

# Integration of contract documents using hyperlinks

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Information items in contract documents are heavily interrelated. Besides, contract documents information is related to codes, standards, and manufacturers' catalogs and instructions, because of reference and proprietary specifications use. On the other hand, construction planning and cost estimating preparations depend heavily on contract documents information. Therefore, use of the contract documents becomes a hard task. This paper proposes hyperlinks application to computerized contract documents as an integration tool in a manner that does not cancel the texts linearity. The proposal includes integration of the related items of the computerized contract documents, besides integration of these documents to the referenced information, illustrative video and computer graphics, planning activity list, and cost inquiries. It aims to facilitate and accelerate integration of the contract documents, in addition to provide the users with a super softcopy accompanying the hardcopy.

رغم شيوع استخدام الحاسب في إعداد مستندات عقد المقاوله، فإن إعداد هذه المستندات يستهدف إنتاج نسخها الورقية. وتؤثر خصائص الورق كوسيط توثيقي سلباً على كَم الوقت والجهد اللازمين للتقل بين كل من أزواج المعلومات ذات الصلة لتلافي التعارض و التكرار و أثناء إعداد النسخة الورقية وكذلك عند استعمالها. و يتعاطم ذلك التأثير السلبي نتيجة لكثافة المعلومات ذات الصلة في مستندات عقد المقاوله وتلك الكائنه في مواصفات المشروع و مراجعها (المواصفات القياسية، الكودات، و كتالوجات المصنّعين) و التي تشكل جزءاً من مواصفات المشروع بالإحالة إليها. هذا علاوة على فقد مستخدم مستندات العقد الورقية لإمكانية استعمالها مباشرة في أداء أنشطة التخطيط و تقدير التكاليف باستخدام الحاسب. لذا فإن خصائص السورق تؤثر بداية بالسلب على جودة مستندات العقد بسبب محدودية المدة المتاحة عادة لإعدادها و على واقعية العطاءات بسبب محدودية المدة المتاحة عادة للمقاولين للتقدم بعطاءاتهم، هذا علاوة على الوقت و الجهد المهدرين عند استعمال مستندات العقد خلال مدة تنفيذ المشروع. من ناحية أخرى، فإن خصائص الحاسب كوسيط توثيقي قد استغلت بنجاح في العديد من التطبيقات وذلك بأعداد المستندات المقروءة على شاشة الحاسب باستخدام أسلوب النص الفائق (hypertext) و الوسائط المتعددة (hypermedia). حيث يتم الجمع بين أزواج المعلومات ذات الصلة في تلك المستندات بواسطة "روابط المعلومات الإلكترونية" (hyperlinks) و التي تُمكن مستخدم الوثيقة من القفز الفوري بينها باستخدام فأرة (mouse). و تتميز تلك المستندات بأن النصوص بها غير خطية (غير متسلسلة بالشكل المؤلف في المستندات الورقية) لذا فهي غير قابلة للطبع. و عليه، اقترح الباحثون الاستفادة من خاصية روابط المعلومات الإلكترونية - المتاحة في برامج الحاسب الأكثر استخداماً في إعداد مستندات عقد المقاوله - لإكساب النسخة الحاسوبية (softcopy) لمستندات عقد المقاوله مزايا مستندات النص الفائق و الوسائط المتعددة مع عدم المساس بإمكانية طباعتها مباشرة لإصدار النسخة الورقية. ويشمل الاقتراح استخدام خاصية روابط المعلومات الإلكترونية و خاصية طبقات الرسم في جمع: (١) الإشارات المرجعية في مستندات العقد النصية مع المعلومات المُسندة، (٢) بنود مواصفات مع مشاهد فيديو و رسوم متحركة توضيحية، (٣) الرسومات التنفيذية مع بنود المواصفات ذات الصلة، (٤) قائمة أنشطة التخطيط و قائمة الكميات مع بنود مواصفات المشروع و الكميات المحسوبة من اللوحات التنفيذية.

**Keywords:** Computerized contract documents, Cost inquiries, Drawing-layers, Planning activity list, Specification writing

## 1. Introduction

Although computer utilization is common nowadays for contract documents production, interest is focused on the hardcopy (prints) of these documents. Paper characteristics as a documentary medium impacts the required time and effort for moving between reference

notices in contract documents and the referenced items. This difficulty is significant due to:

1. The fact that "ninety-percent or more of the specification items are usually reference or proprietary types, Myers [1]",
2. Numerous references are applied to coordinate information items of the contract

documents, and

3. high intensity use of cross-references in each contract document.

Likewise, paper inversely affects accessing the relevant contract documents items during planning activity list and cost inquiries preparation. The mentioned difficulties result in wasting time and effort of the reviewers and users during and after contract documents preparation. On the other hand, microcomputer characteristics have been utilized successfully in many applications to prepare hypertext and hypermedia documents. Hypertext or hypermedia consists of nonlinear information items linked together via hyperlinks, which allow users to jump instantly between couples of related information items using a mouse. However, because of its non-linearity, hypertext and hypermedia documents do not give traditional hardcopies -when they are printed. Fortunately, the prevailing computer programs used presently for preparing contract documents have hyperlinks application facilities. The mentioned considerations led the authors to propose hyperlinks application to integrate computerized contract documents in a manner that does not affect the texts linearity.

The mentioned hyperlinks should be applied to the computerized masters of the contract documents in the design office, in which these hyperlinks can be copied to the project contract documents. The term "hyperlink-source" will be used hereinafter to describe the linked item by a hyperlink, which can be activated by a user to jump forward to the other linked item, which will be termed as "hyperlink-destination".

## 2. Contract documents integration

Contract documents writing quality has been chiefly affected by two factors: standardization and computerization. Standardization, which encompasses methods of measurements, conditions of contract construction, and codes and standards (incorporated by reference), has enhanced the technical content quality of the contract documents. The language format of the comprehensive standard writing format of the

Construction Specification Institute (CSI) has maintained specification explicitness and conciseness (Cox [2]). The CSI structure format (16-division master list and section format) has enhanced specification completeness, items accessibility, ease and speed of preparation, and specification integration to project management activities. Equally important, computerization has enhanced ease and speed of contract documents preparation and freedom from spelling, terminology, and grammatical errors.

### 2.1. Cross-references in contract documents

In order to maintain integration and to avoid repetitions of the specification items, the specifier has to intensively use cross-references. The cross-reference in specification can be sorted in accordance to the location of the referenced item to the following three groups. First, the referenced items are located in the technical section. These cross-references are inherent with the traditional organization of specification section, which is divided into general, materials, and execution parts. Second, the referenced items are located in other technical sections. These cross-references are inherent with existence of the relevant technical sections as earthwork and road works sections. Third, the referenced items are located in general requirement sections. These cross-references are inherent with separation of the common administrative procedures and general requirements in individual specification sections. Table 1 highlight intensity of the hyperlinks required for specification cross-references in accordance to the CSI formats. In addition, numerous defined terms and cross-references are usually applied to conditions of contract, bill of quantities, and technical reports.

Because cross-references are intensively applied to the contract documents, every individual involved in contract documents preparation has to move repeatedly between each cross-reference notice and the referenced item. The referenced item may be a whole section or an item thereof (clause, paragraph, subparagraph, or table). The alphanumeric designations in the cross-reference notice should be edited when the referenced item

address is being changed due to insertion or deletion of a similar class item above it. Thus, during computerized contract documents preparation, for each cross-reference, every reviewer has to search for the referenced item, which may be located in another file –as in case of specification sections.

Likewise, every user of the print of the computerized contract documents has to move, via individual tables of contents, between each cross-reference notice and the referenced item. Especially for specification, users moves are tuff task, because every technical and general requirement section has individual page numbering. Hence, hyperlinks application to the specification cross-references is required for enhancing the quality factors.

## 2.2. Specification integration to its references

Numerous references to the other contract documents, codes, standards, and manufacturer's catalogs should be applied to specification for maintaining information integration and preventing repetitions as highlighted below:

- *Condition Of Contract.* One of the objectives of the general requirements sections of the CSI format is to expand on the administrative and procedural requirements those already stated in the conditions of contract. Therefore, in general requirement sections, the specifier has to refer to the relevant clauses of the general and special conditions of contract.
- *Bill Of Quantities.* In some cases, the specifier has to refer to items in the bill of quantities (BOQ) from a technical section as in this example: 'install steel accessories purchased under a prime cost sum listed in bill no. 19'.
- *Technical Reports.* Especially for the required items to be designed by the contractor, the specifier should refer to the relevant information in the geological, hydrological, or geographical reports.
- *Contract Drawings.* A contract drawing reference from a specification text is done to complement the text with information located in the drawing.
- *Codes and Standards.* Refer to standards or codes substitutes writing characteristics of

materials, workmanship criteria, tests procedures, or design requirements by merely reference notices. Moreover, as the referenced code or standard may cover several types or grades of a product relevant to different weather conditions, the applicable items in the referenced code or standard should be specified in the reference notice.

- *Manufacturers' Catalogs.* For proprietary type of specification, the specifier has to refer to the manufacturer catalog for the specification or the installation instructions of the product.

Obviously, every individual involved in the specification preparation has to repeatedly move between every reference notice and the referenced item. For every reference in the computerized specification, the specifier or the reviewer has to search for the file name of the referenced document to open it, and to look for the referenced item thereof. Likewise, every user of the contract documents prints has to move between every reference notice and the referenced item, which are usually located in different bounded volume of the contract documents or in a referenced book. Consequently, hyperlinks application to the specification reference notices and the referenced items results in enhancing the quality factors.

## 2.3. Video and computer graphics integration to specification

Video scenes are more efficient to illustrate standard test method, installation, handling, and inspection procedures. In addition, video scenes can be used to mitigate the disputes those arise due to insufficient training of the owner staff, especially for projects those executed by a new technology. Consequently, video scenes can be used with contract documents as a means of communications in order to improve explicitness of the computerized specification softcopy with maintaining the conciseness using hyperlinks.

The integration can be extended also to include computer graphic scenes. For instance, it is useful to link the clause "Work Covered by Contract Documents" of the CSI

Table 1.  
Hyperlinks application to specification cross-references (in accordance to the CSI format)

	Hyperlink-source	Hyperlink-destination
Referenced items in the TS*	"Design Requirements" and "Performance Requirements" subparagraphs in Part-1***	"Source Quality Control" clause in Part-2*** or "Site Quality Control" clause in Part- 3***
	"Product Data" subparagraphs in Part-1	"Products" clause in Part-2
	"Shop Drawing" subparagraphs in Part-1	"Fabrication" clause in Part-2
	"Samples" subparagraphs in Part-1	"Quality Assurance" clause in Part-1
	"Design data" subparagraphs in Part-1	"Quality Assurance" clause in Part-1
	"Test Results" subparagraphs in Part-1	"Site Tests and Inspection" paragraph in Part-3
	"Manufacturer's Site Report" subparagraphs in Part-1	"Manufacturer's Site Services" paragraph in Part-3
	"Certificates" subparagraphs in Part-1	"Certificate of Compliance" and "Qualifications" paragraphs in Part-1
	"Qualifications" subparagraphs in Part-1	"Manufacturers" clause in Part-2 and "Acceptable Installers" clause in Part-3
	"Environmental Requirements" paragraphs in Part-1	"Construction/ Installation/ Application" clause in Part-3
Referenced TS	Terms in the technical section	"Definitions" clause in Part-1
	"Construction Elements Supplied But Not Installed Under This Section" subparagraphs in Part-1	The items in the other technical section(s), which specify the installation requirements.
	"Construction Elements Installed But Not Supplied Under This Section" subparagraphs in Part-1	The items in the other technical section(s), which the supplied elements.
	"Related Sections" subparagraphs in Part-1	The referenced technical section(s)
Referenced GRS**	"Sequencing" clause paragraphs in Part-1	"Sequencing" clause paragraphs in Part-1
	"Programming" paragraphs in Part-1	The relevant item(s) in the other TS
	"Construction Elements Only Supplied But Not Installed Under This Section" paragraph in Part-1	"Work Under Other Contracts" GRS**
	"Construction Elements Installed But Not Supplied Under This Section" paragraph in Part-1	"Employer Supplied Items" GRS
	"Related Sections" paragraph in Part-1	"Summary of Work" GRS
	"Codes and Standard" paragraph in Part-1	"Reference Standards" GRS
	"Design Requirements" and "Performance Requirements" paragraphs in Part-1	"Identification Systems" GRS
	"Product Data", "Shop Drawing", "Samples", and "Design data" paragraphs in Part-1	"Submissions" GRS
	"Test Results", "Manufacturer's Site Reports and Instructions", and "Certificates" subparagraph in Part-1	"Submissions" and "Quality Control" GRS
	"Submissions at Completion" subparagraph in Part-1	"Submissions" and "Completion tasks" GRS
	"Statutory Design Requirements" paragraph in Part-1	"Statutory Requirements" GRS
	"Certificate of Compliance" paragraph in Part-1	"Submissions" and "Quality Control" GRS
	"Site Samples" and "Mock-ups" paragraphs in Part-1	"Submissions" and "Quality Control" GRS
	"Pre-installation meetings" clause in Part-1	"Coordination" and "Project meetings" GRS
	"Packing", "Transporting", and "Handling and Unloading" paragraphs in Part-1	"Transportation and Handling" GRS
	"Acceptance at Site" paragraph in Part-1	"Employer supplied items" & "Material & Equipment" GRS
	"Storing and Protection" paragraph in Part-1	"Storage and Protection" GRS
	"Existing Conditions" paragraph in Part-1	"Site Information" GRS
	"Sequencing" clause in Part-1	"Summary of the Work" GRS
	"Programming" clause in Part-1	"Submission" and "Progress Schedule" GRS
"Guarantees" clause in Part-1	"Guarantees and Bonds" GRS	
"Extra Materials" paragraph in Part-1	"Completion Requirements" GRS	
"Maintenance Services" paragraph in Part-1	"Maintenance" GRS	
"Manufacturers" paragraph in Part-2	"Product Options and Substitutions" GRS	
"Testes and Inspection" paragraph in Part-2	"Quality Control" GRS	
"Site Testing and Inspection" paragraph in Part-3	"Quality Control" GRS	
"Manufacturer's Site Services" clause in Part-3	"Quality Control" GRS	
"Adjusting" & "Demonstration" clauses in Part-3	"Commissioning" GRS	
"Cleaning" clause in Part-3	"Construction Cleaning" GRS	
"Protection" clause in Part-3	"Construction Facilities & Temporary Control" GRS	

\*TS: Technical section(s)

\*\*\*Part-1, Part-2, and Part-3 are the general, materials/products, and execution parts respectively of the TS

Based on CSI section format presented by Cox<sup>14</sup>

\*\*GRS: General Requirement Section(s)



general requirement section "Summary of Work" to computer graphic scenes those describe briefly the work to be performed under the contract.

#### 2.4. Drawings and specification integration

During contract documents preparation, segregation of items shown in the drawings prints and repetitive moves between specification texts and the related items in the drawings are required to check that:

1. Each material or product named in the drawings is described in the specification.
2. There is no discrepancy and duplications between the drawings and specification.

The prevalent drafting programs, as the AutoCAD [3], have a useful feature called drawing-layers. Drafting using the drawing-layers feature is similar to drafting manually on a set of overlaid transparencies, in which the draftsman can organize and group different kinds of drawing information. The characteristics of this feature have led the authors to suggest its use in addition to hyperlinks for the specification and drawings integration as follows:

1. For items segregation, specify a drawing-layer for each material (or product) shown on the drawings. Each drawing-layer should have the material name in the specification extended with the alphanumeric-designations of the CSI technical section, in which these drawing-layers can be sorted automatically according to the specification sections.
2. Hyperlink every contract drawing to the Part-2 of the related technical section, or to each of its paragraphs. Thus, the relevant specification item(s) can be instantly accessed -by the hyperlink- and edited if there is any need.

At the end of this section, it is important to note that application of hyperlinks and drawing-layers as integration tools for the contract drawings and specification results in enhancing the following quality factors:

1. *Completeness and freedom from errors.* This is derived from computerizing the integration checks, which prevent referring to absent and irrelevant items.
2. *Ease, speed, and proper cost of preparation.* This is gained due to the great

reduction in the time and effort required for integrating the relevant items in contract documents.

3. *Information items accessibility.* This is derived from allowing the contract documents users to instantly access the relevant items in the contract documents.

### 3. Contract documents integration to management activities

Integration of construction planning and cost estimating and control to the contract documents using hyperlinks is considered in the following subsections.

#### 3.1. Construction planning integration to drawings and specification

Hyperlinks application can facilitate the planner task if he prepares in every technical section file a preliminary activity list that contains the activities related to the technical section. The preliminary activity list should be located after the technical section text -in a Microsoft Word [4] file- to permit the planner applying hyperlinks to the relevant specification items. Actually, following a standard format for specification writing extremely aids the planner to prepare the preliminary activity list, because it standardizes the specification items locations. CSI standard format assists the planner to obtain the relevant specification information to numerous activities and timings. Hyperlinks application to the preliminary activity list is required to integrate the following activity groups and timings to the relevant specification texts:

- Management activities such as site measurements, documentary data submissions, tests, site samples, or cleaning require hyperlinks to the specified requirements in specification.
- Procurement activities require hyperlinks to material or product specification, in addition to requirements of transporting, handling, loading, unloading, delivery, and storing.
- Production activities (construction, application, erection, or installation) require hyperlinks to the relevant technical requirements of execution.

- Logical relationships between production activities require hyperlinks to sequencing and programming information those stated in the specification.

- Activity duration contingencies require hyperlinks to environmental and physical limitations stated in the specification.

Hyperlinks application to the specification cross-references and references proposed in this paper can further facilitate and accelerate the planner task.

Moreover, procurement and production activities in the preliminary activity list involve calculating material and product quantities shown in the drawings. Thus, the planner can prepare a spreadsheet for automatically calculating the required quantities. Hyperlinks can be applied to link the mentioned spreadsheet to every contract drawing for information accessibility, in addition to link the preliminary activity list to the calculated quantities in the spreadsheet.

The preliminary activity list can be further integrated –by hyperlinks application– to a scheduling software file prepared for the project schedule. This is required to allow the planner copying the activities listed in the preliminary activity list.

### 3.2. Cost estimating and control integration to construction planning

The estimator has to prepare inquiries for the specific job materials. Inquiries preparation shares the need for the proposed hyperlinks for the procurement activities in the preliminary activity list. Besides, construction progress control requires an effective correspondence between activities used for scheduling and the codes used for cost accumulation, as remarked by El-Dosouky [6]. Thus, construction cost control has to be hyper-linked to the preliminary activity list.

### 3.3. Bill of quantities integration to contract documents

Specification, drawings, and conditions of contract are integral parts of the bill of quantities (BOQ), which merely gives brief description of the work items that have to be

priced by the contractor. Thus, the BOQ writer has to refer to the relevant contract document items. If the CSI format is used for specification writing, he has to refer to the relevant general requirement sections and condition of contract where applicable in the BOQ general section or preamble(s). He has also to refer to the relevant information items in the specification and drawings. Hence, the bill writer has to move repeatedly between the BOQ and each referenced item to check coordination of information and the alphanumeric-designations in the reference notices. Likewise, every BOQ user has to look for the referenced specification, drawing, and/or condition of contract items. Consequently, hyperlinks application to the BOQ references results in enhancing the contract documents integration and information accessibility.

Moreover, the quantity surveyor has also to scan the contract drawings in order to calculate quantities related to every BOQ item. Thus, he can further divide the drawing-layers into ones pertinent to every BOQ item. These are required to facilitate measuring areas and lengths using AutoCAD [3] facilities. The measured items can be copied then pasted in an Excel [7] spreadsheet prepared to calculate the quantities related to BOQ items. Therefore, hyperlinks are required to integrate the BOQ items to the quantities calculated in the spreadsheet cells.

## 4. A case study

The contract documents of the project named Kampala industrial park [8] are adopted to be the case study for the hyperlinks proposed in this paper.

### 4.1. Description of the contract documents

1. The work covered by the contract documents consists of a new industrial area in Kampala (Uganda), which includes factories, buildings, and associated civil engineering works together with the mechanical and electronic engineering works. The contract documents, which are listed in table 2, are produced and executed by Egyptian private firms. The softcopy saved on floppy disks is supplied at

Table 2.  
The used contract documents

Volume I	Volume II	Drawings album
Instruction to tenderizers	Technical specifications	Planning,
Brief description of works	Earthwork / Road Works / Concrete Works	Road,
Form of tender and appendices	Pipelines / Waterproof membrane / Electrical	Water,
Form of agreement	Installation / Telecommunication Network	Sewer,
Form of tender bond		Storm water,
Form of advanced payment bond	Bill of quantities	Electrical,
Drawing list	Definitions and method of measurement	Tele-
Special conditions	Bill of quantities	Communication,
		Mechanical

bidder request. The project specification is produced using a computerized specification master saved in the design office. For more details, consult ref. [9].

#### 4.2. Notes on the studied documents

Detailed study of the contract documents concludes the following findings:

1. Numerous omissions and repetitions of specification items.
  2. Many restrictions and contingencies are located randomly in the specification.
  3. Frequent omissions and undetermined notices of references in the specification. For example: "Unless specified otherwise...", "...as specified", "...as shown in the Drawings or in the Bill of Quantities", and "... except where otherwise specified".
  4. Various video scenes are required to enhance the specification explicitness.
  5. Nemours terminology conflicts in the specification, drawings, and BOQ.
- Lake of specification items for items shown in the drawings.

#### 4.3. Preparations

Because the original specification format (OSF) is not compatible with the CSI format, a version that suits the CSI format is created. Creation of the revised specification format (RSF), is based on the information presented by Cox [2] for CSI division, section, and page formats. The following procedures are accomplished to alter the OSF to the RSF. First, a template file (.dot), which saves the auto-numbering system, margins, tabs, lines

and paragraphs spacing, and fonts, is prepared to maintain the CSI section and page formats. Second, two text files (.doc) based on the mentioned template file are created for outlining specification sections. The file that outlines the technical section is comprised the standard parts and clause headings, and augmented with hidden notes specifying the purpose of each clause. The other file that outlines the general requirement section comprised the standard clause headings of the first part only, while title of the second and third parts are merely followed by the words 'not used'. Third, a copy for every section required for the RSF is created and named in a compatible way to CSI section titles. Fourth, the OSF items are relocated in the RSF by copying them. The performed RSF sections titles are shown in table 3.

Concrete works in the project specification are selected as an instance for applying hyperlinks to illustrative video scenes. These hyperlinks required the following preparations:

1. The videotapes (analogue form) shown in table 4 are transformed to AVI files (digital form) via a video capture-board (hardware device).
2. For reducing sizes of the AVI files, they are transformed to MPG files via the software XingMPEG Encoder [10].

For hyperlinks to the codes and standard, which are referenced in the contract documents, a scanner is used for creating a soft copy of the codes and standard prints. Construction activity list and/or BOQ hyperlinks to materials quantities involve

Table 3  
OSF and RSF specification sections

OSF section title	RSF section title
-	01010 (Summary of work)
-	01092 (Abbreviation and symbols)
Earthwork	02100 (Earthwork)
Road works	02200 (Road works)
Pipelines	02300 (Pipelines)
Concrete works	03100 (Concrete works)
Waterproof membrane	07100 (Waterproof membrane)

Table 4  
The utilized video scene

Video tape No.	Contents	Time (min)	Computer file
Inspection before placement of concrete			
1 (ref. [10])	Pre-construction meeting	8	PREMEET.MPG
	Excavation and foundation (inspection)	2.5	EXCAVAT.MPG
	Forms for concrete (inspection)	5	FORMS.MPG
	Placing reinforcement (inspection)	6	RFTPLACE.MPG
	Embedments (inspection)	2	EMBED.MPG
	Joints (inspection)	2.5	JOINTS.MPG
	Batching and mixing plant (inspection)	7	MIXING.MPG
Inspection during placement of concrete			
2 (ref. [10])	Placing techniques (inspection)	9	CONCPLACE.MPG
	Cold weather concrete (inspection)	3	COLDPLACE.MPG
	Hot weather concrete (inspection)	7	HOTPLACE.MPG
	Consolidation (inspection)	2	CONSOLID.MPG
	Construction joints (inspection)	4	CJOINTS.MPG
3 (ref. [11])	Finishing (inspection)	6	FINISH.MPG
	<i>Testing techniques</i>		
	ASTM C 78 : "flexure strength of concrete"	10	ASTMC78.MPG
4 (ref. [11])	ASTM C 123 : "light weight pieces in aggregate"	8	ASTMC123.MPG
	ASTM C 192 : "making and curing concrete test laboratory"	24	ASTMC192.MPG
Certification of concrete laboratory techniques			
4 (ref. [11])	ASTM C 617 : "capping cylindrical concrete specimen"	10	ASTMC617.MPG
	ASTM C 39 : "compressive strength of cylindrical concrete Specimen"	11	ASTMC39.MPG

preparation of a spreadsheet (Microsoft Excel [7] file) to facilitate calculating quantities shown in the drawings.

The spreadsheet is hyper-linked to each drawing pertinent to road works, which are selected as an example, to facilitate data extraction. In addition, the hidden equations facility of the spreadsheet is utilized, in which future works calculations can be developed by merely replacing data given in the drawings. For more information about quantity surveying spreadsheet see this paper appendix. However, the calculated quantities include:

1. Layers of road-net,

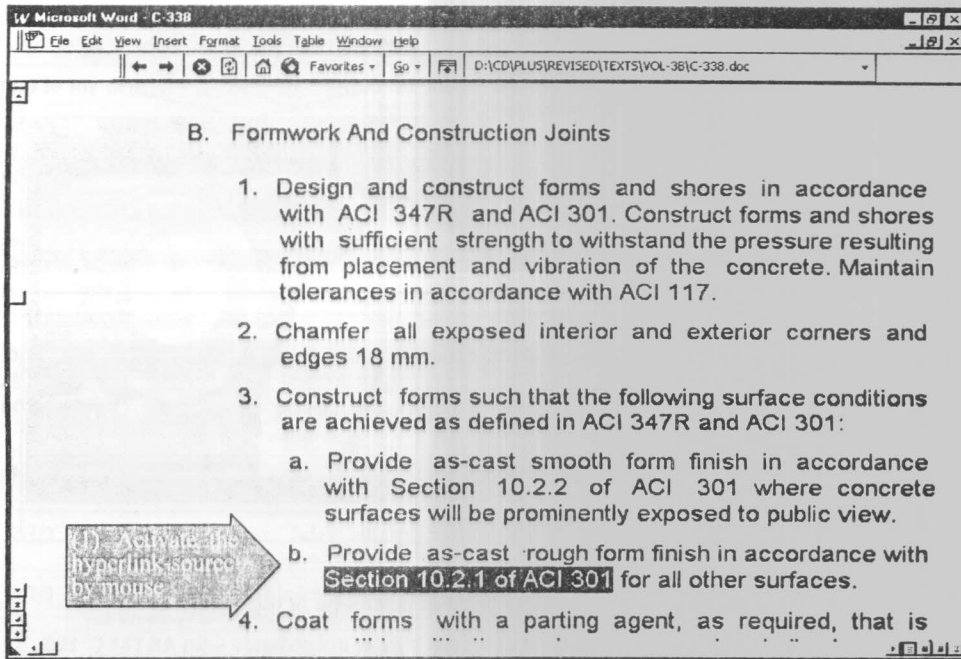
2. Cut and fill for forming subgrade,
3. Pitching in mortar materials
4. Safety, depressed, and barrier kerbs, and
5. Retaining walls materials.

#### 4.4. Hyperlinks application

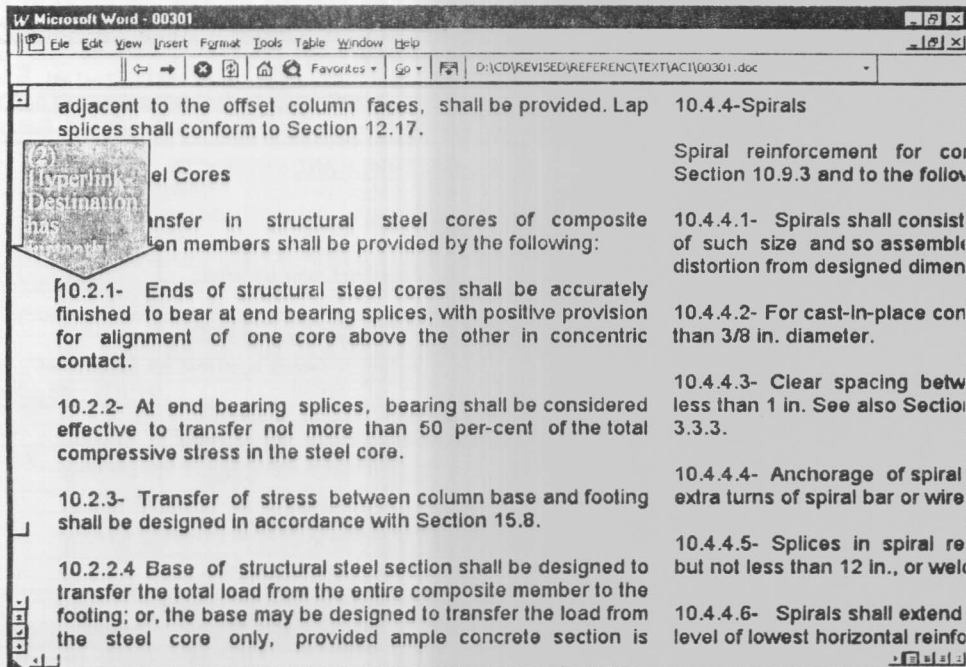
Hyperlinks are applied to the contract documents for integrating:

1. Every cross-reference notices to the referenced item in contract documents,
2. Every code and standard designation to the referenced code or standard (textual form) or items thereof as shown in fig 1,
3. Every term to its definition,





(a)



(b)

Fig. 1. Hyperlink jump to a referenced code or standard (textual form)  
 (a) the hyperlink-source and (b) the hyperlink-destination.

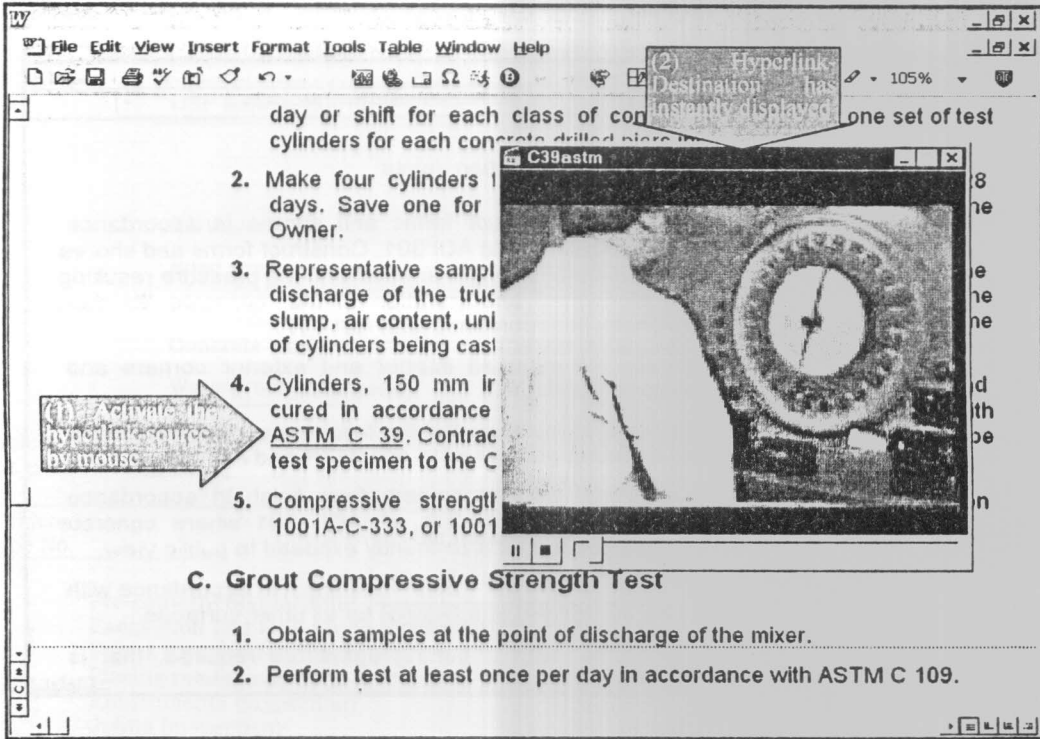


Fig. 2. Hyperlink jump to a video scene (referenced standards test).

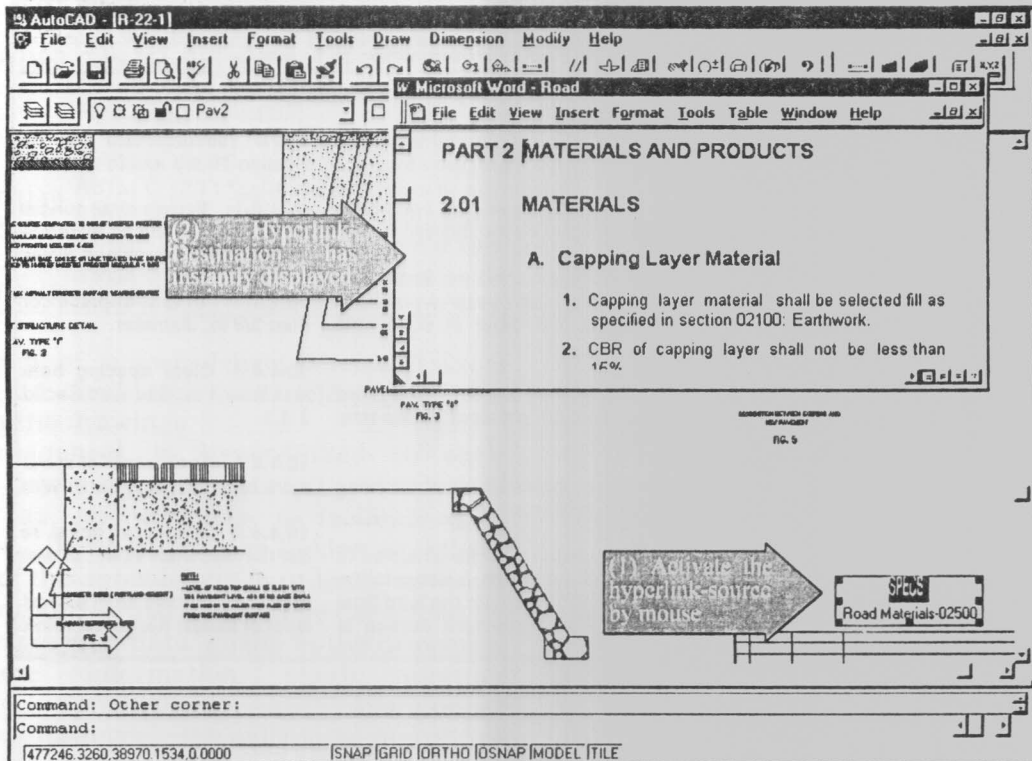


Fig. 3. Hyperlink jump to the relevant specification item from a contract drawing.

Microsoft Word - BOQ

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE
2-1	<b>ROADS-NETWORK</b>			
2-1/1	Excavation and filling to final <u>formation level</u> as per drawings and specification			
	a- <u>Excavation</u> by any means accepted by the Engineer in any type of soil or whatever nature	m <sup>3</sup>	18597.48	
	b- <u>Filling</u> with suitable excavated material in layers including leveling and compacting	m <sup>3</sup>	14796.59	
	c- <u>Remove of surplus</u> and unsuitable excavated materials off site.	m <sup>3</sup>	33800	
2-1/2	Compact 30 cm layer below cut areas or existing ground to form subgrade as per drawings and specification.	m <sup>2</sup>	28160.19	
2-1/3	Compact 15 cm layer below embankments or improved subgrade as per drawings and specification.	m <sup>2</sup>	24168.11	
2-1/4	Provide. approved suitable excavated materials. spread. leveled and			

Callout: (1) Activate the Hyperlink-Source by mouse

(a)

Microsoft Excel - Qsurvey

Road	cut area (measured)	fill area (measured)	length of cut (measured)	length of fill (measured)	mean depth of cut or fill (m)	Volume of Excavation (m3)	Volume of Fill beneath road (m3)	Surface area of excavation (compaction) (m2)	Surface area of fill (compaction) (m2)
136	1	253.548		67.6	0.37507101	263.05785		743.6	
137	2		828.679		0.25540251		932.71157		3569.0
138									
139	L								
140	1	2224.706		106.147	2.0958727	2913.44666		1167.617	
141	2		62.501		0.38485837		108.6571		276.0
142									
143	M								
144	1		96.235		0.46738708		168.0974		350.0
145	2	1268.661		85.7	1.48035123	2344.53009		942.7	
146	3		86.578		0.22517035		149.13208		653.6
147	4	36.089		25.37	0.14225069	61.8646685		279.07	
148	5		62.447		0.3803106		108.53483		279.1
149	6	229.605		62.2	0.36913987	398.804136		684.2	
150									
151	Total								
152		37283.52	11040.73					24168.11	
153									

Callout: (2) Hyperlink-Destination has instantly displayed

(b)

Fig. 4. Hyperlink jump from a BOQ item to the relevant calculated quantity, (a)The hyperlink-source and (b) The hyperlink-destination.

4. Specification items to illustrative video scenes as shown in fig. 2.

In addition, road works in this contract documents are selected as an example for:

1. Coordination of contract drawings and specification by drawing-layers and hyperlinks application as shown in fig. 3,
2. Calculation of materials quantities from the drawings using a spreadsheet, and
3. Preparation of a preliminary activity list for the activities related to the specification. This activity list is augmented by hyperlinks to the relevant specification items and to the calculated quantities from the drawings.
4. Integration of the BOQ items to the relevant specification items and to the calculated quantities from the drawings as shown in fig. 4, using hyperlinks.

## 5. Summary and recommendations

This paper has proposed hyperlinks application to the computerized contract documents in a manner that does not disturb the texts linearity. This is to produce a super softcopy of the contract documents accompanying the hard one. The proposal aims to integrate:

1. Reference notices in contract documents to the referenced items. These hyperlinks prevent referring to absent, irrelevant, and fault references. In addition, they enhance the referenced items accessibility.
2. Terms, units, abbreviations to the definitions in the contract documents. These hyperlinks prevent terminology conflicts and enhance the definitions accessibility.
3. Video scenes to specification items. These hyperlinks enhance specification explicitness.
4. Contract drawings and specification. These hyperlinks, together with drawing-layers utilization, facilitate coordination and accessibility of the information items.
5. Planning activity list to the relevant specification items and the quantities calculated from drawings. These hyperlinks are required during construction planning and cost estimating.
6. BOQ to the relevant specification items and quantities calculated from drawings. These hyperlinks are required during and after contract documents production.

The paper recommends both hyperlinks application to computerized contract documents and production of a standard Arabic format compatible to the CSI one for writing construction specification in Egypt.

## 6. Appendix

### Quantity calculation

The applied technique for quantity calculation can be expressed by the following pseudocode:

1. Prepare a calculation table in a worksheet of an Excel file by specifying cells for input and output data.
2. Formulate appropriate hidden equation for the intended calculation process in the first output cell(s) by selecting the suitable Excel 'Function' and using the input data cell(s) as the hidden equation variable(s).
3. Copy the first output cell(s) to the rest ones.
4. Link the Excel file to the relevant contract document in an AutoCAD drawing file using 'Linking as icon' option of the Windows' 'OLE' facility.
5. If the required data to be extracted from the contract drawing is length, parameter, or area measurement, continue; if its not so, go to step 11.
6. Measure the intended length, parameter, or area measurement using the AutoCAD's facility for automatic measurement.
7. Copy the measurement from AutoCAD's 'text window'.
8. Activate the linked Excel file.
9. Paste the copied measurement in the specified input data cell in the calculation table.
10. Go to step 14.
11. Extract the required data from the contract document.
12. Activate the linked Excel file.
13. Input the extracted data in the specified input data cell in the calculation table.
14. End.

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