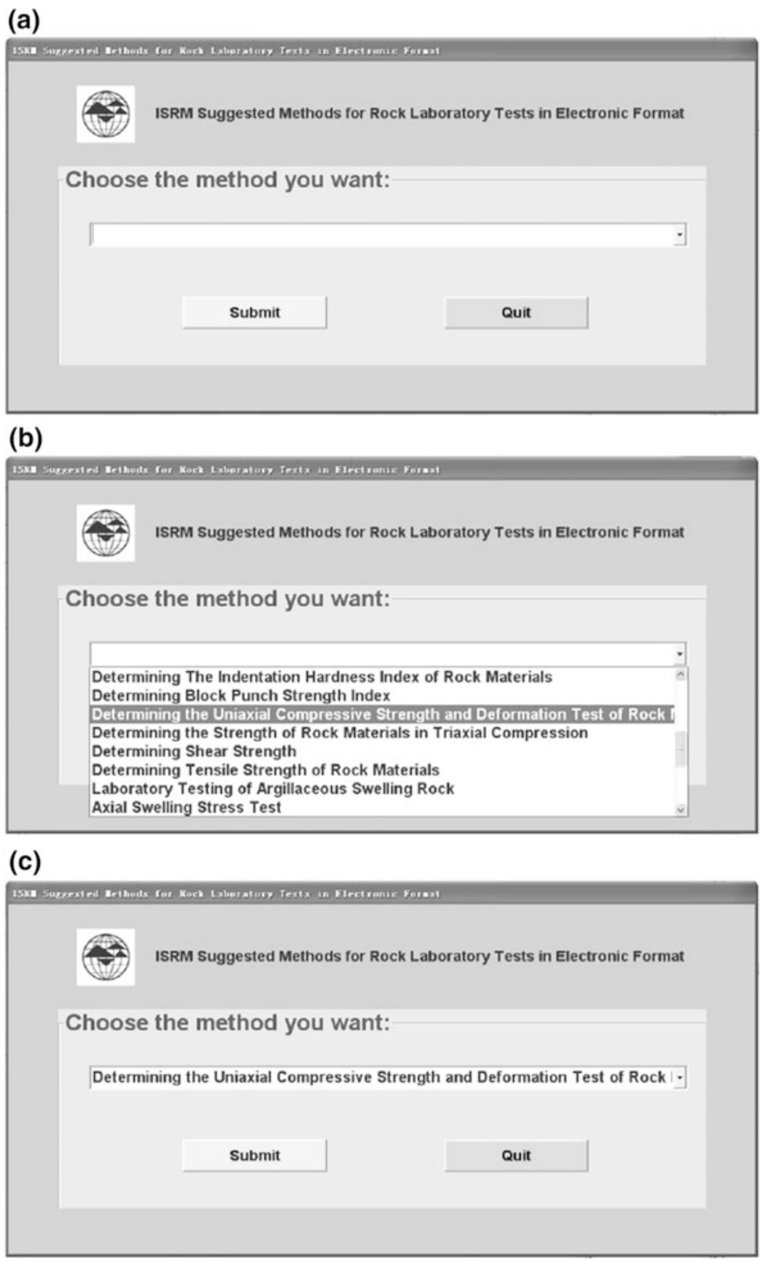



**Fig. 12** Interface for selection of the ISRM suggested methods

Step 4: Perform a standard process of electronic format.

1. Select input mode of the testing results by using input interface or uploading the test result file obtained by the software of the testing system. For the former, the testing results for each specimen are inputted one by one (see Fig. 5). For the latter, the data structure in the existing Excel file shall follow the standard format suggested in this method and matching the data structures (see Fig. 9a). Upload the photographs of failure mode and stress–strain curve of each specimen by clicking the corresponding boxes and files (see Figs. 6, 7).
2. Upload the original data file by clicking the box (see Fig. 8). The data structure in the existing file shall follow the standard format suggested in this method. For some testing systems, there may be some calculations—for example, for UCS testing, calculating stress and strain. The system provides this function (see Fig. 8).
3. Input the file name of the testing results given by the user with the format of "ProjectSite_Rocktype_FormationCode" (Fig. 14). For example, Longyou_sandstone_J3_UCS.xml for the testing results for sandstone

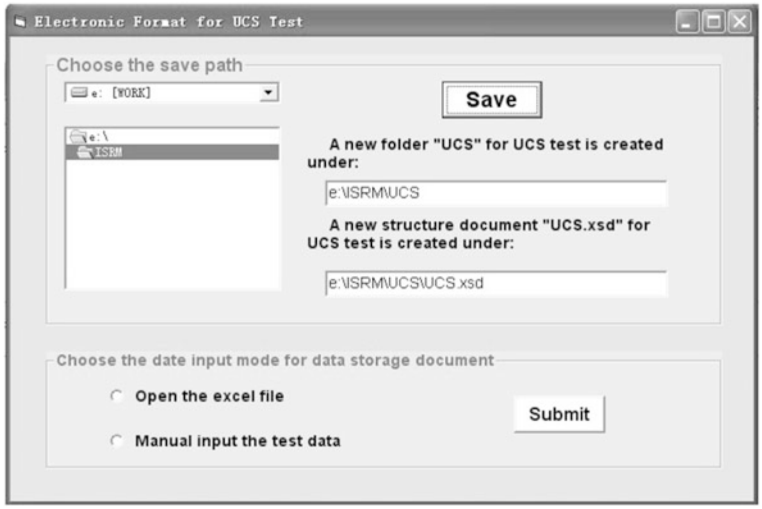



**Fig. 13** Interface for designating the storage path for the digitised files and creating the data structure document for testing

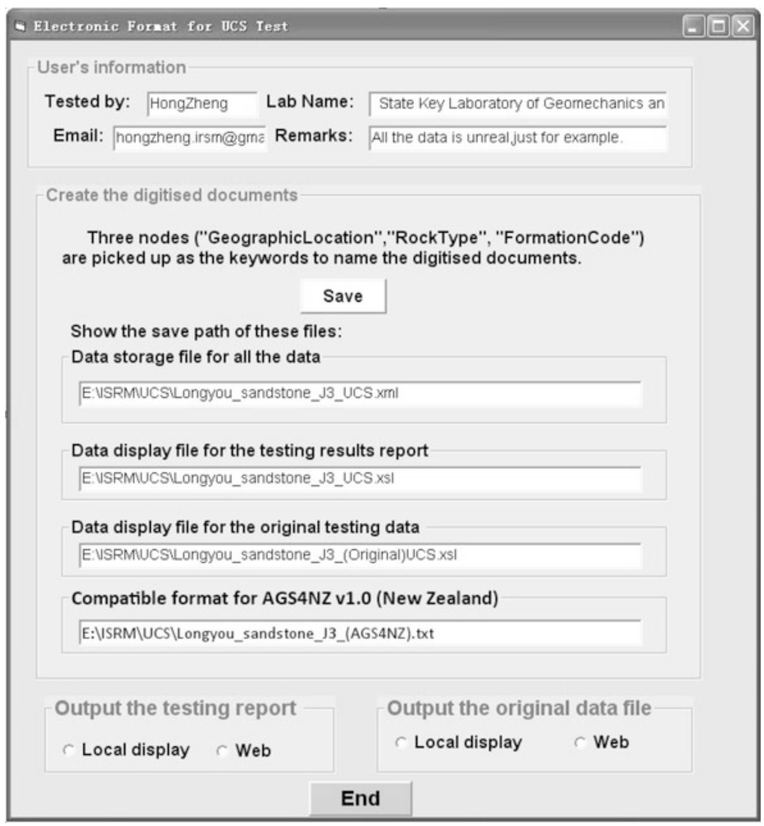



**Fig. 14** Input of file names and display type of the testing report and original data

of late Jurassic, J3, at Longyou Grottoes. All the testing results, plus the original testing data for each specimen, are stored as standard electronic format ".xml".

4. Input the data display file names for the testing results report and the original testing data (see Fig. 14), e.g., Longyou_sandstone-_J3_UCS.xsl for the testing results report and Longyou_sandstone_J3_ (Original)UCS.xsl for the original testing data.

Step 5: Output the testing report at the local computer by clicking the box "Local display" and at the Web by clicking the box "Web" (see Fig. 14). Output the original data file at the local computer by clicking the box "Local display" and at the Web by clicking the box "Web" (see Fig. 14). If the testing report and the original testing data are displayed in the local computer, they will be transferred into the excel format and displayed in this format (see Fig. 9a).

With the procedure outlined above, the users do not need to be experts in XML. The electronic formats for updated or new ISRM Suggested Methods for rock laboratory tests can be obtained by modifying the three documents mentioned above. The corresponding codes with interfaces can be developed accordingly.

## 5 Postscript

There may exist compatibility/uniformity problems between the proposed SM for reporting rock laboratory test data in electronic format with some existing formats for the electronic data transfer of site investigation data which some countries have or are adopting, for example, the AGS, MZGS BTA, AGS4NZ v1.0 (New Zealand), AGS(SG), etc. Nevertheless, the laboratory test data are just a part of the full site investigation data. In order to have the compatibility with the existing electronic transfer formats, e.g., AGS4NZ v1.0 (New Zealand), AGS(SG), and BCA, etc., the SM can also give the output of the testing results in the format used in these formats. As an example, it shows the additional format for the output for UCS in Appendix 5.4. Input the file name of the compatible format file for AGS4NZ v1.0 (New Zealand) (see Fig. 14), e.g., Longyou_sandstone-_J3_(AGS4NZ).txt. The ISRM will be further addressing this issue with the intention of producing a future document on the subject for other existing electronic transfer formats.

**Acknowledgments** The reviewers, especially Dr. Antonio Samaniego and Professors Hasan Gercek and Seokwon Jeon and Prof. Resat Ulusay, President of ISRM Commission on Testing Methods, Dr. Beck David, Dr. Yingxin Zhou, and Dr. Luis Lamas provided most helpful comments which enabled us to improve the manuscript. They are all appreciated.

## Appendix 1

The digital data structure for the "complex type" nodes including root nodes, parent nodes and middle nodes in Fig. 3

```
<xs:element name="Name of a root node, a parent node or a middle node">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="name of its secondary node 1"/>
                …
                <xs:element ref=" name of its secondary node n"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

For example, the root node "Test" can be defined as follows:

```
<xs:element name="Test">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="ApparatusInformation"/>
                <xs:element ref="RockInformation"/>
                <xs:element ref="SampleSource"/>
                <xs:element ref="Specimen" maxOccurs="unbounded"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
```

This part can be modified or extended according to changes of the "complex type" nodes in Fig. 3.

## Appendix 2

The digital data structure for the children nodes of "selection" type

```
<xs:element name="Name of a children node in selection type">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:enumeration value="Option 1"/>
                …
                <xs:enumeration value="Option n"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
```

For example, the children node "Failure Type" can be defined as follows

```
<xs:element name="FailureType">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:enumeration value="Shear"/>
                <xs:enumeration value="Axial Cleavage"/>
                <xs:enumeration value="Other"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
```

This part can be modified or extended according to the change of 'children nodes' in Fig. 3.

## Appendix 3

The digital data structure for the children node of "decimal" type

```
<xs:element name="Name of a children node in decimal type">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="?"/> → Restrict the maximal decimal digits
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
```

For example, the children node "Diameter" can be defined as follows

```
<xs:element name="Diameter">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="4"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
```

## Appendix 4

The digital data structure for the children nodes of "string" type

*<xs:element name="Name of a children node in string type" type="xs:string"/>*

For example, the children node "Apparatus Name" can be defined as follows
*<xs:element name="ApparatusName" type="xs:string"/>*

## Appendix 5

The data structure with its children nodes description and the structure of three digitised documents for determining the uniaxial compressive strength and deformability of rock material.

### 5.1 The Data Structure

According to the overall structure tree in Fig. 3, the data structure for UCS test is built up as follows by filtering nodes and defining the children nodes. In this structure tree, the children nodes of the middle node "Result Parameters" are defined as "Uniaxial Compressive Strength", "Young's modulus", "Poisson's ratio", "Modulus Method" and "Axial Level". For the middle node "Original Testing Data", its children nodes include "Time", "Pressure", "Axial Strain", "Lateral Strain" and "Stress".

### 5.2 Description of the Children Nodes in the Data Structure

See Table 2.

**Table 2** Description of the children nodes in the data structure

| Children node name | Suggested unit/type | Description | Example |
|---|---|---|---|
| Apparatus type | String | Type of testing machine | MTS 815.04 |
| Apparatus name | String | Name of testing machine | Materials testing system |
| Measuring span | String | Testing measuring span for force capacity, axial extensometer and circumferential extensometer | Axial force capacities 2,600 kN; Maximum travel range for axial extensometer: −4 to +4(mm); Maximum chordal travel range for circumferential extensometer: −2.5 to +12.5 mm |
| Calibration information | String | Calibration accuracy for force capacity, axial extensometer and circumferential extensometer | Axial force: 0.5 % of full scale range; maximum non-linearity for axial extensometer: 0.15 % of range; maximum non-linearity for circumferential extensometer: 0.30 % of range |
| Rock type | String | Rock type | Sandstone |

(continued)

**Table 2** (continued)

| Children node name | Suggested unit/type | | Description | Example |
|---|---|---|---|---|
| Apparatus type | | String | Type of testing machine | MTS 815.04 |
| Lithology | | String | Petrographic description of rocks, including the sample's texture, fracturing, alteration, matrix, degree of weathering, structure, etc. | Contains quartz, feldspar, mica and a small amount of accessory minerals and composited by chlorite, gypsum |
| Formation code | | String | Formation code in geologic age | J3 (Late Jurassic) |
| Weathering and alteration | | String | Describe the weathering and alteration condition of sample | Moderate weathering; no alternation |
| Project name | | String | Project title | Historic preservation for Longyou grottoes |
| Project site | | String | Location of the project | Longyou |
| X-coordinate | m | Decimal (fraction digits: 2) | X-coordinate to describe the geographic location of sampling site | 143.76 |
| Y-coordinate | m | Decimal (fraction digits: 2) | Y-coordinate to describe the geographic location of sampling site | 22.52 |
| Z-coordinate | m | Decimal (fraction digits: 2) | Depth to top of sample | 131.42 |
| Drill hole _ID | | String | Sample unique global identifier | 327-16A |
| DH position | m | Decimal (fraction digits: 2) | Down-hole position of drill hole | 24.55 |
| Orientation | | String | Sample orientation | North by West |
| Sample date | yyyy-mm-dd | Data | Sampling date | 2009-04-09 |
| Sampling method | | String (enumeration) | Sampling method | Drill hole sampling |
| Number of specimens | | Integer | The number of specimens in test | 5 |
| Specimen number | | Integer | Specimen number | 1 |
| Diameter | mm | Decimal (fraction digits: 1) | Specimen diameter | 50.0 |
| Height | mm | Decimal (fraction digits: 1) | Specimen height | 100.0 |
| Ends flatness | mm | Decimal (fraction digits: 2) | The flatness of ends of specimen | 0.02 |
| Sides flatness | mm | Decimal (fraction digits: 2) | The flatness of ends of specimen | 0.30 |
| Water content | % | Decimal (fraction digits: 1) | Water content of specimen tested | 2.1 |
| Saturation deg | % | Decimal (fraction digits: 1) | Saturation deg of specimen tested | 2.1 |
| Test duration | Hour | Decimal (fraction digits: 2) | Test duration | 0.15 |

(continued)

**Table 2** (continued)

| Children node name | Suggested unit/type | | Description | Example |
|---|---|---|---|---|
| Apparatus type | | String | Type of testing machine | MTS 815.04 |
| Test date | yyyy-mm-dd | Date | Test date | 2010-02-01 |
| Loading orientation | deg | Decimal (fraction digits: 1) | Orientation of the axis of loading with respect to specimen anisotropy | 90.0 |
| Loading rate | MPa/s | Decimal (fraction digits: 1) | Loading stress rate | 0.5 |
| Failure type | | String (enumeration) | Mode of failure | Shear |
| UCS | MPa | Decimal (fraction digits: 1) | Uniaxial compressive strength | 16.8 |
| Young's modulus | GPa | Decimal (fraction digits: 1) | Young's modulus | 36.2 |
| Poisson's ratio | | Decimal (fraction digits: 2) | Poisson's ratio | 0.33 |
| Modulus method | | String (enumeration) | Method of determining Young's modulus | Tangent modulus |
| Axial level | % | Decimal (fraction digits: 1) | Stress level at which modulus has been measured | 50 % |
| Time | s | Decimal (fraction digits: 1) | Time in original test data | 76.5 |
| Pressure | KN | Decimal (fraction digits: 4) | Pressure in original test data | 24.880201 |
| Axial strain | 10–5 mm/mm | Decimal (fraction digits: 4) | Axial strain in original test data | 2.0581676 |
| Lateral strain | 10–5 mm/mm | Decimal (fraction digits: 4) | Lateral strain in original test data | −4.610667 |
| Stress | MPa | Decimal (fraction digits: 4) | Stress in original test data | 1.678518 |
| Test method | | String | Test method | ISRM Suggested Method for the uniaxial compressive strength test of rock materials |
| Accrediting body | | String | Accrediting body and reference number (when appropriate) | UKAS 0000 |
| Checked by | | String | The checker of the tests | C. Einstein |
| Tested by | | String | The tester of the tests | Tom Yao |
| Lab name | | String | Name of testing laboratory/organisation | SKLGME |
| Email | | String | Email address of responsible person | hongzheng@gmail.com |
| Remark | | String | Remarks | Specimen tested outside required 2.5–3.0 diameter to length ratio |

## 5.3 Three Digitised Documents

1. The structure of the data structure document (*UCS.xsd*):
   The structure of the data structure document, UCS.xsd, can be generated by combining the format of Appendices 1, 2, 3 and 4 by following the structure of Appendix 5.1 above. It is described as follows.


```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<!--W3C Schema generated by XMLSpy v2005 rel. 3 U (http://www.altova.com)-->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified">
    <xs:annotation>
        <xs:documentation>XML Schema is for the Uniaxial Compressive Strength Test of
Rock Materials.
</xs:documentation>
</xs:annotation>
<xs:element name="ApparatusName" type="xs:string"/>
<xs:element name="ApparatusType" type="xs:string"/>
<xs:element name="MeasuringSpan" type="xs:string"/>
<xs:element name="CalibrationInformation" type="xs:string"/>
<xs:element name="RockType" type="xs:string"/>
<xs:element name="Lithology" type="xs:string"/>
<xs:element name="FormationCode" type="xs:string"/>
<xs:element name="WeatheringAndAlteration" type="xs:string"/>
<xs:element name="ProjectName" type="xs:string"/>
<xs:element name="ProjectSite" type="xs:string"/>
<xs:element name="SampleDate" type="xs:date"/>
<xs:element name="Orientation" type="xs:string"/>
<xs:element name="SamplingMethod" type="xs:string"/>
<xs:element name="TestDate" type="xs:date"/>
<xs:element name="FailurePhoto" type="xs:string"/>
<xs:element name="TestMethod" type="xs:string"/>
<xs:element name="AccreditingBody" type="xs:string"/>
<xs:element name="CheckedBy" type="xs:string"/>
<xs:element name="TestedBy" type="xs:string"/>
<xs:element name="LabName" type="xs:string"/>
<xs:element name="Email" type="xs:string"/>
<xs:element name="Remark" type="xs:string"/>
<xs:element name="SpecimenNo" type="xs:integer"/>
<xs:element name="NumberOfSpecimen" type="xs:integer"/>
<xs:element name="Drillhole_ID" type="xs:integer"/>
<xs:element name="DHPosition" type="xs:integer"/>
<xs:element name="ModulusMethod">
    <xs:simpleType>
        <xs:restriction base="xs:string">
            <xs:enumeration value="Tangent Modulus"/>
            <xs:enumeration value="Average Modulus"/>
            <xs:enumeration value="Secant Modulus"/>
        </xs:restriction>
```

```
        </xs:simpleType>
    </xs:element>
    <xs:element name="FailureType">
        <xs:simpleType>
            <xs:restriction base="xs:string">
                <xs:enumeration value="Shear"/>
                <xs:enumeration value="Axial Cleavage"/>
                <xs:enumeration value="Other"/>
            </xs:restriction>
        </xs:simpleType>
        </xs:element>
        <xs:element name="Xcoordinate">
            <xs:simpleType>
                <xs:restriction base="xs:decimal">
                    <xs:fractionDigits value="2"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="Ycoordinate">
            <xs:simpleType>
                <xs:restriction base="xs:decimal">
                    <xs:fractionDigits value="2"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="Zcoordinate">
            <xs:simpleType>
                <xs:restriction base="xs:decimal">
                    <xs:fractionDigits value="2"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="Time">
            <xs:simpleType>
                <xs:restriction base="xs:decimal">
                    <xs:fractionDigits value="1"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="EndsFlatness">
            <xs:simpleType>
                <xs:restriction base="xs:decimal">
                    <xs:fractionDigits value="2"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="SidesSmoothness">
            <xs:simpleType>
                <xs:restriction base="xs:decimal">
                    <xs:fractionDigits value="2"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="TestDuration">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="2"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="LoadingRate">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="1"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="AxialLevel">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="1"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="LoadingOrientation">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="1"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="WaterContent">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="1"/>
            </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="SaturationDegree">
        <xs:simpleType>
            <xs:restriction base="xs:decimal">
                <xs:fractionDigits value="1"/>
            </xs:restriction>
        </xs:simpleType>
```

```
</xs:element>
<xs:element name="Diameter">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="1"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="Height">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="1"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="UCS">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="1"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="YoungsModulus">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="1"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="PoissonsRatio">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="2"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="Pressure">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="4"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="AxialStrain">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="4"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="LateralStrain">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="4"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="Stress">
    <xs:simpleType>
        <xs:restriction base="xs:decimal">
            <xs:fractionDigits value="4"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="GeographicLocation">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Xcoordinate" minOccurs="0"/>
            <xs:element ref="Ycoordinate" minOccurs="0"/>
            <xs:element ref="Zcoordinate" minOccurs="0"/>
            <xs:element ref="Drillhole_ID" minOccurs="0"/>
            <xs:element ref="DHPosition" minOccurs="0"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="FailurePattern">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="FailureType"/>
            <xs:element ref="FailurePhoto"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="SpecimenSize">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Diameter"/>
            <xs:element ref="Height"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="ApparatusInformation">
<xs:complexType>
    <xs:sequence>
```

```
                <xs:element ref="ApparatusType"/>
                <xs:element ref="ApparatusName"/>
                <xs:element ref="MeasuringSpan"/>
                <xs:element ref="CalibrationInformation"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="RockInformation">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="RockType"/>
                <xs:element ref="Lithology"/>
                <xs:element ref="FormationCode"/>
                <xs:element ref="WeatheringAndAlteration"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="SampleSource">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="ProjectName"/>
                <xs:element ref="ProjectSite"/>
                <xs:element ref="GeographicLocation"/>
                <xs:element ref="Orientation"/>
                <xs:element ref="SampleDate"/>
                <xs:element ref="SamplingMethod"/>
                <xs:element ref="NumberOfSpecimen"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="ResultParameters">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="UCS"/>
                <xs:element ref="YoungsModulus"/>
                <xs:element ref="PoissonsRatio"/>
                <xs:element ref="ModulusMethod"/>
                <xs:element ref="AxialLevel"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="OriginalTestData">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Time"/>
            <xs:element ref="Pressure"/>
            <xs:element ref="AxialStrain"/>
                <xs:element ref="LateralStrain"/>
                <xs:element ref="Stress"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="Specimen">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="SpecimenNo"/>
                <xs:element ref="SpecimenSize"/>
                <xs:element ref="EndsFlatness"/>
                <xs:element ref="SidesSmoothness"/>
                <xs:element ref="WaterContent"/>
                <xs:element ref="SaturationDegree"/>
                <xs:element ref="TestDuration"/>
                <xs:element ref="TestDate"/>
                <xs:element ref="LoadingOrientation"/>
                <xs:element ref="LoadingRate"/>
                <xs:element ref="FailurePattern"/>
                <xs:element ref="ResultParameters"/>
                <xs:element ref="OriginalTestData" minOccurs="0"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="Test">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="ApparatusInformation"/>
                <xs:element ref="RockInformation"/>
                <xs:element ref="SampleSource"/>
                <xs:element ref="Specimen" maxOccurs="unbounded"/>
                <xs:element ref="TestMethod"/>
                <xs:element ref="AccreditingBody"/>
                <xs:element ref="CheckedBy"/>
                <xs:element ref="TestedBy"/>
                <xs:element ref="LabName"/>
                <xs:element ref="Email"/>
                <xs:element ref="Remark"/>
            </xs:sequence>
            </xs:complexType>
        </xs:element>
    </xs:schema>
```

(2) The data storage document for UCS (UCS.xml)

Generally, according to the sequence of the children nodes from top to down shown in Fig. 15, the data storage document is structured as follows

```
<Name of root node>
    <Name of parent node 1>
        <Name of middle node 1>
          <Name of children node 1> Value of children node <Name of children node 1 >
            ...
          <Name of children node m> Value of children node <Name of children node m>
        </Name of middle node 1>
        ...
        <Name of middle node n>
          <Name of children node 1> Value of children node <Name of children node 1 >
            ...
          <Name of children node p> Value of children node <Name of children node p>
        </Name of middle node n>
    </Name of parent node 1>
</Name of root node>
```

Accordingly, the data storage document for UCS of a specimen of Longyou Sandstone is defined as:


```
<?xml version="1.0" standalone="yes"?>
<?xml-stylesheet type="text/xsl" href="Longyou_sandstone_J3_UCS.xsl"?>
<Test>
    <ApparatusInformation>
        <ApparatusType>MTS 815.04</ApparatusType>
        <ApparatusName>Materials testing system</ApparatusName>
        <MeasuringSpan>Axial force capacities 2600 kN; Maximum travel range for axial
extensometer:-4 to +4(mm); Maximum chordal travel range for circumferential extensometer:
-2.5 to +12.5mm</MeasuringSpan>
        <CalibrationInformation>Axial force:0.5% of full scale range; Maximum non-linearity
for axial extensometer: 0.15% of range; Maximum non-linearity for circumferential extensometer:
0.30% of range</CalibrationInformation>
    </ApparatusInformation>
    <RockInformation>
        <RockType>sandstone</RockType>
        <Lithology>Contains quartz, feldspar, mica and a small amount of accessory minerals
and composited by chlorite, gypsum.</Lithology>
        <FormationCode>J3</FormationCode>
        <WeatheringAndAlteration>moderate weathering;no
alternation</WeatheringAndAlteration>
    </RockInformation>
    <SampleSource>
        <ProjectName>Historic preservation for Longyou grottoes</ProjectName>
        <ProjectSite>Longyou</ProjectSite>
        <GeographicLocation>
```

```
        <Xcoordinate>143.76</Xcoordinate>
        <Ycoordinate>22.52</Ycoordinate>
        <Zcoordinate>131.42</Zcoordinate>
    </GeographicLocation>
    <Orientation>North by West </Orientation>
    <SampleDate>2010-01-01</SampleDate>
    <SamplingMethod>Drill hole sampling</SamplingMethod>
    <NumberOfSpecimen>5</NumberOfSpecimen>
</SampleSource>
<Specimen>
    <SpecimenNo>1</SpecimenNo>
    <SpecimenSize>
        <Diameter>50.0</Diameter>
        <Height>100.0</Height>
    </SpecimenSize>
    <EndsFlatness>0.02</EndsFlatness>
    <SidesSmoothness>0.30</SidesSmoothness>
    <WaterContent>2.1</WaterContent>
    <SaturationDegree>2.1</SaturationDegree>
    <TestDuration>0.15</TestDuration>
    <TestDate>2010-02-01</TestDate>
    <LoadingOrientation>90.0</LoadingOrientation>
    <LoadingRate>0.5</LoadingRate>
    <FailurePattern>
        <FailureType>Shear</FailureType>
    </FailurePattern>
    <ResultParameters>
        <UCS>17.5</UCS>
        <YoungsModulus>3614.1</YoungsModulus>
        <PoissonsRatio>0.32</PoissonsRatio>
        <ModulusMethod>Tangent Modulus</ModulusMethod>
        <AxialLevel>50.0</AxialLevel>
   </ResultParameters>
    <OriginalTestData>
        <Pressure>0.0000</Pressure>
        <AxialStrain>0.0000</AxialStrain>
        <LateralStrain>0.0000</LateralStrain>
        <Stress>0.0000</Stress>
    </OriginalTestData>
    <OriginalTestData>
        <Pressure>1.3800</Pressure>
        <AxialStrain>0.0020</AxialStrain>
        <LateralStrain>0.0005</LateralStrain>
        <Stress>4392.6800</Stress>
    </OriginalTestData>
    <OriginalTestData>
        <Pressure>1.7200</Pressure>
        <AxialStrain>0.0030</AxialStrain>
        <LateralStrain>0.0004</LateralStrain>
        <Stress>5474.9350</Stress>
    </OriginalTestData>
    <OriginalTestData>
        <Pressure>2.2400</Pressure>
        <AxialStrain>0.0040</AxialStrain>
        <LateralStrain>0.0005</LateralStrain>
        <Stress>7130.1470</Stress>
    </OriginalTestData>
    … …
</Specimen>
<Specimen>
    <SpecimenNo>2</SpecimenNo>
    <SpecimenSize>
        <Diameter>50.0</Diameter>
        <Height>100.0</Height>
    </SpecimenSize>
    <EndsFlatness>0.02</EndsFlatness>
    <SidesSmoothness>0.30</SidesSmoothness>
    <WaterContent>2.1</WaterContent>
    <SaturationDegree>2.1</SaturationDegree>
    <TestDuration>0.15</TestDuration>
    <TestDate>2010-02-02</TestDate>
    <LoadingOrientation>90.0</LoadingOrientation>
    <LoadingRate>0.5</LoadingRate>
    <FailurePattern>
        <FailureType>Shear</FailureType>
    </FailurePattern>
    <ResultParameters>
        <UCS>13.3</UCS>
        <YoungsModulus>3806.1</YoungsModulus>
        <PoissonsRatio>0.37</PoissonsRatio>
        <ModulusMethod>Tangent Modulus</ModulusMethod>
        <AxialLevel>50.0</AxialLevel>
    </ResultParameters>
</Specimen>
<Specimen>
    <SpecimenNo>3</SpecimenNo>
    <SpecimenSize>
        <Diameter>50.0</Diameter>
        <Height>100.0</Height>
    </SpecimenSize>
    <EndsFlatness>0.02</EndsFlatness>
    <SidesSmoothness>0.30</SidesSmoothness>
    <WaterContent>2.1</WaterContent>
    <SaturationDegree>2.1</SaturationDegree>
```

<TestDuration>0.15</TestDuration>
<TestDate>2010-02-03</TestDate>
<LoadingOrientation>90.0</LoadingOrientation>
<LoadingRate>0.5</LoadingRate>
<FailurePattern>
<FailureType>Shear</FailureType>
</FailurePattern>
<ResultParameters>
<UCS>18.7</UCS>
<YoungsModulus>3428.5</YoungsModulus>
<PoissonsRatio>0.33</PoissonsRatio>
<ModulusMethod>Tangent Modulus</ModulusMethod>
<AxialLevel>50.0</AxialLevel>
</ResultParameters>
</Specimen>
<Specimen>
<SpecimenNo>4</SpecimenNo>
<SpecimenSize>
<Diameter>50.0</Diameter>
<Height>100.0</Height>
</SpecimenSize>
<EndsFlatness>0.02</EndsFlatness>
<SidesSmoothness>0.30</SidesSmoothness>
<WaterContent>2.1</WaterContent>
<SaturationDegree>2.1</SaturationDegree>
<TestDuration>0.15</TestDuration>
<TestDate>2010-02-04</TestDate>
<LoadingOrientation>90.0</LoadingOrientation>
<LoadingRate>0.5</LoadingRate>
<FailurePattern>
<FailureType>Shear</FailureType>
</FailurePattern>
<ResultParameters>
<UCS>13.8</UCS>
<YoungsModulus>2964.9</YoungsModulus>
<PoissonsRatio>0.31</PoissonsRatio>
<ModulusMethod>Tangent Modulus</ModulusMethod>
<AxialLevel>50.0</AxialLevel>
</ResultParameters>
</Specimen>
<Specimen>
<SpecimenNo>5</SpecimenNo>
<SpecimenSize>
<Diameter>50.0</Diameter>
<Height>100.0</Height>
</SpecimenSize>
<EndsFlatness>0.02</EndsFlatness>

```
            <SidesSmoothness>0.30</SidesSmoothness>
            <WaterContent>2.1</WaterContent>
            <SaturationDegree>2.1</SaturationDegree>
            <TestDuration>0.15</TestDuration>
            <TestDate>2010-02-05</TestDate>
            <LoadingOrientation>90.0</LoadingOrientation>
            <LoadingRate>0.5</LoadingRate>
            <FailurePattern>
                <FailureType>Shear</FailureType>
            </FailurePattern>
            <ResultParameters>
                <UCS>16.8</UCS>
                <YoungsModulus>2861.4</YoungsModulus>
                <PoissonsRatio>0.29</PoissonsRatio>
                <ModulusMethod>Tangent Modulus</ModulusMethod>
                <AxialLevel>50.0</AxialLevel>
            </ResultParameters>
        </Specimen>
        <TestMethod>ISRM:Suggested Method for the Uniaxial Compressive Strength Test of Rock
Materials</TestMethod>
        <AccreditingBody>UKAS 0000</AccreditingBody>
        <CheckedBy>Tom</CheckedBy>
        <TestedBy>HongZheng</TestedBy>
        <LabName>State Key Laboratory of Geomechanics and Geotechnical
Engineering</LabName>
        <Email>hongzheng.irsm@gmail.com</Email>
        <Remark>All the data is unreal,just for example.</Remark>
</Test>
```


(3) The data display document for UCS (UCS.xsl):

The data display document is structured as the format of the tabling of the testing results including pictures. According to the sequence of the children nodes from top to bottom shown in Fig. 15, the data display document is arranged tabling row by row. For each row of the data, it is structured as follows

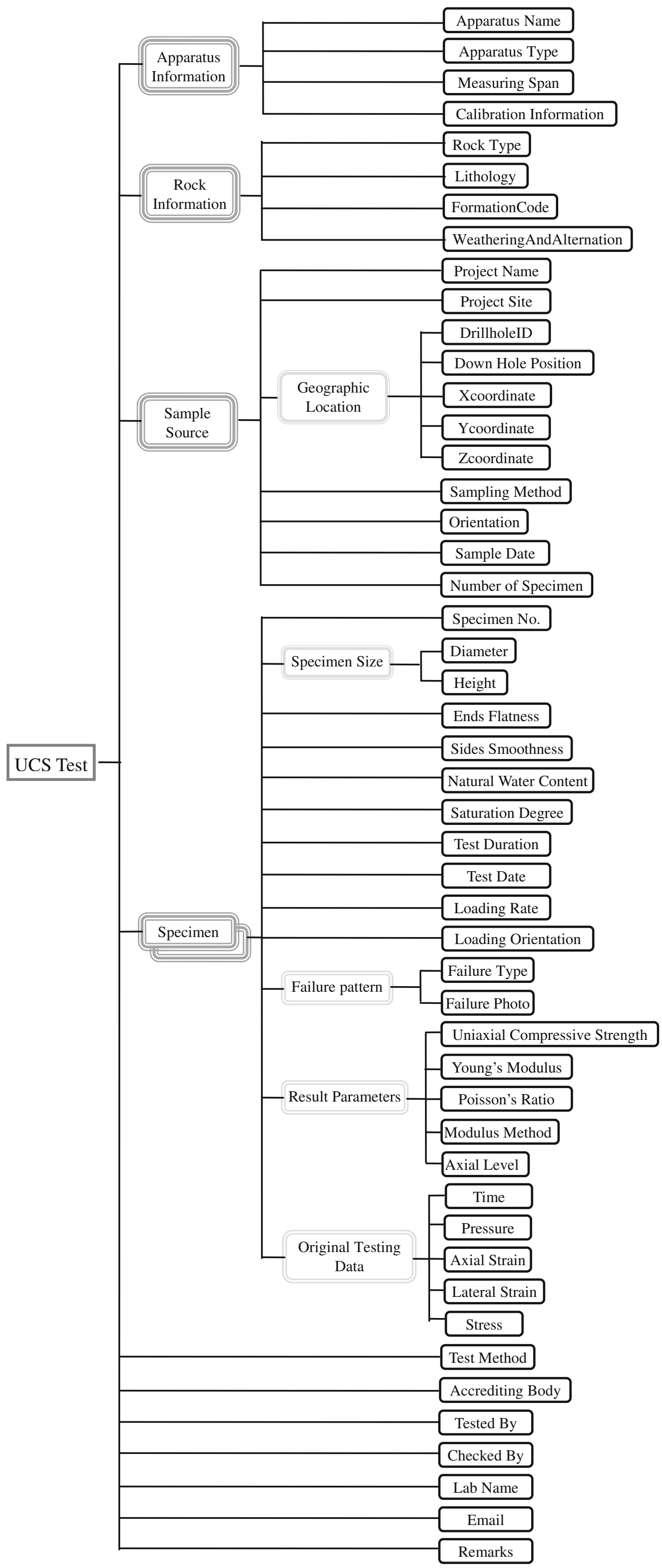



**Fig. 15** The data structure for determining the uniaxial compressive strength and deformability of rock material

```
<tr>
<td colspan="length" style=" Font format specification "> Name of children node i:</td>
<td colspan="length"><xsl:value-of select=Value of the children node i/></td>
...
<td colspan="length" style=" Font format specification "> Name of children node j:</td>
<td colspan="length"><xsl:value-of select= Value of children node j /></td>
</tr>
```

The format for display two pictures is written by

```
<tr>
<td width="value of width" bgcolor="value of back ground color">
<center>          //picture is located at the center
</center>
</td>
<td width="value of width">
<center>
<img src="file name of picture"/>
</center>
</td>
<td width="value of width">
<center>
<img src="file name of picture 1"/>
</center>
</td>
</tr>
```

The data display document for UCS tests in UCS.xsl is accordingly described as follows

```
<?xml version="1.0" encoding="GB2312"?>
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
<xsl:template match="/">
<html>
<head style="font-family: arial">Format For Uniaxial Compressive Test of Rock Materials
</head>
<body style="font-family: arial">
<center>
<H1>The Uniaxial Compressive Test Of Rock Materials</H1>
</center>
<table width="100%" border="1" bgcolor="#ffffcc">
<tr>
<td colspan="50" style="font-weight: bold; color:#FF9900; font-size: 22"><center>Apparatus
Information</center></td>
```

```
</tr>
<tr>
<td colspan="8" style="font-weight: bold; color:#FF9900">Apparatus Name:</td>
<td colspan="22"><xsl:value-of select="Test/ApparatusInformation/ApparatusName"/></td>
<td colspan="6" style="font-weight: bold; color:#FF9900">Apparatus Type:</td>
<td colspan="14"><xsl:value-of select="Test/ApparatusInformation/ApparatusType"/></td>
</tr>
<tr>
<td colspan="8" style="font-weight: bold; color:#FF9900">Measuring Span:</td>
<td colspan="42"><xsl:value-of select="Test/ApparatusInformation/MeasuringSpan"/></td>
</tr>
<tr>
<td colspan="8" style="font-weight: bold; color:#FF9900">CalibrationInformation:</td>
<td colspan="42"><xsl:value-of
select="Test/ApparatusInformation/CalibrationInformation"/></td>
</tr>
</table>
<table width="100%" border="1" bgcolor="#ffccff">
<tr>
<td colspan="50" style="font-weight: bold; color:#cc0099; font-size: 22"><center>Rock
Information</center></td>
</tr>
<tr>
<td colspan="8" style="font-weight: bold; color:#cc0099">Rock Type:</td>
<td colspan="8"><xsl:value-of select="Test/RockInformation/RockType"/></td>
<td colspan="12" style="font-weight: bold; color:#cc0099">Lithology:</td>
<td colspan="22"><xsl:value-of select="Test/RockInformation/Lithology"/></td>
</tr>
<tr>
<td colspan="8" style="font-weight: bold; color:#cc0099">Formation Code:</td>
<td colspan="8"><xsl:value-of select="Test/RockInformation/FormationCode"/></td>
<td colspan="12" style="font-weight: bold; color:#cc0099">Alteration and Weathering:</td>
<td colspan="22"><xsl:value-of
select="Test/RockInformation/WeatheringAndAlteration"/></td>
</tr>
</table>
<table width="100%" border="1" bgcolor="#E0FFFF">
<tr>
<td colspan="100" style="font-weight: bold; color:#006600; font-size: 22"><center>Sample
Source</center></td>
</tr>
<tr>
<td colspan="5" style="font-weight: bold; color:#006600">Project Site:</td>
<td colspan="10"><xsl:value-of select="Test/SampleSource/ProjectSite"/></td>
<td colspan="85" style="font-weight: bold; color:#006600"
bgcolor="#CCFFCC"><center>Geographic Location</center></td>
</tr>
```

```
<tr>
<td colspan="5" style="font-weight: bold; color:#006600">Project Name:</td>
<td colspan="10"><xsl:value-of select="Test/SampleSource/ProjectName"/></td>
<td colspan="5" style="font-weight: bold; color:#006600"
bgcolor="#CCFFCC">X-coordinate(m):</td>
<td colspan="5" bgcolor="#CCFFCC"><xsl:value-of
select="Test/SampleSource/GeographicLocation/Xcoordinate"/></td>
<td colspan="5" style="font-weight: bold; color:#006600"
bgcolor="#CCFFCC">Y-coordinate(m):</td>
<td colspan="5" bgcolor="#CCFFCC"><xsl:value-of
select="Test/SampleSource/GeographicLocation/Ycoordinate"/></td>
<td colspan="5" style="font-weight: bold; color:#006600"
bgcolor="#CCFFCC">Z-coordinate(m):</td>
<td colspan="5" bgcolor="#CCFFCC"><xsl:value-of
select="Test/SampleSource/GeographicLocation/Zcoordinate"/></td>
<td colspan="5" style="font-weight: bold; color:#006600"
bgcolor="#CCFFCC">Drillhole_ID:</td>
<td colspan="23" bgcolor="#CCFFCC"><xsl:value-of
select="Test/SampleSource/GeographicLocation/Drillhole_ID"/></td>
<td colspan="5" style="font-weight: bold; color:#006600"
bgcolor="#CCFFCC">DHPosition(m):</td>
<td colspan="23" bgcolor="#CCFFCC"><xsl:value-of
select="Test/SampleSource/GeographicLocation/DHPosition"/></td>
</tr>
<tr>
<td colspan="5" style="font-weight: bold; color:#006600">Orientation:</td>
<td colspan="10"><xsl:value-of select="Test/SampleSource/Orientation"/></td>
<td colspan="10" style="font-weight: bold; color:#006600">Number of Specimen:</td>
<td colspan="5"><xsl:value-of select="Test/SampleSource/NumberOfSpecimen"/></td>
<td colspan="10" style="font-weight: bold; color:#006600">Sample Date:</td>
<td colspan="10"><xsl:value-of select="Test/SampleSource/SampleDate"/></td>
<td colspan="10" style="font-weight: bold; color:#006600">Sampling Method:</td>
<td colspan="40"><xsl:value-of select="Test/SampleSource/SamplingMethod"/></td>
</tr>
<tr>

<td colspan="5" style="font-weight: bold; color:#006600">Remark:</td>
<td colspan="95"><xsl:value-of select="Test/Remark"/></td>
</tr>
</table>
<table width="100%" border="1">
<tr>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Specimen
No</center></td>
<td colspan="4" style="font-weight: bold; color:#330099"><center>Specimen
Size</center></td>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Ends
```

```
Flatness (mm)</center></td>
<td rowspan="2" colspan="4" style="font-weight: bold; color:#330099"><center>Sides
Smoothness (mm)</center></td>
<td rowspan="2" colspan="2" style="font-weight: bold; color:#330099"><center>Water
Content(%)</center></td>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Saturation
Degree(%)</center></td>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Test
Duration(Hour)</center></td>
<td rowspan="2" colspan="4" style="font-weight: bold;
color:#330099"><center>TestDate</center></td>
<td rowspan="2" colspan="4" style="font-weight: bold; color:#330099"><center>Loading
Orientation(deg)</center></td>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Loading
Rate(MPa/s)</center></td>
<td rowspan="2" colspan="2" style="font-weight: bold; color:#330099"><center>Failure
Pattern</center></td>
<td rowspan="2" colspan="2" style="font-weight: bold;
color:#330099"><center>UCS(MPa)</center></td>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Young's
Modulus (GPa)</center></td>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Poisson's
Ratio</center></td>
<td rowspan="2" colspan="3" style="font-weight: bold; color:#330099"><center>Type of
modulus of elasticity</center></td>
<td rowspan="2" colspan="4" style="font-weight: bold; color:#330099"><center>Axial stress
level to determine the modulus(%)</center></td>
</tr>
<tr>
<td colspan="2" style="font-weight: bold;
color:#330099"><center>Diameter(mm)</center></td>
<td colspan="2" style="font-weight: bold;
color:#330099"><center>Height(mm)</center></td>
</tr>
<xsl:for-each select="Test/Specimen">
<tr>
<td colspan="3"><center><xsl:value-of select="SpecimenNo"/></center></td>
<td colspan="2"><center><xsl:value-of select="SpecimenSize/Diameter"/></center></td>
<td colspan="2"><center><xsl:value-of select="SpecimenSize/Height"/></center></td>
<td colspan="3"><center><xsl:value-of select="EndsFlatness"/></center></td>
<td colspan="4"><center><xsl:value-of select="SidesSmoothness"/></center></td>
<td colspan="2"><center><xsl:value-of select="WaterContent"/></center></td>
<td colspan="3"><center><xsl:value-of select="SaturationDegree"/></center></td>
<td colspan="3"><center><xsl:value-of select="TestDuration"/></center></td>
<td colspan="4"><center><xsl:value-of select="TestDate"/></center></td>
<td colspan="4"><center><xsl:value-of select="LoadingOrientation"/></center></td>
<td colspan="3"><center><xsl:value-of select="LoadingRate"/></center></td>
```

```
<td colspan="2"><center><xsl:value-of select="FailurePattern"/></center></td>
<td colspan="2"><center><xsl:value-of select="ResultParameters/UCS"/></center></td>
<td colspan="3"><center><xsl:value-of
select="ResultParameters/YoungsModulus"/></center></td>
<td colspan="3"><center><xsl:value-of
select="ResultParameters/PoissonsRatio"/></center></td>
<td colspan="3"><center><xsl:value-of
select="ResultParameters/ModulusMethod"/></center></td>
<td colspan="4"><center><xsl:value-of
select="ResultParameters/AxialLevel"/></center></td>
</tr>
</xsl:for-each>
</table>
<table width="100%" border="1">
<tr>
<td colspan="10" style="font-weight: bold; color:#b22222">Tested By:</td>
<td colspan="23"><xsl:value-of select="Test/TestedBy"/></td>
<td colspan="10" style="font-weight: bold; color:#b22222">Lab Name:</td>
<td colspan="23"><xsl:value-of select="Test/LabName"/></td>
<td colspan="10" style="font-weight: bold; color:#b22222">Email:</td>
<td colspan="23"><xsl:value-of select="Test/Email"/></td>
</tr>
<tr>
<td colspan="10" style="font-weight: bold; color:#b22222">Test Method:</td>
<td colspan="23"><xsl:value-of select="Test/TestMethod"/></td>
<td colspan="10" style="font-weight: bold; color:#b22222">Accrediting Body:</td>
<td colspan="23"><xsl:value-of select="Test/AccreditingBody"/></td>
<td colspan="10" style="font-weight: bold; color:#b22222">Checked By:</td>
<td colspan="23"><xsl:value-of select="Test/CheckedBy"/></td>
</tr>
</table>
<table width="100%" border="1">
<tr>
<td style="font-weight: bold; color:#330099"><center>Specimen No</center></td>
<td style="font-weight: bold; color:#330099"><center>Failure Picture</center></td>
<td style="font-weight: bold; color:#330099"><center>Stress-Strain Curve</center></td>
</tr>
<tr>
<td width="10%">
<center>
</center>
</td>
<td width="45%">
<center>
<img src="specimen1.JPG"/>"
</center>
</td>
```

```
<td width="45%">
<center>
<img src="curve1.JPG"/></center>
</td>
</tr>
<tr><td width="10%">
<center>
</center>
</td>
<td width="45%">
<center>
<img src="specimen2.JPG"/>"
</center>
</td>
<td width="45%">
<center>
<img src="curve2.JPG"/></center>
</td>
</tr>
<tr><td width="10%">
<center>
</center>
</td>
<td width="45%">
<center>
<img src="specimen3.JPG"/>
</center>
</td>
<td width="45%">
<center>
<img src="curve3.JPG"/></center>
</td>
</tr>
<tr><td width="10%">
<center>
</center>
</td>
<td width="45%">
<center>
<img src="specimen4.JPG"/>
</center>
</td>
<td width="45%">
<center>
<img src="curve4.JPG"/></center>
</td>
</tr>
```

```
<tr><td width="10%">
<center>
</center>
</td>
<td width="45%">
<center>
<img src="specimen5.JPG"/>
</center>
</td>
<td width="45%">
<center>
<img src="curve5.JPG"/></center>
</td>
</tr>
</table>
</body>
</html>
</xsl:template>
</xsl:stylesheet>
```

## 5.4 The Compatibility of the Output Format in the SM with AGS4NZ v1.0 (New Zealand)

In order to have the compatibility with the AGS4NZ v1.0 (New Zealand), the SM can also give the output of the testing results in the format used in the AGS4NZ v1.0 (New Zealand). It is showing as follows:

For The Group “PROJ”, the data output format is as follows

```
“GROUP”,”PROJ”
“HEADING”,”PROJ_NAME”,”PROJ_LOC”
“UNIT”,””,””
“TYPE”,”X”,”X”
“DATA”,”Historic preservation for Longyou grottoes”,”Longyou”
```

For The Group “RUCS”, the data output format is as follows

```
“GROUP”,”RUCS”
“HEADING”,”LOCA_ID ”,”SAMP_TOP ”,”SAMP_TYPE ”,”SPEC_REF”,”SPEC_DESC”,”SPEC_PREP”,”RU
CS_SDIA”,”RUCS_LEN”,”RUCS_MC”,”RUCS_DURN”,”RUCS_STRA”,”RUCS_UCS ”,”RUCS_MODE”,”RU
CS_E”,”RUCS_MU”,”RUCS_ESTR”,”RUCS_ETYP”,”RUCS_MACH”,”RUCS_REM”,”RUCS_METH”,”RUCS
_LAB”,”RUCS_CRED”,”TEST_STAT”
“UNIT”,”ID”,”2DP”,”PA”,”ID”,”X”,”X”,”1DP”,”1DP”,”1DP”,”T”,”1DP”,”3FS”,”X”,”3FS”,”2DP”,”X”,”PA”,”X
”,”X”,”X”,”X”,”X”,”X”
“DATA”,”327-16A”,”24.55”,”U”,”1”,”sandstone”,”Prepared according to client
instructions”,”50.0”,”100.0”,”2.1”,”09:00”,”0.5”,”17.5”,”Shear”,”3614.1”,”0.32”,”0-50%UCS,
8.75MPa”,”Tangent”,”MTS 815.04”,”All the data is unreal, just for example.”,”ISRM: Suggested Method for the
Uniaxial Compressive Strength Test of Rock Materials”,”SKLGT”,”UKAS 0000”,”checked”
```

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